

# Cardiac rehabilitation: a good measure to improve quality of life in peri- and postmenopausal women with microvascular angina

Wojciech Szot<sup>1,2</sup>, Joanna Zając<sup>1</sup>, Magdalena Kostkiewicz<sup>2,3</sup>, Jakub Owoc<sup>4</sup>, Iwona Bojar<sup>5</sup>

<sup>1</sup> Hygiene and Dietetics Dept, Jagiellonian University Medical College, Cracow, Poland

<sup>2</sup> Nuclear Medicine Dept, John Paul II Hospital, Cracow, Poland

<sup>3</sup> Cardiovascular Diseases Clinic, Jagiellonian University Medical College, Cracow, Poland

<sup>4</sup> College of Public Health, Zielona Góra, Poland

<sup>5</sup> Department for Health Problems of Ageing, Institute of Rural Health in Lublin, Poland

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## Abstract

Cardiac Syndrome X (CSX) was considered a stable coronary syndrome, yet due to its nature, CSX symptoms often have a great impact on patients' Quality of Life (QoL). According to ESC 2013 stable coronary artery disease criteria, CSX was replaced by Microvascular Angina (MA). Unfortunately, most CSX or MA patients, after classical angina (involving main coronary vessels) has been ruled out, often do not receive proper treatment. Indications for pharmacological treatment of MA patients were introduced only recently. Another problematic issue is that scientists describing the pathophysiology of both CSX and MA stress a lack of a deeper insight into the multifactorial etiology of the source of pain associated with this disease. In the presented article we have attempted to study the influence of cardiac rehabilitation (3 months programme) on the QoL of patients recognized as suffering from MA, as well as to check if changes in myocardial perfusion in these patients at baseline and after completion of cardiac rehabilitation match changes in their QoL. Therefore, after screening 436 women for MA, we studied 55 of them who were confirmed as having MA and who agreed to participate in the study. Exercise tests, Myocardial Perfusion Imaging, and QoL questionnaires were studied at baseline and after completing 3 months period of cardiac rehabilitation. Results were subsequently compared, which showed a link between improved perfusion score in SPECT study and improved overall physical capacity, on one hand, and improved QoL score on the other. These results confirm that cardiac rehabilitation is a very useful treatment option for MA patients. It seems that training during cardiac rehabilitation is a very important factor (improved physical efficiency → increase in self-belief), and that taking into consideration the multifactor pathophysiology of pain, it is connected with a better quality of life for MA patients.

## Key words

cardiac syndrome X, microvascular angina, quality of life, single photon emission computed, tomography, cardiac rehabilitation

## INTRODUCTION

Cardiac syndrome X (CSX) or Microvascular Angina (MA) as it is known nowadays, is currently considered a stable coronary syndrome [1]. The term 'cardiac syndrome X' was first introduced in 1973 by Kemp [2], who studied patients with functional disturbances in cardiac function and normal main coronary vessels as seen via arteriography. In 1988, CSX was linked to flow disturbances in heart microvasculature [3]. According to ESC 2013 stable coronary artery disease criteria, CSX was replaced by Microvascular Angina (MA) [1]. Patients who were diagnosed with CSX constitute 10–20% of all patients with coronary artery disease symptoms; almost 70% of these are menopausal or post-menopausal women [4]. In more than 50% of patients with cardiac syndrome X, there is a characteristic persistence of chest pain more than 10–20 minutes after the end of exercise, and poor or no response to short-acting nitrates. Another problematic issue is that most MA patients, after classical angina (involving main coronary vessels) has been ruled out, are not or only partly covered by reasonable treatment in the majority of cases. Indications for pharmacological treatment of CSX

patients were introduced only recently [1]. The therapies used most frequently in MA are typical stable-angina agents [1, 5], with additional indications regarding modification of lifestyle, dietary habits and increased levels of physical activity. Disturbances in microperfusion of heart muscle, characteristic for CSX, and the reason why ESC experts decided to change name and definition to Microvascular Angina, are best viewed via positron emission tomography (PET); this method is considered a 'gold standard' in the evaluation of the perfusion of CSX and MA patients [6]. Nevertheless, using Single Photon Emission Computed Tomography (SPECT) perfusion scintigraphy methods, we can also try to evaluate heart perfusion deficiencies in patients whose coronary vessels have already been evaluated and found to be normal via coronary arteriography. Treatment of MA is a challenge for cardiologists. The main problems include poorly understood background of the disease and the heterogeneity of the patient base, arising from the complexity of the symptoms and the underlying circumstances. Most MA patients suffer from recurrent chest pains of various degrees of intensity, often accompanied by anxiety and dyspnea, which significantly lower their quality of life. The aim of this study was to determine the effect of non-pharmacological procedures (cardiac rehabilitation) in patients diagnosed with microvascular angina on changes in left ventricular perfusion, as assessed by myocardial SPECT (Single Photon

Address for correspondence: Wojciech Szot, Hygiene and Dietetics Dept, Jagiellonian University Medical College, ul. Kopernika 7, 31-034 Cracow, Poland  
E-mail: mcszot@cyf-kr.edu.pl

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Emission Computed Tomography) together with potentially-related quality-of-life improvements.

## MATERIAL AND METHODS

### Screening

In the period May 2008-ecember 2012, screening for the presence of MA was performed on a group of 436 women who were patients in the Cardiology Clinic of the John Paul II Specialist Hospital and the Department of Cardiac and Vascular Diseases, Jagiellonian University Medical College in Cracow.

All women participating in the study underwent scintigraphy, which confirmed the presence of the following perfusion disorders:

**Subgroup A** – persistent, transmural defects, tracer accumulation at grade 4 or 3 according to the Visual Score scale in 58 (11.36%) patients (the applied Visual Score scale is discussed later in the methodology). The presence of such severe changes confirms the presence of previous ischaemic events (e.g. myocardial infarction), thus excluding the presence of MA.

**Subgroup B** – exercise-induced perfusion defects, tracer uptake grade 3 or 2 according to the Visual Score scale in 133 (26.03%) patients, indicating a high probability of changes in the large coronary arteries. In this group of patients, MA was excluded through coronary angiography.

**Subgroup C** – permanent non-transmural defects, tracer accumulation at grade 2 or 1 according to the Visual Score scale in 169 (33.07%) patients. Within this group of patients, in 82 individuals angiography neither confirmed the presence of vascular changes nor recognised MA.

**Subgroup D** – exercise-induced defects, tracer accumulation at grade 2 or 1 according to the Visual Score scale in 76 (14.87%) patients. In this group, verification was performed using coronary angiography (66 patients) or angio-CT (10 patients), unequivocally showing the absence of significant coronary changes. This indicated a high degree of probability of the diagnosis of MA.

Patients were then referred to adenosine stress echocardiography (which was performed according to standardized method with adenosine infusion at a maximum dose of 140 µg/kg/min over 6 min). Imaging was performed prior to and after starting adenosine infusion) according to ESC criteria to diagnose MA [1].

For the remaining women (75 subjects), the SPECT study yielded a normal perfusion scan.

From Groups C and D, a total of 55 patients (13 from C, 42 from D) agreed to further participation in the study and cardiac rehabilitation (Tab. 1).

### Scoring assessments of well-being and quality of life

For the purposes of this study, a shortened version of the Ferrans & Powers Quality of Life Index – Cardiac Version IV [7] questionnaire was used. The questionnaire includes an assessment of responses to 35 questions on various aspects of quality of life and the potential impact of the current disease, the severity of its symptoms, and the degree to which they constitute a nuisance in everyday life. It was decided to apply this test because its credibility in patients with cardiac disease undergoing cardiac rehabilitation has been highly rated

**Table 1.** Design of the study

Phase I: preliminary study	Assessment of quality of life with subjective assessment of well-being Assessment of basic anthropometric parameters and evaluation of physical activity and exercise capacity during treadmill stress test Assessment of myocardial perfusion at rest and during stress using SPECT myocardial perfusion imaging tests (SPECT MPI)
Phase II – three-month cardiac rehabilitation with interval training	
Phase III – study after rehabilitation	Assessment of quality of life with subjective assessment of well-being Assessment of basic anthropometric parameters and evaluation of physical activity and exercise capacity during treadmill stress test Assessment of myocardial perfusion at rest and during stress using SPECT MPI
Phase IV	Comparison of the results obtained in studies at baseline and after cardiac rehabilitation Evaluation of non-pharmacologic treatment

(coefficient alpha = 0.92) [8]. Patients assessed their current state of well-being using a 6-point response scale (1 – very dissatisfied, 2 – dissatisfied, 3 – moderately dissatisfied, 4 – rather satisfied, 5 – satisfied, 6 – very satisfied). The assessment was dependent on the total number of points awarded in the questionnaire, as well as, separately, on the sum of the points referring directly to questions evaluating the severity of the symptoms associated with heart disease. The survey was performed twice: prior to and subsequent to cardiac rehabilitation, immediately before commencing post-exercise myocardial perfusion scintigraphy. Taken into account both before and after cardiac rehabilitation were the total number of points scored on the test, and the number of points scored in the responses to questions about symptoms related to heart disease.

### Basic anthropometric survey and assessment of nutritional status:

a) body weight measurement (rounded to the nearest 100g);  
b) body height measurement (accurate within 1 cm, in accordance with the principles of anthropometric testing);

On the basis of the measurements, BMI values (Body Mass Index, BMI = (body weight [kg] / body height [m]<sup>2</sup>) were calculated according to WHO criteria.

### Stress test on a treadmill

Tests were performed on a treadmill according to the modified Bruce protocol. The test consists of brisk walking in consecutive 2–3-minute stages, with each succeeding stage performed using an increased angle of inclination and difficulty expressed in units of MET (Metabolic Equivalent of Task). While increasing the difficulty, the physical exercise was adapted to the current EANM/ESC guidelines for conducting and evaluating the test [9].

### Myocardial perfusion scintigraphy – study protocol:

Myocardial scintigraphy was performed using a two-day protocol [10]. On the first day, a stress study was performed, which included exercise on a treadmill. For all patients, a radioisotope tracer was administered at peak stress, and exercising was continued for 1–2 minutes in order to obtain the best distribution of the perfusion imaging tracer during the exercise. On the second day, rest studies were performed.

In both the stress and resting tests, data acquisition was carried out in the 40–60 minutes following tracer injection using a dual-head gamma camera, E.Cam (Siemens Medical

Systems, Inc.), with a matrix of 64×64. Radionuclide scintigraphy was performed using the gated method (GSPECT) with a preparation of technetium-99 combined with MIBI tracer administered intravenously with an activity range of 18–25 mCi (700–925 MBq). Data acquisition was set at 25 seconds for each of the 32 projections in a single cardiac cycle. The heads moved in a rotary fashion around the patient, from a 45° right anterior oblique (RAO45) position for head No. 1, to a 45° right posterior oblique (RPO45) position for head No. 2. Corridor 4DM reconstruction software (Siemens) was used to process the acquired raw data, enabling images of the 3 sections of the left ventricle to be obtained, i.e. along the horizontal long axis (HLA), vertical long axis (VLA) and short axis (SA). Cross-section cardiac images, divided into 17 segments, were evaluated using the semi-quantitative method. This division of the left ventricle to 17 segments was used for perfusion assessment in each segment, together with a summary analysis of perfusion in segments corresponding to the areas of main coronary vasculature, i.e. the left anterior artery (LAD – segments 1,2,7,8,13,14,17), circumflex artery (LCX – segments 5,6,11,12,16) and right coronary artery (RCA – segments 3,4,9,10,15).

For the purposes of this study, the extent of the tracer uptake in the individual segments was assessed on the Visual Score 5-point scale, where the degree of tracer accumulation corresponded to the following points:

- 0 – standard image of the heart muscle (normal perfusion);
- 1 – slight impairment of tracer accumulation or non-uniformly marked heart muscle (50–70% preserved perfusion) (equivocal);
- 2 – significantly reduced nonuniform collection of 99m Tc-MIBI (30–50% preserved perfusion) (mild perfusion change);
- 3 – heart area only ‘marked’ (10–30% preserved perfusion) (severe perfusion deficit);
- 4 – ‘cold’ scintigraphy image – complete absence of accumulation of Tc-99m-MIBI (0–10% preserved perfusion) (no tracer uptake).

### Cardiac rehabilitation

Activities in the field of rehabilitation were conducted at the Beluga-Med private healthcare centre, 3 times a week for 3 months. Prior to beginning the cycle, the maximum allowable difficulty level was calculated for each individual patient, based on age, using the results of the final stress test performed during scintigraphy.

Activities were performed for 90 minutes in groups of 6, and consisted of:

- warm-up – 30 minutes, including breathing and general coordination exercises;
- training – using a bicycle ergometer with gradually increasing difficulty, selected individually – 30 minutes. Training was conducted on Aspel equipment. During this phase, heart rate, ECG, and blood pressure were continuously monitored. The entire 3-month training cycle was divided into 3 parts, each lasting approximately 4 weeks, in which continually increasing maximum loads were attempted: in the first stage 70 W, the second 100 W, the third 120 W. If at any point in this part of the training the heart rate limit (80% RH) was exceeded, the ergometer load was reduced accordingly.
- 30 minutes of relaxation exercises.

The 3-month rehabilitation programme was divided into 2 phases lasting 1.5 months each. Trained in successive phases, the group was subjected to increasing difficulty, both during the warm-up (by gradually increasing the number of repetitions and the degree of difficulty of the exercise) and during exercise using a bicycle ergometer.

### Statistical analysis:

The statistical analysis of the data obtained in our study was performed using the STATISTICA 10.0™ Software.

## RESULTS

We studied 55 patients, aged 49–69 years. The mean age was  $57.25 \pm 5.43$  years. Heights of patients ranged from 1.54–1.71 m (mean  $1.63 \pm 0.05$ ). The mean BMI was  $27.53 \pm 2.87$  and values ranged from 21.94–34.6.

At the time of inclusion in the study, the women were asked for a current subjective assessment of their well-being on a 6-point scale, where 1 – poor, 6 – very good. The patients cited intermediate values (2–5); the mean score in the study group was  $3.2 \pm 0.65$  points (median: 3 points).

Following completion of the cardiac rehabilitation course, the average subjective assessment value was  $3.78 \pm 0.71$  points (median: 4 points). Comparison of the cited subjective self-assessment values at baseline and after cardiac rehabilitation resulted in a significant increase in the studied group ( $p < 0.05$ ).

Evaluating the results of the Ferrans & Powers Quality of Life Index – Cardiac Version IV questionnaire, the average number of points scored by the group of patients was  $154.18 \pm 11.65$  (median: 156 points), while for questions directly reflecting the quality of life associated with cardiac symptoms, the average number of points was  $35.42 \pm 3.61$  (median: 36 points). Following completion of cardiac rehabilitation, the average number of points scored by the group of patients was  $158.45 \pm 8.47$  (median: 159 points), while for questions directly reflecting the quality of life associated with cardiac symptoms, the average number of points was  $36.64 \pm 2.84$  (median: 37 points). Comparing the results obtained from the test before the start of rehabilitation with the results obtained afterwards, there was an increase in both the total number of points and the number of points obtained from the answers to the questions directly reflecting the quality of life related to cardiac symptoms ( $p < 0.05$ ).

In all studied patients, the treadmill stress test according to the modified Bruce protocol was conducted at baseline, before the start of cardiac rehabilitation.

In regard to blood pressure control, in the studied group prior to the stress test, 49 patients (89.09%) were within the normal range; for the remaining 6 patients (10.81%), systolic blood pressure was within the range 145–160 mmHg. In terms of diastolic blood pressure prior to the stress test, 51 patients (92.73%) were within the normal range; the remaining 4 (7.27%) were in the range 91–100 mmHg.

The average length of stress tests on the treadmill according to the modified Bruce protocol was 635.87 seconds, with an average difficulty of 6.52 MET. The obtained result values were within normal limits.

The study group showed a statistically significant mean decrease in body weight and BMI after cardiac rehabilitation completion. Individual analysis showed a decrease in BMI





in 39 patients (70.91%) and a small, insignificant increase in BMI in 16 patients (29.09%).

While comparing the parameters obtained in the exercise test, a mean decrease from baseline in blood pressure, both systolic and diastolic, was noted.

The great majority of cases (53 patients, or 96.36%) showed improvement in stress test times. A stress test with shorter duration, but the same MET value (Metabolic Equivalent of Task), was noted in only 2 (3.64%) patients. An increase in MET value was observed in 52 patients (94.55%), while for 1 patient the same MET values were noted, with the test slightly prolonged (35 seconds).

The results of studies performed at baseline and after completion of the cardiac rehabilitation period are summarised in Table 2.

**Table 2.** Comparison of body weight, BMI and parameters obtained during exercise treadmill study at baseline and after completion of cardiac rehabilitation course

	Baseline	After rehabilitation	p*
	Mean±SD		
Weight [kg]	72.8±8.2	71.23±6.81	<0.001
BMI [kg/m <sup>2</sup> ]	27.53±2.87	27.0±2.52	<0.001
Base SBP [mmHg]	134.91±11.03	128.55±8.64	<0.001
Base DBP [mmHg]	81.55±8.38	77.82±7.86	<0.001
Base HR	83.15±10.81	78.07±7.39	<0.001
TET [sec]	635.87±157.07	760.02±142.49	<0.001
METS	6.52±2.09	8.13±2.06	<0.001
Max SBP [mmHg]	160±16.64	158.45±11.5	NS
Max DBP [mmHg]	81.6±14.62	81.36±10.82	NS
Max HR	134±13.86	136.13±11.16	NS
% of predicted HR	82.4±8.74	83.73±7.32	NS

\*p for Wilcoxon signed-rank test

Base SBP – systolic blood pressure value at baseline

Base DBP – diastolic blood pressure value at baseline

Base HR – heart rate value at baseline

TET – duration of exercise test (seconds)

METS – maximal amount of METS during exercise

Max SBP – systolic blood pressure value at peak exercise

Max DBP – diastolic blood pressure value at peak exercise

Max HR – maximal heart rate value at peak exercise

% of predicted HR – percentage of maximal predicted heart rate for given age

Comparing the results obtained before the start of the rehabilitation programme with those obtained after its completion, a significant increase in perfusion was noted in the post-exercise test in the majority of subjects, both for segments corresponding to the areas of individual coronary vasculature and those corresponding to overall perfusion. For the resting test, slightly worse values for perfusion were obtained, both for segments corresponding to the areas of individual coronary vasculature and for those corresponding to overall perfusion. In the case of post-exercise tests, the differences were statistically significant; in the case of resting tests, the differences were not statistically significant. In analyzing the differences in perfusion of individual segments between the resting and post-exercise tests carried out before the start of cardiac rehabilitation and at the end, a reduction was noted in the differences in perfusion in the segments corresponding to the vasculature of all 3 major coronary arteries. The clearest difference was found in the right coronary artery vasculature and, to a lesser extent, in the left anterior artery vasculature. The least difference was found in the circumflex artery vasculature. The overall difference in perfusion of the left ventricle also decreased.

Changes in perfusion differences between studies at baseline and after completion of cardiac rehabilitation, for the most part were statistically significant (Tab. 3).

**Table 3.** Comparison of results of scintigraphic assessment of left ventricular perfusion at baseline and after completion of cardiac rehabilitation

	Baseline	After rehabilitation	p*
	Mean±SD		
SSS LAD	2.82±2.97	1.67±2.19	<0.01
SSS Cx	0.54±1.02	0.47±0.92	NS
SSS RCA	3.49±2.96	2.27±2.17	<0.01
SSS sum	6.95±3.16	4.51±2.58	<0.01
SRS LAD	1.53±2.0	1.67±2.19	0,241
SRS Cx	0.2±0.52	0.31±0.60	0,260
SRS RCA	2.2±2.15	2.36±2.40	0,375
SRS sum	3.93±2.71	4.35±3.13	0,102
SDS LAD	1.4±1.49	0.47±1.05	<0.01
SDS Cx	0.36±0.75	0.16±0.50	<0.01
SDS RCA	1.33±1.36	0.25±0.58	<0.01
SDS sum	3.09±1.58	0.89±1.26	<0.01

\*p for Wilcoxon signed-rank test

SSS LAD – total stress score in left anterior descending artery region

SSS CX – total stress score in circumflex coronary artery region

SSS RCA – total stress score in right coronary artery region

SSS sum – total summed stress score for left ventricle perfusion

SRS LAD – total rest score in left anterior descending artery region

SRS Cx – total rest score in circumflex coronary artery region

SRS RCA – total rest score in right coronary artery region

SRS sum – total summed rest score for left ventricle perfusion

SDS LAD – total difference score between stress and rest value in left anterior descending artery region

SDS Cx – total difference score between stress and rest value in circumflex coronary artery region

SDS RCA – total difference score between stress and rest value in right coronary artery region

SDS sum – total difference score between stress and rest value for left ventricle perfusion

Analysis of the relationship between changes in the perfusion of the left ventricular myocardium between baseline research and research after completing cardiac rehabilitation showed no significant correlation between the change in SDS-sum parameters and the difference in the sum of points scored in the Ferrans & Powers Quality of Life Index – Cardiac Version IV survey. Nevertheless, comparison of the change in SDS parameters with the difference of the total points from the Ferrans & Powers survey from questions directly reflecting the quality of life associated with symptoms of MA revealed the presence of a weak but statistically significant correlation (coefficient  $r = -0.28$ ,  $p < 0.05$ ).

## DISCUSSION

Quality of Life (QoL) is an indicator describing life over a wide range of contexts simultaneously. Assessment of quality of life can be useful as an indicator of the effectiveness of diagnostic and therapeutic procedures. For diagnosis and therapy, so-called health-related quality of life (HRQoL) is especially important. In practice, up-to-date HRQoL assessment is performed by patients using appropriate questionnaires, and is considered the best method for obtaining reliable data.

Intensification of effects and differences in pain perception characterize illnesses of different backgrounds. The basis of both cardiac syndrome X or microvascular angina nowadays is still not entirely clear. Given the inability to perform a

precise diagnosis and the insufficiency of medical imaging, there are no methods for anatomical reflection of the disabled area. (1,4,7) Moreover, the lack of reliable assessment of changes in the microcirculation of the occupied myocardium area during invasive and non-invasive examination, in combination with decreased retractility in the examined area and the difficulty in capture and quantifying measurement of ischaemic and necrosis markers, are still problems. It must be stated that risk factors for MA and those for other forms of ischaemic heart disease are identical. They include unmodified factors (e.g. genetic factors, age or gender), modified factors (e.g. lifestyle, diet, physical activity), and the presence of other disorders (e.g. hypertension or diabetes).

During rest, patients with MA usually reveal normal or slightly lower blood flow in peripheral vessels. This situation changes during physical activity, when the increase of blood flow in vessels is about 20% lower compared to healthy individuals. There is evidence that regular physical training, for example, aerobic physical activity, can improve endothelial function, lower the resistance of peripheral vessels and, finally, improve perfusion and blood flow in skeletal muscles [4, 11]. In stable angina, the modification of risk factors through non-invasive methods leads to clinical improvement and at least partial remission of symptoms, but in the case of patients with MA the impact of non-invasive treatment remains an open question. In the presented study among patients who underwent physical training, an improvement in general physical efficiency, together with an improvement in perfusion of the left ventricle were noted. Moreover, general clinical improvement was observed. Our data are in agreement with many other studies in which physical activity was proved to be an effective tool in the treatment of all kinds of coronary artery disease, especially in post myocardial infarction patients, as well as chronic heart failure, by reducing overweight and obesity, influencing feelings and improving assessment of life satisfaction among patients [12, 13, 14, 15].

It has been commonly believed that apart from a lower quality of life, there is no basis for a poor prognosis for patients with MA. Although quality of life is important, the prognosis is even more so. However, data published in recent years in the WISE (Women's Ischaemia Syndrome Evaluation) study [16, 17] revealed that even 50% of women with the above-mentioned symptoms may have MA associated with a poorer prognosis. In small vessel heart disease with a complex etiology, many women undergo sclerotic changes (as confirmed during intravascular ultrasound examination) associated with a serious risk of cardiac incident at the rate of about 2.5% per year, including myocardial infarction, cerebrovascular accident, symptoms of heart failure or cardiac death [18]. Both the frequency and intensity of these symptoms influence the patients' quality of life. It is important to offer them the best possible treatment, but American [19] guidelines do not refer directly to MA therapy; only the latest update, published a few months ago, refers to this disorder [1]. According to the above-mentioned guidelines, treatment should focus on 2 directions: inhibition of the progress of sclerotic changes, which will prevent ischaemia; and reduction of the incidence of symptomatic angina pectoris, which will improve the quality of life. These aims can be achieved using pharmacological treatment and modification of lifestyle. Non-pharmacological intervention is similar to that applied in other forms of ischaemic heart disease,

mainly diet modification and increased physical activity. In the current study, a positive response for modification of lifestyle was noted and confirmed during cardiac stress tests, resulting in increased tolerance for physical activity, increased duration of the tests and improvement in blood pressure readings during physical activity. These effects were connected with improvement in the perfusion parameters of the left ventricle, after changes both in the level of physical activity and stable subendocardial changes; moreover, they were linked to improvement in the quality of life in the examined group. These results support the claim that non-pharmacological treatment has a positive impact on the microcirculation disorders described as MA.

Researchers describing the pathophysiology of CSX and MA stress a lack of a deeper insight into the multifactorial etiology of the source of pain. As described, in CSX and MA, pain signals are sent to the brain – not to a single receiving centre but to different connected centres [20]. Moreover, the feeling of pain and the perception of its intensity are most probably modulated in the neural networks using mechanisms which are not fully understood. Patients' perception of pain in the presence of similar morphological changes in microcirculation may be very severe or completely absent. Additionally, pain perception may be modified by psychological factors, for example, the patient's fears or tendency toward depression, which are typical for MA and atypical for other similar heart disorders [21, 22]. Another important difficulty, in the case of some patients with CSX or MA, is the lack of a straightforward connection between chest pain and changes in the ST-T part of EKG readings. In the presented study, for some patients (12 women, 21.8%), during the initial cardiac stress test a cardiac-type chest pain was noted without any changes in the EKG reading. Other patients (7 women; 12.7%) had changes in their ECG readings, but felt no chest pain. Both situations have been similarly described by other authors: Camici [23], Eriksson [24] and Valeriani [22]. In their conclusions, these authors stressed the high probability of changes in perception of chest pain connected with dysregulation in both the central and peripheral nervous systems, probably caused by sympathetic activity. This means that pain pathophysiology in CSX or MA nowadays has a different basis, inconsistent with that observed in other forms of ischaemic heart disease. In the current study, a trend (weak correlation) was found between heart perfusion improvement and better quality-of-life assessment, caused mainly by a decrease in the frequency and intensity of cardiac-type chest pain.

Persistent pain is the reason for common cardiac hospitalisations and subsequent haemodynamic examinations that often confirm the absence of serious sclerotic changes in coronary arteries. Even though doctors assure patients that the disorder is not serious, many patients still seek help and are convinced that they have severe heart disease. Such thoughts and feelings are typical for somatoform disorders. Another point of view is presented by Bugiardini et al. [25] who consider their results strong proof that endothelial dysfunction is a predictor of future sclerosis in initially normal coronary vessels. Over 10 years of observation, they noted that in 1/3 of a group of women with CSX, sclerosis of the coronary vessels of varying severity developed; one woman died of myocardial infarction. The authors point out a lack of normal reaction of endothelium to acetylcholine (diastole of vessels) as an indicator of dysfunction.



To sum up, the results obtained in this study indicate that there is a connection between improved blood flow in the left ventricle and improved quality of life among the examined women.

One of the most important still-unsolved questions involves regular physical training during cardiac rehabilitation as a useful treatment to prevent and reverse structural, morphological and functional changes in the myocardium.

## CONCLUSIONS

1. Cardiac rehabilitation of women with microvascular angina leads to measurable effects connected with an improved feeling of well-being, improvement in general physical efficiency, reduction of pain and better quality of life. It seems that training during cardiac rehabilitation is a very important factor (improved physical efficiency & increase in self-belief), and that taking into consideration the multifaceted pathophysiology of pain, it is connected with a better quality of life for MA patients.
2. Cardiac rehabilitation of women with MA improved perfusion of the left ventricle in radioisotope examination. This, together with noted clinical improvement in the examined group, is an important reason for a better prognosis. As is known from epidemiological studies used to construct standardised guidelines in ischaemic heart disease (ESC), the risks of acute coronary syndrome and sudden cardiac death are lower for patients with improved myocardial perfusion and clinical improvement.
3. Positive modification of lifestyle, along with increased physical activity, leads to an improved clinical state in patients with microvascular angina.

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