CONTINUING MEDICAL EDUCATION

The Impact of Complex Cardiac Rehabilitation on Manifestation of Risk Factors in Patients With Coronary Heart Disease

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Key words: *coronary heart disease; cardiac rehabilitation; dietary changes.*

Summary. *Background. Each year more than 4.3 million people in Europe will die of cardiovascular disease. Therefore, the implementation of simple interventions such as smoking cessation, weight loss, improved diets, and increased exercise is the top priority in prevention and rehabilitation programs. The aim of this study was to evaluate the impact of complex rehabilitation on the manifestation of risk factors and cardiac events in patients with coronary heart disease.*

Material and Methods. A total of 140 patients with coronary heart disease and NYHA functional class II–IV ischemic heart failure were recruited to the study. The patients were divided into 2 groups: 70 patients who underwent a 6-month complex rehabilitation course (rehabilitation group) and 70 patients who received drug treatment only (control group). Smoking, dietary, and physical activity habits were documented using the questionnaires. Blood pressure (BP), body weight and height, and total serum cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, triglyceride (Tg), and blood glucose levels were measured. Measurements were repeated after 3 and 6 months.

Results. After 6 months, significantly reduced systolic BP was observed in both the groups as compared with the baseline values (P<0.05). A significant decrease in the diastolic BP; total cholesterol, LDL-cholesterol, triglyceride and blood glucose levels; body mass index, and percentage of patients with the metabolic syndrome as compared with the baseline data was documented only in the rehabilitation group (P<0.05). All the patients quitted smoking as well as all the patients in the rehabilitation group changed their dietary habits (P<0.05). Fewer patients were excluded from the rehabilitation group because of cardiac events as compared with the control group (7.1% vs. 11.4%, P<0.05).

Conclusions. Complex long-term rehabilitation of cardiovascular patients significantly reduced the manifestation of major cardiovascular risk factors and the rate of cardiac events. Aerobic exercise must be the most important part of training but well-done resistance training must also be encouraged.

Introduction

The EUROASPIRE III (European Action on Secondary and Primary Prevention by Intervention to Reduce Events III) study was carried out in 2007. Its results, published in 2009, have shown that the risk factor manifestation and lifestyle correction in 22 European countries is insufficient. The comparison of the EUROASPIRE I, II, and III studies has revealed that preventive cardiovascular risk measures are too short and deficient in coherency (1, 3). The percentage of young smoking women increased from 30% to 50%, and the percentage of obese patients increased from 25% in the EUROASPIRE I to 32.6%

and 38% in the EUROASPIRE II and III, respectively. The frequency of self-reported diabetes mellitus increased from 17.4% to 20.1% and 28.0%, respectively. Patients usually prefer drug treatment instead of lifestyle changes, and therefore, the use of all cardioprotective drugs (aspirin and antiaggregants, beta-blockers, ACI inhibitors and statins) has been constantly increasing. The proportion of patients with raised blood pressure was similar (58.1% in EUROASPIRE I, 58.3% in II, and 60.9% in III), whereas the proportion of patients with elevated total cholesterol level ($\geqslant$4.5 mmol/L) decreased from 94.5% to 76.7% and 46.2% (1–3).

In 2007, the CINDI (the Countrywide Integrated Noncommunicable Diseases Intervention) program was carried out in 5 randomly selected Lithuanian regions. It has shown a high prevalence of arte-

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rial hypertension among men (60.3%) and women (44.6%). Half (50%) of the population was found to have hypercholesterolemia; the metabolic syndrome was diagnosed in 15.1% of men and in 21.5% of women. There were 47.5% of male and 18.1% of female smokers. Leisure physical activity of the population was insufficient (4, 5). The prevalence of cardiovascular risk factors in the Kaunas city population was similarly high (6).

The recommendations of the European Society of Cardiology (ESC), American Heart Association (AHA), and the American National Cholesterol Education Program indicate strict directions regarding the aims and priorities of rehabilitation and secondary prevention (7–12). However, the implementation of recommendations concerning lifestyle changes in practice is rather complicated. Insufficient complexity and duration of the programs limit their application in daily practice. The study of the European Society of Cardiology trial EUROACTION (nurse-coordinated multidisciplinary, family-based cardiovascular disease prevention program) has shown that rehabilitation and secondary prevention programs are more effective if they are complex, long-term, and family-based (13).

The aim of this study was to evaluate the impact of complex rehabilitation on the manifestation of risk factors and cardiac events in patients with coronary heart disease.

Material and Methods
Study Population
A total of 140 patients with angiographically confirmed coronary heart disease and NYHA functional class II–IV ischemic heart failure, aged 57.5 years (SD, 10.7), were recruited to the study if the following criteria were met: presence of stable angina pectoris (class I or II) and stable chronic heart failure (NYHA functional class II–IV). The exclusion criteria were as follows: any systemic disease limiting exercise performance, cardiac valvular disease requiring surgery, idiopathic dilated or hypertrophic cardiomyopathy, uncontrolled hypertensive heart disease, peripheral vascular disease, sustained ventricular arrhythmias, primary pulmonary disease, and refusal to take part in the 6-month counseling and rehabilitation program.

New episodes of cardiac failure, unstable angina pectoris, myocardial infarction or need for coronary revascularization were considered clinical endpoints.

Consecutive randomly selected patients were divided into 2 groups: 70 patients who underwent a 6-month complex rehabilitation course (rehabilitation group) and 70 patients who received drug treatment only without any rehabilitation program (control group). The mean age of the patients in the control and rehabilitation groups was 58.5 (SD, 7.2) and 57.7 (SD, 10.7), respectively. The use of cardioprotective medications was similar in both groups (P>0.05).

There were no significant differences between the groups regarding age, sex, body mass index, smoking, heart failure functional class, blood pressure, and physical activity (Table 1).

Five patients (7.1%) were excluded from the rehabilitation group: 3 patients (4.3%) because of unstable angina pectoris; 1 patient (1.4%) because of worsening heart failure; and 1 patient (1.4%) died. A total of 65 patients completed the entire 6-month rehabilitation program. From the control group, 8 patients (11.4%) were excluded: 4 patients (5.7%) due to unstable angina; 2 patients (2.8%) because of worsening heart failure, and 2 patients (2.8%) died. A total of 62 patients remained until the end of the study.

The Ethics Committee at the Lithuanian University of Health Sciences approved the study protocol, and written informed consent was obtained from all patients before entering the study.

Methods
Health examination included questionnaires, clinical examinations, and laboratory tests. With

Table 1. Characteristics of Study Population

Parameter	Rehabilitation Group n=70	Control Group n=70	P
Age, mean (SD), years	57.5 (10.7)	58.5 (7.2)	0.5
Sex, %			
Men	90.3	87.5	0.6
Women	9.7	12.5	
Smoking, n (%)	10 (14.3)	8 (11.4)	0.6
Body mass index, mean±SE, kg/m^2	29.8±2.5	28.6±1.5	0.8
Heart failure functional class (NYHA), %			
II	32.4	36.2	0.1
III/IV	67.6	33.8	
Systolic blood pressure, mean±SE, mm Hg	153.1±7.2	150.2±8.8	0.5
Diastolic blood pressure, mean±SE, mm Hg	94.5±1.3	92.1±3.4	
Physically active, n (%)	35 (50.0)	33 (47.1)	0.1

the help of questionnaires, data on medical history and health behaviors (cigarette smoking, dietary and physical activity habits) were gathered. Clinical examination included the measurements of blood pressure (BP), body height, and body weight. BP was measured with a standard mercury sphygmomanometer on the right arm of the participant who was seated for 5 minutes before the measurement. Systolic BP and diastolic BP were recorded to the nearest 2 mm Hg. Two BP measurements were taken, and the average was calculated and used for the analysis. Patients were classified as hypertensive if their systolic BP was $\geqslant$130 mm Hg and/or diastolic BP was $\geqslant$80 mm Hg, or if they received antihypertensive drug treatment during the last 2 weeks. Body height was measured without shoes, to the nearest cm, using a stadiometer. Body weight was measured without shoes in light indoor clothing, to the nearest 0.1 kg, using medical scales. Body mass index (BMI) was calculated as body weight divided by height squared (kg/m^2). Overweight was defined as BMI $\geqslant$25 kg/m^2 and obesity as BMI $\geqslant$30 kg/m^2 (5).

The fasting cubital venous blood for a biochemical lipid investigation was taken using vacutainers. Total serum cholesterol, low-density lipoprotein (LDL) cholesterol, high–density lipoprotein (HDL) cholesterol, and triglyceride (Tg) levels were determined using an autoanalyzer Bayer ADVIA 1650. The lipid analysis was performed in the Laboratory at the Hospital of Lithuanian University of Health Sciences. Hypercholesterolemia was defined when total serum cholesterol was $\geqslant$5.0 mmol/L. Glucose level in venous blood was determined using an Accutrend GC system. Hyperglycemia was defined as a glucose level of $\geqslant$6.1 mmol/L. The metabolic syndrome was defined by the NCEP-ATP III recommendations if 3 or more of the following symptoms were present: BP, $\geqslant$130/85 mm Hg; serum Tg, $\geqslant$1.7 mmol/L; HDL cholesterol, <1.0 mmol/L for men and <1.3 mmol/L for women; venous blood glucose level, $\geqslant$6.1 mmol/L; and waist circumference, $\geqslant$102 cm for men and $\geqslant$88 cm for women (7).

Information on smoking and physical activity was gathered using a questionnaire. A person who smoked at least one cigarette per day was considered a regular smoker.

The patients were regarded physically active if they had leisure, professional, or daily physical activities for 30 minutes 5 times a week, leading to mild shortness of breath or sweating.

Dietary habits were evaluated using the questionnaire about the type and frequency of food consumption. The types of food were as follows: fish, poultry and lean meat, whole grains, fruits and vegetables, skimmed dairy products, unheated vegetable oil, saturated fat, and fat red meat. The patients were divided according to the different frequency of product intake: 1–2 times a month, 1 time a week, 2 times a week, 5 times per week, and daily.

Questionnaire-based interviews, clinical examinations, and laboratory tests were repeated after 3 and 6 months. The results were statistically analyzed using the Statistika 5.0 software. Mean values and standard deviations (SD) were calculated. All data were analyzed using the Student t test for continuous variables. Differences at a P value of less than 0.05 were considered statistically significant.

Rehabilitation Interventions

The 3-stage rehabilitation was carried out. The first 7-day inpatient rehabilitation stage in the Department of Cardiology included bed and floor exercises and motivation for risk factor correction.

The second 20-day outpatient rehabilitation stage included 5 lectures, individual aerobic exercise training, and recommendations for dietary changes and smoking cessation. Patients attended 5 lectures comprising cardiovascular anatomy and pathophysiology, risk factors for ischemic heart disease, their management and correction according to the ESC 2007 and the AHA 2000 and 2006 recommendations (9–11).

Aerobic capacity was determined during an incremental cardiopulmonary exercise test on a Shiller CS200 spiroergometer using the Bruce protocol. The aerobic exercise training was performed for 20–30 minutes on a bicycle ergometer, and the patients were asked to achieve their individual aerobic capacity.

Dietary recommendations included advices to eat fruits and vegetables every day at least 5 servings, whole grains at least once a day, fish at least twice a week, poultry and lean meat, unheated vegetable oil, and skimmed dairy products and to avoid fat red meat. Patients were encouraged to change dietary habits with new knowledge that they could eat delicious and healthy food from the world cuisine heritage.

Recommendations for smoking cessation included the period of smoking cessation and nicotine replacement therapy for 3 months.

The third rehabilitation stage included individual programs at home. The patients were asked to exercise 30 minutes per day until attaining the heart rate, adequate to their aerobic capacity, and to follow dietary and smoking cessation recommendations (5 months). Healthy lifestyle counseling was performed once a month. The patients were suggested to use symptomatic and cardioprotective drugs every day.

Seventy patients were studied as controls under the same protocol. They were given drug treatment only without any rehabilitation program.

Results
Changes in Manifestation of Cardiovascular Risk Factors

At entry, the mean values of systolic and diastolic blood pressures, total cholesterol, LDL-cholesterol, triglyceride, and glucose levels, and body mass index were increased in both the groups as compared with reference values, showing no significant differences comparing the corresponding variables between the groups ($P>0.05$) (Table 2). There were 14.3% and 11.4% of cigarette smokers and 17.1% and 18.5% of patients with the metabolic syndrome in the rehabilitation and control groups, respectively. Nearly 50% of all the studied patients were physically active.

After 3 months, systolic and diastolic BP significantly decreased in the rehabilitation and control groups as compared with the baseline data ($P<0.05$). All the patients quitted smoking. The triglyceride level significantly decreased in both the groups, while a significant decrease in the LDL-cholesterol and blood glucose levels was documented only in the rehabilitation group ($P<0.05$). There was a significant reduction in the percentage of patients with the metabolic syndrome in the rehabilitation group as compared with the baseline data ($P<0.05$). All patients in the rehabilitation group exercised in accordance with their aerobic capacity. No significant changes in the total cholesterol level and body mass index were seen in both the groups.

After 6 months, a significantly reduced diastolic BP was observed in both the groups ($P<0.05$). A significant decrease in the diastolic BP; total cholesterol, LDL-cholesterol, triglyceride and blood glucose levels; body mass index, and percentage of patients with the metabolic syndrome as compared with the baseline data was documented only in the rehabilitation group ($P<0.05$). All patients in the rehabilitation group exercised in accordance with their aerobic capacity ($P<0.05$).

Dietary Changes

Figs. 1–6 summarize the changes in dietary habits of patients during the 6-month rehabilitation. The patients used too much red fat meat, too little fish, vegetables and fruits, and lean meat. Whole grain products and unheated vegetable oil were commonly consumed 1–2 times per month. The patients usually did not use skimmed dairy products.

After 3-months of a strict adherence to dietary recommendations, the patients in the rehabilitation group significantly changed their dietary habits. The consumption of fish increased to once-twice a week; and that of poultry and lean meat, to 2–5 times a week. They ate fruits, vegetables, and whole-grain products every day and used unheated vegetable oil mostly 5–7 times a week. The consumption of fat red meat decreased generally to 1–2 times a month.

After 6 months, the patients were encouraged to keep eating healthy diets once a month. The overwhelming majority (95%) of the patients reported enjoying their meal. After the 6-month rehabilitation, the consumption of fish increased to 2–7 times a week. The consumption of poultry and white meat increased mostly to 2–5 times a week. The patients ate fresh vegetables and fruits every day, used whole-grain products to 5–7 times a week and unheated vegetable oil usually 5 times a week. The consumption frequency of fat red meat (pork, sausages) decreased to 1–2 times a month.

Discussion

The results of this study have shown that patients in the rehabilitation group significantly reduced the manifestation of common cardiovascular risk factors and had fewer cardiovascular events during the 6-month study period. The use of cardioprotective medications was similar in both the groups of patients. Despite this, there were less significant changes in the manifestation of risk factors in the

Table 2. Changes in the Manifestation of Cardiovascular Risk Factors
After 3- and 6-Month Complex Rehabilitation

Variable	Baseline		After 3 Months		After 6 Months	
	Rehabilitation Group (n=70)	Control Group (n=70)	Rehabilitation Group (n=70)	Control Group (n=68)	Rehabilitation Group (n=65)	Control Group (n=62)
Systolic BP, mm Hg	153.1±7.2	150.2±8.8	140.3±6.5*	141.1±6.1*	132.4±5.3*	142.1±8.8*
Diastolic BP, mm Hg	94.5±1.3	92.1±3.4	83.8±2.2*	86.7±3.5*	81.1±2.4*	90.5±2.3
Cigarette smoking, n (%)	10 (14.3)	8 (11.4)	0 (0)*	0 (0)*	0 (0)*	0 (0)*
Total cholesterol, mmol/L	6.2±1.5	6.0±1.3	6.1±0.9	6.1±1.2	5.0±0.5*	6.0±1.5
LDL-cholesterol, mmol/L	3.7±0.8	3.9±1.4	2.5±0.9*	3.8±1.1	2.2±0.4*	3.5±1.6
HDL-cholesterol, mmol/L	1.0±0.2	1.2±0.1	1.2±0.2	1.1±0.3	1.3±0.2	1.1±0.2
Triglycerides, mmol/L	2.1±0.8	2.5±0.6	1.5±0.7*	1.8±0.5*	1.3±0.6*	2.1±0.7
Glucose, mmol/L	7.2±2.1	7.1±3.1	5.5±1.5*	6.1±2.3	5.1±2.2*	6.0±2.3
Metabolic syndrome, n (%)	12 (17.1)	13 (18.5)	7 (10.0)*	12 (17.6)	5 (7.1)*	11 (16.9)
Physically active, n (%)	35 (50.0)	33 (47.1)	70 (100)*	38 (55.9)	70 (100)*	35 (56.5)
Body mass index, kg/m²	29.8±2.5	28.6±1.5	27.5±1.2	27.8±1.2	26.9±2.2*	27.4±1.1

Values are mean±SE unless otherwise indicated. BP, blood pressure; LDL-cholesterol, low-density lipoprotein cholesterol; HDL-cholesterol, high-density lipoprotein cholesterol.
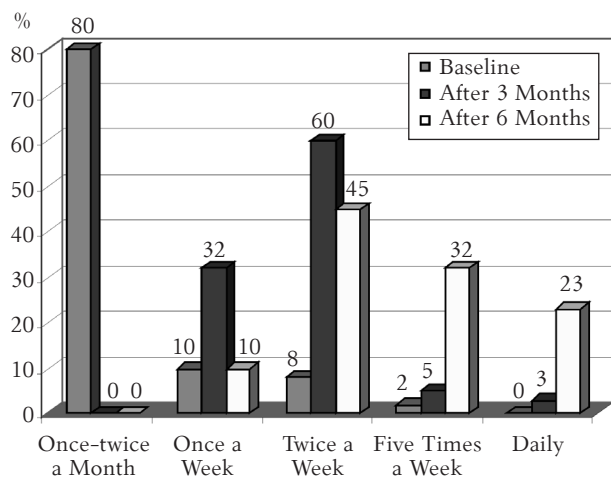*$P<0.05$, compared with the baseline data.

Fig. 1. Changes in the consumption of fish during the study period
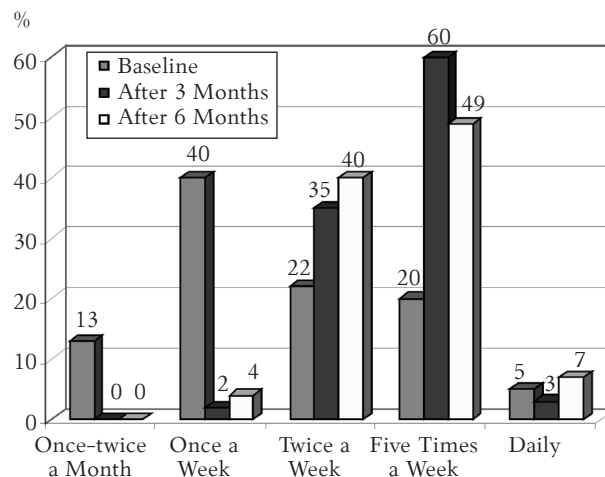

Fig. 2. Changes in the consumption of poultry and lean meat during the study period
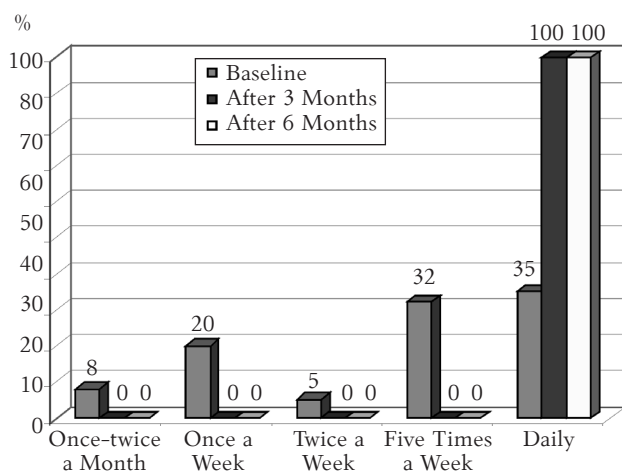

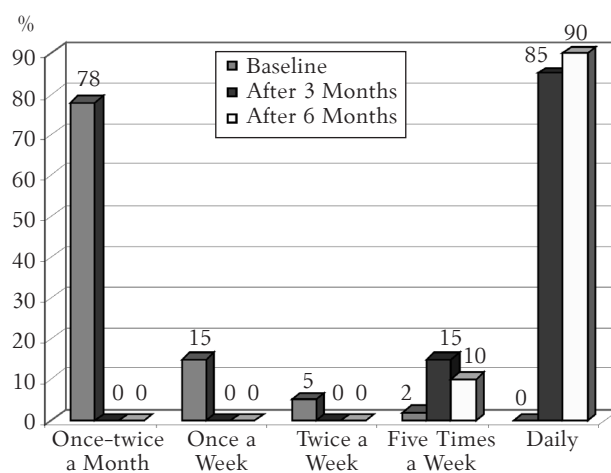Fig. 3. Changes in the consumption of fruits and vegetables during the study period

Fig. 4. Changes in the consumption of whole grains during the study period
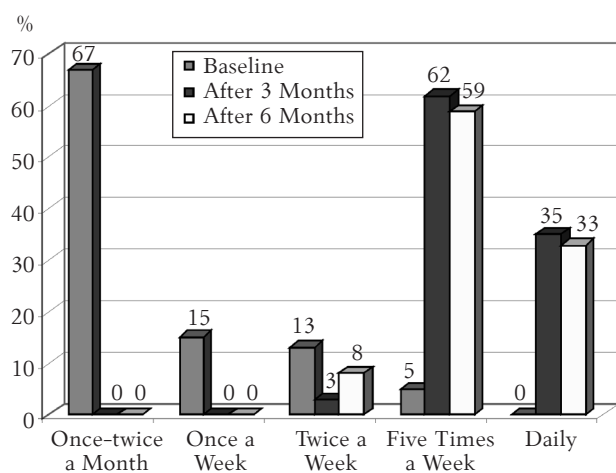

Fig. 5. Changes in the consumption of unheated vegetable oil during the study period
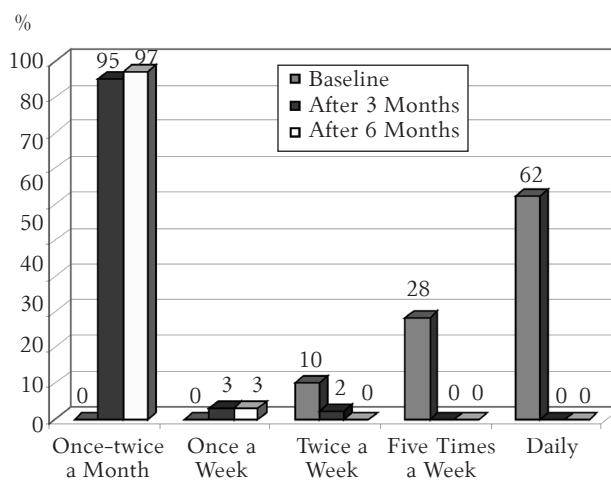

Fig. 6. Changes in the consumption of red fat meat during the study period

control group. Rehabilitation was comprehensive and included all behavioral changes (physical activity, dietary recommendations, and smoking cessation).

The professional and daily physical activities (not only leisure) should be evaluated. In our study, 23.2% of patients had physical activity leading to sweating for 7–8 hours a day at home or at workplace. Such physical activity is regarded as too long and intensive, and patients should be recommended to work less and slower. Aerobic exercise must be the most important part of training (12, 14). The physical training in our study was individualized according to the patient's aerobic capacity, assessed during a cardiopulmonary exercise test. Consequently, there were no cardiac events during the exercise and 2 hours after the test. Individualized aerobic regimen is very important for safety and efficiency of exercise training programs. We could not find any studies or recommendations concerning the most effective extent and duration of training for cardiovascular patients (15). Methods for defining the most appropriate intensity of training differ throughout the studies: the assessment of heart rate reserve and maximum aerobic heart rate, the Borg scale, which would correspond to an absolute energy expenditure of metabolic equivalents (METs), or calculations using the Karvoven formula to estimate the target heart rate during training (16, 17). However, an agreement was achieved in the European Guidelines on cardiovascular disease prevention in clinical practice, where it is stated that exercise prescription must be tailored to the clinical profile of the individual (15). In patients with CVD, an aerobic exercise training of moderate-to-vigorous intensity of 3–5 sessions per week for 30 min per session can be assigned. Sedentary patients should be strongly encouraged to start light-intensity exercise programs after an adequate exercise-related risk stratification (15).

In our opinion, at present, the most correct method used in prescribing aerobic training is a cardiopulmonary exercise test.

At least 60 minutes of physical activity in most days of the week were recommended for adults attempting to lose body weight. The physical activity can be accumulated throughout the day.

Another currently important issue is whether individual home-based training programs can be as effective as institution-based, supervised physical exercise programs. The HF-ACTION study and some other studies have demonstrated that home-based programs are equally effective and safe and even can be superior to institution-based exercise programs (18).

The results of our study have shown that long-term aerobic physical training is effective and safe as well. Similar findings were observed in one re-

cent large meta-analysis that included middle-aged men after myocardial infarction and mechanical heart revascularization (19). According to this meta-analysis, the 3-month aerobic physical training is associated with a 30% reduction in total cardiovascular mortality (19). In the HF-ACTION study, the 30-month aerobic exercise program was associated with fewer deaths and hospitalizations in 2032 patients with systolic HF as compared with the control group (18).

Appropriate nutrition is another important part of complex rehabilitation program. The Seven Countries Study has shown that there is a marked difference in mortality among patients in Northern and Southern Europe even after they were stratified according to cardiovascular risk factors (BP, cholesterol, and smoking). The patients following the so-called Mediterranean diet demonstrated a significantly lower cardiovascular mortality rate (20). As the diet used in our study, the Mediterranean diet includes a higher amount of fruits, vegetables, whole-grain products, fish and unsaturated fatty acids (especially olive oil) as well as a low amount of meat and saturated fatty acids. Our study data confirm the reduction of CVD events and risk in cases of changes in whole dietary habits.

The European Guidelines on cardiovascular disease prevention in clinical practice (version 2012) include the complex nonpharmacologic principles of secondary prevention: 1) cognitive-behavioral strategies to lifestyle changes; 2) professional nutritional counseling (<5 g of salt per day, 200 g of fruit per day (2–3 servings), 200 g of vegetables per day (2–3 servings), fish at least twice a week); 3) long-term individual exercise and physical activity; and 4) professional management of stress and psychosocial risk factors (15).

The dietary recommendations in our study were set positively and clearly and helped patients understand that healthy food may be delicious. They usually did not feel the sense of loss, and there were no patients who refused long-term rehabilitation.

Cessation of smoking remains one of the most important goals of long-term complex rehabilitation. Studies have demonstrated that smoking cessation is most effective after a cardiovascular event (e.g., myocardial infarction). A systematic meta-analysis of 20 studies has shown that smoking cessation after myocardial infarction reduces mortality by 36% among patients who quitted smoking compared with those who continued smoking (21). Smoking cessation is difficult due to psychological and physical dependence. In such cases, professional and continuous counseling and nicotine replacement therapy are essential. Current medical knowledge indicates that a first-choice therapy for smoking cessation is various forms of nicotine re-

placement therapy (chewing gum, transdermal nicotine patches); however, treatment with varenicline or bupropion is more difficult and can be associated with side effects as well as a negative impact on the cardiovascular system (22). In our study, patients used nicotine replacement therapy for 3 months, and all of them quitted smoking.

Screening results of the EuroAspire III study have revealed the failure of effective cardiovascular risk factor correction in all 22 participating EU countries. How long should cardiac rehabilitation programs last to impact motivation for lifestyle changes? The relationship between the duration and comprehension of rehabilitation programs and outcomes is unknown (23). Vasiliauskas et al. (17) have shown that a long–term (6 months) versus short–term (4 weeks) rehabilitation program for cardiovascular patients significantly reduced the mani-

festation of major cardiovascular risk factors (blood pressure, body mass index, dietary habits, dyslipidemia, sedentary lifestyle, smoking), the rate of cardiac events, chronic fatigue and improved the use of cardioprotective drugs.

This study has shown that the complex 6-month 3-stage rehabilitation program led to significant changes in modifiable atherosclerotic risk factors.

Conclusions

Complex long-term rehabilitation of cardiovascular patients significantly reduced the manifestation of major cardiovascular risk factors and the rate of cardiac events. Aerobic exercise must be the most important part of training.

Statement of Conflicts of Interest
The authors state no conflicts of interest.

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