

Original Article

Physical rehabilitation program of patients with ischemic heart disease with metabolic syndrome

MARIIA BALAZH¹, VOLODYMYR KORMILTSEV², VLADYSLAV KOSTENKO³, VOLODYMYR VITOMSKYI⁴, SERHII STROHANOV⁵, MARIANA SABADOSH⁶, OLEKSANDR YURCHENKO⁷, IGOR MARTSENIUK⁸

^{1,2,3,4,5,6,7,8} Physical Therapy and Ergotherapy Department, National University of Ukraine on Physical Education and Sports, UKRAINE

⁶ Physical Rehabilitation Department, Uzhhorod National University, UKRAINE

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Abstract

The article deals with the development and approbation of the complex physical rehabilitation program of the patients with ischemic heart disease (IHD) complicated by the metabolic syndrome (MS). There were identified the sequence, dosage, and parameters of the therapeutic exercises using, the tools of apparatus physiotherapy and psychotherapy on different motor settings with consideration of functional class (FC) of the angina pectoris of patients. The defining features of the complex physical rehabilitation program of patients with IHD with MS are the using of modified methods of therapeutic walking, special physical exercises in static and dynamic mode, elements of yoga gymnastics, diet therapy, apparatus physiotherapy and psychotherapy, elimination or reduction of manifestations of the MS, restoration of a structural and functional condition of the cardiovascular system, the formation of compensatory mechanisms and increasing the quality of life of patients subject. The developed complex program allows purposefully to correct the components of MS, to influence the restoration of the structural and functional condition of the cardiovascular system and to improve the quality of life of patients with IHD, and also provides for the motivation of patients for lifestyle modification, which opens the prospects for secondary prevention of the disease.

Keywords: physical rehabilitation, ischemic heart disease, metabolic syndrome.

Introduction

In the world, diseases of the circulatory system occupy the first place in the structure of disease prevalence and the hierarchy of causes of death of the able-bodied population. According to international organizations in the period 2012-2019, the share of diseases of the circulatory system in the structure of the overall incidence was 30.63%, and the mortality from them was 66,6%(Donald M. Lloyd-Jones, 2010; Roger V.L., Go A.S., Lloyd-Jones D.M., Benjamin E.J., Berry J.D., Borden W.B., Bravata D.M. & Turner M.B., 2012). Among diseases of the circulatory system, the most common pathology is IHD, in which 64.7% determines the mortality rate of the population from diseases of the circulatory system(Helena Poplawska, Agnieszka Dmitruk&Wojciech Holub, 2010). As for the post-Soviet countries, unlike in Western Europe and North America, where the death toll from IHD has been declining over the last decades, they have seen an increase in this indicator - the death rate from diseases of the circulatory system has increased by almost 20% over the last ten years (Helena Poplawska, Agnieszka Dmitruk&Wojciech Holub (2019).This situation is associated with the disregard of measures that have proven to be of high medical and social effectiveness in overcoming the epidemic in the followed countries, which include the implementation of effective rehabilitation and secondary prevention programs (Hagberg, L.A., & Lindholm, L, 2010; Chan, M, 2016).

The modern approach to the rehabilitation of patients with IHD involves the prevention, detection, and correction of risk factors for the development of pathology of the cardiovascular system (Ades PA, Savage PD &Toth MJ, 2000). Particular attention has been paid in recent years to the selection of an important prognostic complex of adverse factors, the so-called "metabolic syndrome" (MS), consists from a combination of abdominal obesity, arterial hypertension, dyslipidemia, and impaired carbohydrate tolerance. (Ades PA, Savage PD &Toth MJ, 2000; Volodymyr Vitomkiy, Iryna Hruzevych, SvitlanaSalnikova, AllaSulyma, Volodymyr Kormiltsev, YuriyKyrychenko, LarysaSarafinjuk, 2018). The high prevalence of MS in the population of patients with IHD and its crucial role in the development of threatening complications: as the myocardial infarction, stroke, heart failure necessitates the inclusion in the modern programs of cardiorehabilitation measures for the control of obesity, arteriole hypoglycemia. It is important that patients with MS are a heterogeneous group with varying degrees of clinical manifestation of individual components of the pathology and, accordingly, with different levels of functional and physical fitness (Helena Poplawska, Agnieszka Dmitruk&Wojciech Holub, 2010), causes difficulties in the selection of the tools and methods of physical rehabilitation and construction of

complete rehabilitation program for this contingent of patients. All of the followed testifies to the need for scientific substantiation, development, and checking of the effectiveness of a complex physical rehabilitation program for patients with IHD and MS, based on the use of adequate to the disease the tools and methods of physical rehabilitation.

Purpose of the research The research is devoted to scientific and strategic substantiation and development of a complex physical rehabilitation program of patients with ischemic heart disease with metabolic syndrome.

Materials & Methods

Participants The materials were obtained during the examination of 130 patients with IHD and MS based on the department of atherosclerosis and chronic IHD of the National Science Center "M.D. Strazhesko Institute of Cardiology" of the National Academy of Medical Sciences of Ukraine.

Instruments/Procedure All patients during the admission to the hospital were examined by the followed doctors: cardiologist, endocrinologist, neurologist, ophthalmologist, urologist, gastroenterologist, psychotherapist. Diagnosis of underlying and comorbidities was made by doctors of the relevant profile. The presence of MS in patients was determined by a physician following the criteria recommended by the International Diabetes Federation (IDF) (2005), according to which the main criterion for MS is the presence of abdominal obesity, in combination with any two of the four following factors: 1) increased levels of triglycerides or specific hypolipidemic therapy; 2) reduced high-density lipoprotein cholesterol (HDL cholesterol), or specific therapy for dyslipidemia; 3) hypertension, or antihypertensive therapy for previously diagnosed hypertension; 4) fasting plasma glucose on an empty stomach or previously diagnosed with type 2 diabetes. The physical rehabilitation program contained tools and methods of rehabilitation aimed not only at the pathogenetic links of IHD but also at treating the MS components. The defining feature of the proposed complex physical rehabilitation program was the application of the modified method of therapeutic walking, including reducing the intensity and duration of exercise and increasing its multiplicity, the use of special physical exercises in static and dynamic mode and elements of yoga exercises. The followed tools of therapeutic exercises corresponded to the reduced functional capabilities of patients and at the same time exerted sufficient training influence on the body of patients, allowed to solve the special problems of rehabilitation. For increasing the tone of the central nervous system and for activating the metabolism, patients were prescribed the water procedures of a tonic nature. Considerable attention was paid to the methods of psychotherapeutic correction, including the theoretical sessions on the Internet, aimed at the formation of patients' attitudes towards lifestyle modification, and progressive muscular relaxation in combination with music therapy. The whole set of used tools was carried out against the background of diet.

Developed a complex physical rehabilitation program of for people with IHD and MS envisaged the phased implementation of rehabilitation measures over the three phases (preparatory, basic, supportive), with differed tasks, level of physical activity, focus and physical rehabilitation tools (fig. 1):

- *Preparatory phase* (duration was 2 weeks for patients of II FC and 3 weeks for patients of III FC; the period corresponded to the clinical period of the treatment). Default motor settings were during the phase. Therapeutic exercise sessions were conducted in the form of therapeutic walking, special gymnastics, morning exercises and walking stairs (for patients with FC II). In patients with FC II, we used therapeutic massage. There were performed theoretical and progressive muscle relaxation sessions combined with music therapy. Apparatus physiotherapy procedures were applied (as the magnetotherapy, laser therapy for patients with II FC, laser therapy for patients with III FC) and diet therapy bringing the main and related diseases.
- *Basic phase* (duration was determined individually, and approximately ranging from 9 to 11 weeks; patients were treated at home). Moderate motor settings were during the phase. The sessions were conducted in the form of therapeutic exercises, therapeutic walking, morning exercises, and walking stairs (for patients of FC II). The phase also included the use of progressive muscle relaxation in combination with music therapy, healing treatments (as the wiping, a contrast shower) and adhering to a diet.
- *Supportive phase* of rehabilitation (duration was 3 months; patients were treated at home). The sessions were conducted in the form of therapeutic exercises, therapeutic walking, morning exercises, and walking stairs (for patients of FC II). The patients continued using progressive muscle relaxation in combination with music therapy, healing treatments, diet.

To determine the effectiveness of a complex physical rehabilitation program we were formed four groups of patients: the first (n = 31) - the main group 1 (MG1) consisted of patients with stable angina pectoris of functional class II (FC) with MS; the second (n = 32) - control group 2 (CG2) consisted of patients with stable angina pectoris with FC II; the third (n = 33) - the main group 3 (MG3) consisted of patients with stable angina pectoris of III FC with MS; fourth (n = 34) - control group 4 (CG4) consisted of patients with stable angina pectoris III with MS. Patients of the MG1 and MG3 engaged in a complex physical rehabilitation program, patients of the CG2 and CG4 engaged in a conventional rehabilitation program. Re-examination of patients was performed after three months (the intermediate stage of the study) and six months (the final stage of the study) from the beginning of rehabilitation.

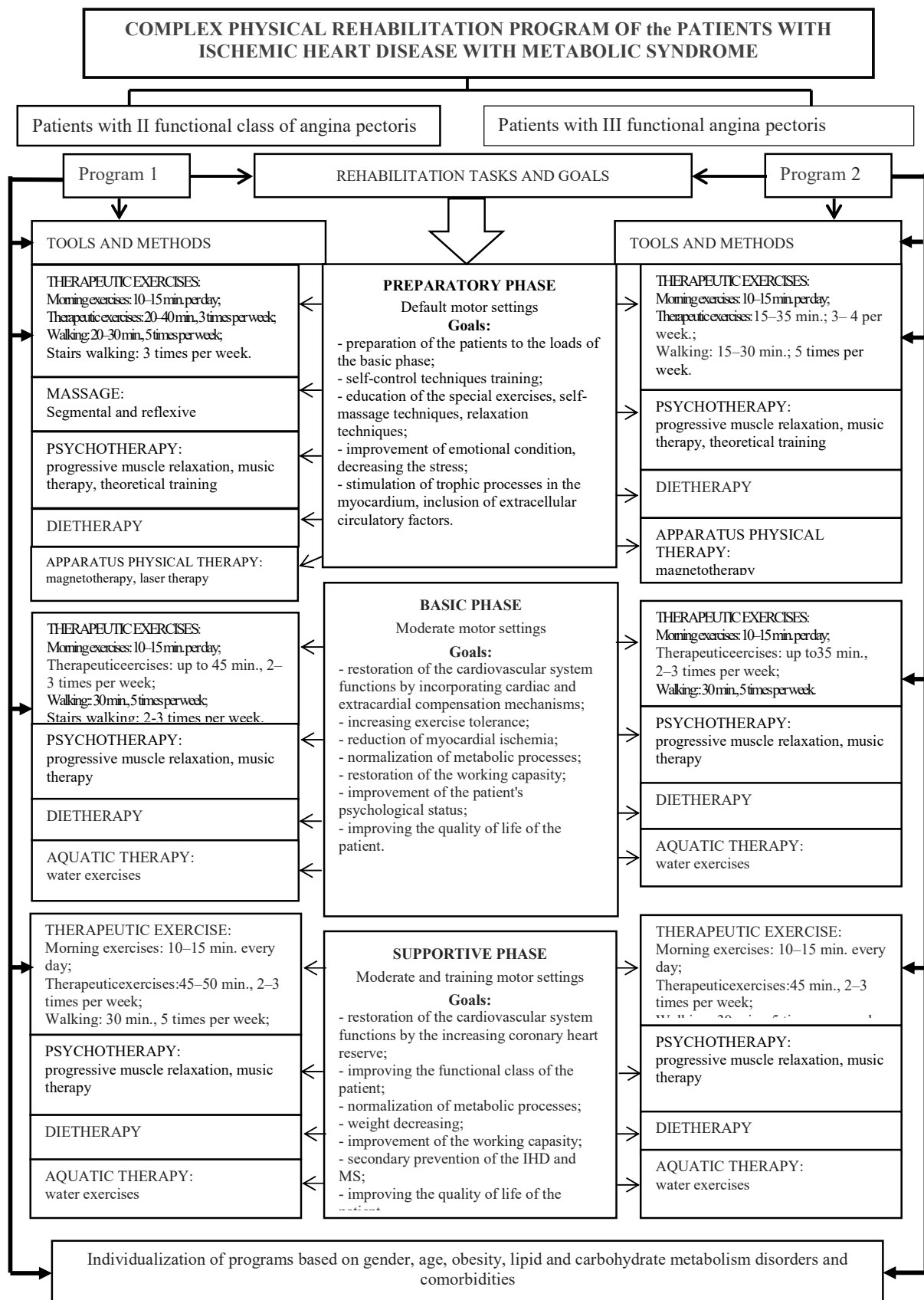


Fig. 1. Logistics of a complex physical rehabilitation program of patients with ischemic heart disease with metabolic syndrome

Statistical analysis

The analysis of the correspondence of the type of distribution of quantitative indicators of the law of normal distribution was tested by the Shapiro-Wilk test (W). For the quantitative indicators that had a normal distribution, the mean was determined (\bar{x}) and standard deviation (S). For the metrics that had a distribution that did not fit the normal, we determined the median (Me) and the upper and lower quartiles (25%; 75%). The significance of the difference for the independent groups was evaluated using the Mann-Whitney U-test and for the dependent groups using the Wilcoxon test. The significance of the difference for the qualitative indicators was evaluated using Fisher's exact test. Trait link analysis was performed using the Spearman rank correlation method (ρ). Integrated Statistical and Graphics Packages (StatSoft Inc., USA, 2007) and Excell 2007 tables editor (Microsoft, USA).

Results

The effectiveness of the physical rehabilitation course was evaluated by the favorable dynamics of clinical features, decreasing of the anthropometric parameters, improvement of blood pressure, positive changes in the lipid and carbohydrate metabolism, positive dynamics of structural and functional indicators of the cardiovascular system, increasing of tolerance to physical loads and quality of life. Initial indicators of the studied parameters, as well as indicators of age distribution, the relative number of smokers among patients and frequency of drug-using in patients of the main and control groups had no statistically significant differences ($p > 0,05$).

The results showed more pronounced positive dynamics in the main groups compared to the control groups. Thus, the analysis of clinical indicators revealed a positive effect of rehabilitation intervention on the weekly frequency of angina attacks and the need for patients to receive nitroglycerin after three months, but the most pronounced positive dynamics were observed in the main groups at the final stage of the studying. After six months of the rehabilitation process, the following changes were observed in the groups of patients: reduction of angina attacks (Me (25%; 75%)) from 14,5 (12; 15) to 5 (4; 5) attacks per week ($p < 0,01$) in the males of MG1 and from 12 (11; 13) to 4 (3; 4) attacks in the females of the MG1 ($p < 0,01$) with a corresponding decrease in the weekly need for nitroglycerin. In the CG2 the number of the attacks (Me (25%; 75%)) decreasing from 13 (12; 14) to 5 (5; 6) attacks in males ($p < 0,01$), and from 12,5 (11; 13) to 5 (4; 5) attacks in females ($p < 0,01$) with a corresponding decrease in the weekly need for nitroglycerin. In the MG3 we were observed a decrease in the weekly number of angina attacks (Me (25%; 75%)) from 24 (20; 25) to 6 (5; 8) attacks ($p < 0,01$) in males and from 21,5 (18,5; 25) to 5,5 (4,5; 7) attacks in females ($p < 0,01$). In the CG4 the indicator of number of attacks (Me (25%; 75%)) decreased from 23 (20; 25) to 10,5 (9; 12) attacks ($p < 0,01$) in males and from 22 (20,5; 23) to 9 (8,5; 10) attacks in females ($p < 0,01$). In both groups also were observed a decrease in the use of nitroglycerin tablets ($p < 0,01$).

After six months of the intervention, there was a decrease in the number of concomitant complaints in the main groups, with a reduction in subjective symptoms among patients in the control groups (fig. 2).

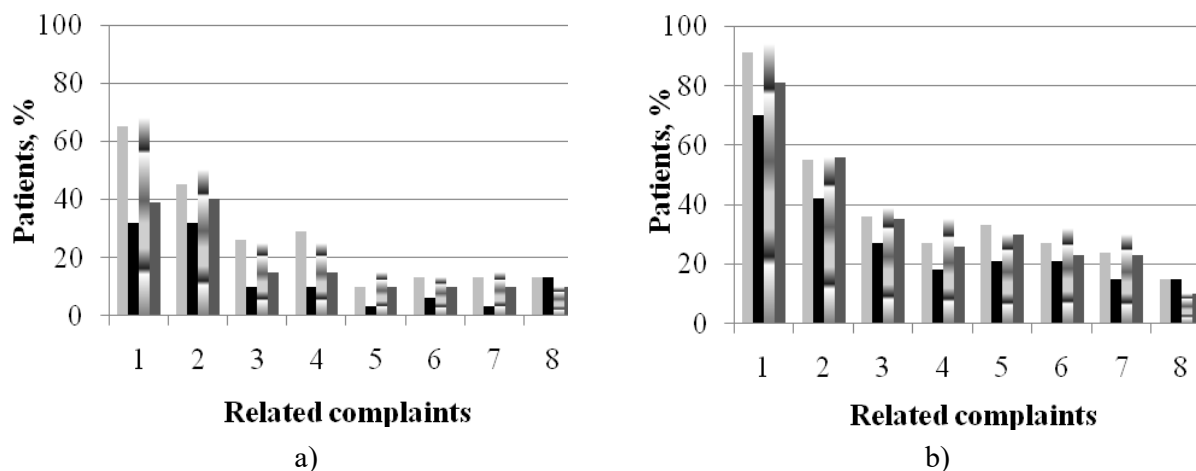


Fig. 2. Dynamics of concomitant complaints in the examined groups of patients before and after the rehabilitation intervention:

☐ – the main group before rehabilitation; ■ – main group after intervention; ☐ – control group before rehabilitation; □ – control group after rehabilitation; 1 – palpitation; 2 – headache; 3 – general weakness; 4 – sleep disorders; 5 – dyspnea; 6 – edema; 7 – emotional lability; 8 – weather sensitivity; a) – patients of functional class II; b) – patients of functional class III.

During the study, we were researched a positive impact of the rehabilitation intervention on the severity

of MS manifestations. Thus, according to the results of absolute indicators of waist circumference after six months of rehabilitation the number of patients with abdominal obesity decreased from 100% to 68% in the MG1 ($p<0,01$) and to 79% in the MG3 ($p<0,01$), whereas in CG2, the number of patients with abdominal obesity in the re-examination was 81% ($p<0,05$), and in the CG4 same indicator was 94% ($p>0,05$). Indicators of the waist /hip circumference (Me (25%; 75%)) decreased in the MG1 from 1,01 (0,98; 1,02) to 0,98 (0,96; 1,01) units in the males ($p<0,01$) and from 0,92 (0,89; 0,95) to 0,9 (0,8; 0,92) units ($p<0,01$) in the females. In the CG2 we founded changes in the waist /hip circumference indicators (Me (25%; 75%)) from 1,01 (0,99; 1,02) to 1,01 (1,0; 1,04) units in the males ($p<0,01$), and from 0,92 (0,88; 0,95) to 0,92 (0,86; 0,95) units ($p>0,05$) in the females, that is, in the females from CG2, positive changes were not statistically significant, and in the males this indicator worsened. In the MG3 waist /hip circumference indicators (Me (25%; 75%)) decreased from 1,01 (0,98; 1,03) to 1,01 (0,98; 1,02) units in the males ($p<0,01$) and from 0,91 (0,9; 0,94) to 0,9 (0,88; 0,93) units ($p<0,01$) in the females. In the CG4 we observed statistically insignificant changes in the same indicators (Me (25%; 75%)): from 1,01 (0,97; 1,03) to 1 (0,97; 1,02) units in the males, and from 0,91 (0,88; 0,94) to 0,91 (0,88; 0,95) units in the females ($p>0,05$).

Besides, 35% of patients experienced a reduction in overall obesity in the MG1 ($p<0,01$) and in 24% of MG3 patients ($p<0,01$). In CG2, obesity was reduced in 22% of patients ($p<0,01$), and CG4 has recorded the decrease in the degree of general obesity in 6% of patients ($p>0,05$).

Conducting rehabilitation measures in both the main and control groups contributed to a significant improvement in the blood pressure indicators within three months. The continued participation of patients in the rehabilitation program did not contribute to further reduction of blood pressure, but patients in the control groups after six months showed a tendency to deteriorate compared with those obtained after three months, which was not observed in the main groups. The number of patients with a level of blood pressure exceeding the target values for patients with IHD with MS ($<130/85$ mmHg), after six months of rehabilitation, decreased from 97 to 52% in the MG1 ($p<0,01$), in the CG2 same indicator, decreased from 97 to 69% ($p<0,01$), in the MG3 same indicator, decreased from 94 to 67% ($p<0,01$), in the CG4 same indicator, decreased from 91 to 82% ($p>0,05$).

After the rehabilitation intervention in patients of the main groups observed the decrease in the manifestation of other components of MS, as hypertriglyceridemia, decreased levels of HDL cholesterol, impaired carbohydrate metabolism (fig. 3).

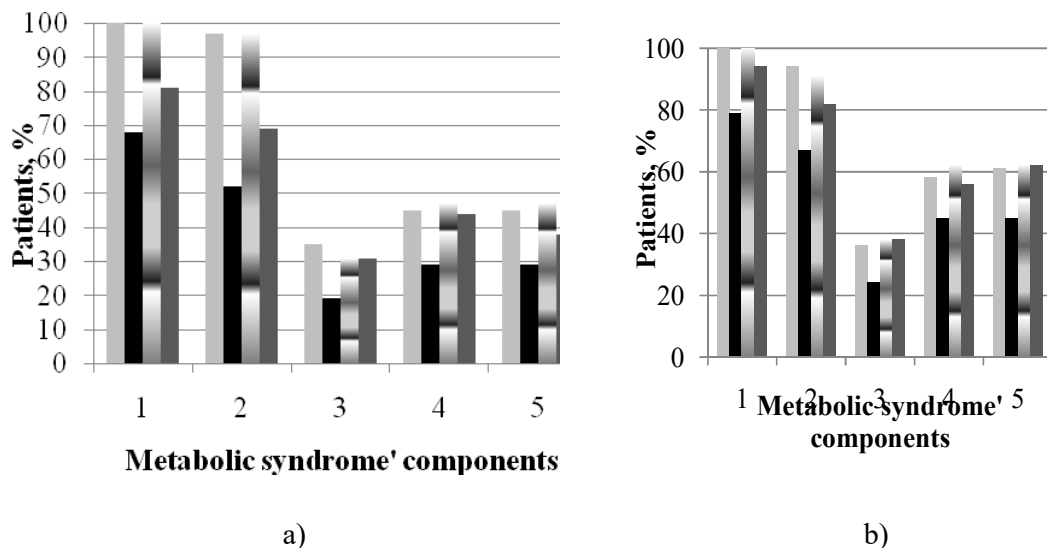


Fig. 3. Dynamics of manifestations of metabolic syndrome in the examined groups of patients before and after the rehabilitation intervention:

□ – the main group before rehabilitation; ■ – main group after intervention; ▨ – control group before rehabilitation; ▩ – control group after rehabilitation; 1 – abdominal obesity; 2 – hypertension; 3 – hypertriglyceridemia; 4 – reduced high-density lipoprotein cholesterol; 5 – impaired glucose metabolism; a) – patients of functional class II; b) – patients of functional class III.

The effectiveness of the proposed complex physical rehabilitation program is confirmed by the positive dynamics in the structural and functional condition of the cardiovascular system in the patients with IHD and MS. Thus, in patients in the main groups, there was a statistically significant decreasing in the number of extrasystoles and episodes of painless myocardial ischemia ($p<0,05$). Improvements in cardiac contractile function were observed, as evidenced by an increase in ejection fraction and a decrease in end-systolic and end-diastolic size of the left ventricle ($p<0,05$). Additionally, after six months of rehabilitation, patients in the main

groups showed a trend towards positive changes in the types of left ventricular geometry, which, however, had no statistical significance.

According to the results of the bicycle ergometric test six months later, patients from main groups noted an increase in exercise tolerance. Metabolic equivalent increased in the MG1 males from 5 (4,5; 6,3) to 6,2 (5,7; 7,5) METs (Me (25%; 75%)) ($p < 0,01$), in the females same indicator increased from 5 (4,4; 6,1) to 6,5 (5,8; 7,6) METs ($p < 0,01$). In the CG2 the corresponding changes were followed: in the males indicator increased from 5,5 (4,3; 6,3) to 6,5 (5,3; 7) METs ($p < 0,01$), in the females same indicator increased from 5,3 (5; 5,5) to 6,3 (6; 6,5) METs ($p < 0,01$). In the MG3 positive changes were less pronounced and there are followed: in the males indicator increased from 3,2 (2,9; 3,5) to 3,8 (3,8; 3,9) METs ($p < 0,01$), in the females same indicator increased from 3 (2,8; 3,3) to 3,8 (3,7; 3,9) METs ($p < 0,01$). In the CG4 observed slight positive changes that reached statistical significance only in the females ($p < 0,05$).

After undergoing rehabilitation was observed an improvement of the FC IHD in the 35% patients of the MG1 ($p < 0,01$), in the 15% of patients of the CG2 ($p < 0,05$), in the 25% patients of the MG3 ($p < 0,01$), and in the 6% of patients of the CG4 ($p > 0,05$).

According to the results of a quantitative assessment of the quality of life at the end of the studying, patients from MG1 and MG3 noted an increase in indicators reflecting both physical and mental components of health, while in CG2 and CG4 patients there was a statistically significant improvement only the components of physical health. The indicator of social functioning in all groups remained practically unchanged at the stages of the study ($p > 0,05$).

According to the overall evaluation of the effectiveness of the rehabilitation program, the improvement was observed in 52%, 34%, 27% and 6% of patients in the groups №№ 1, 2, 3, and 4 accordingly. 48%, 63%, 70% and 79% of patients observed the “unchanged” result, respectively. Worsening after the rehabilitation intervention was noted in 3%, 3% and 15% of patients in the groups №№ 2, 3 and 4 accordingly.

Discussion

The results of the overall evaluation of the effectiveness of the complex physical rehabilitation program confirmed that in most patients with angina pectoris FC II the proposed complex program contributed to the improvement of the general condition by reducing the manifestations of MS more effectively than the conventional physical rehabilitation program (Donald M. Lloyd-Jones, 2010; Giada, F., Biffi, A., Agostoni, P., Anedda, A., Belardinelli, R., Carlon, R. & Zeppilli, P., 2008; Giada, F., Biffi, A., Agostoni, P., Anedda, A., Belardinelli, R., Carlon, R. & Zeppilli, P., 2008)

The positive changes in the group of patients with FC III were less pronounced compared to patients of FC II, but the absence of negative dynamics observed in the CG4 was evidence of the positive impact of the proposed complex program. These data confirm that a complex physical rehabilitation program for patients with IHD and MS, which contains strategical and organizational approaches to the interventions against obesity, arterial hypertension, disorders of lipid and carbohydrate metabolism, and aimed at reducing the risk of possible complications, contributes to more effective recovery of the cardiovascular system, formation of compensatory mechanisms and improvement of quality of life of patients, and is also safer for patients with severe (FC Antonio Jesus Sanchez-Oliver, Christian Martin Garcia, Pablo Galvez-Ruiz & Jose Antonio Gonzales-Jurado, 2018).

Summarizing the data obtained in the course of the study, it should be noted that in patients with FC II in the majority of the studied indicators observed more significant improvements than patients in FC III. At the same time, in the patients of III FC, the proposed complex program was more effective compared to the conventional ones, the implementation of which is a large number of patients of the CG 4 led to the deterioration of the general condition. These data suggest that in the rehabilitation of patients with severe functional class, preference should be given to static and dynamical loads that are more sparing and safe than traditional dynamic ones. The obtained data will be bringing in the management of the rehabilitation process, during the construction of a complex physical rehabilitation program and in determining its effectiveness.

Conclusions

The positive impact of the proposed complex program was noted on subjective manifestations of angina pectoris and on the expressiveness of MS components in patients with IHD, which had statistically significant differences compared to the corresponding indicators of control groups. Thus, the number of patients with abdominal obesity decreased by 32% in the MG1 ($p < 0,01$) and by 21% MG3 ($p < 0,01$), whereas in CG 2 the number of patients with abdominal obesity decreased by 19% ($p < 0,01$) and in the CG4 same indicator decreased by 6%.

The positive impact of the proposed complex program on the objective manifestations of cardiovascular disease was noted: the number of patients with hypertension decreased after six months of rehabilitation from 97 to 52% in the MG1 ($p < 0,01$), from 97 to 69% in the CG2 ($p < 0,01$), from 94 to 67% in the MG3 ($p < 0,01$), and from 91 to 82% in the CG4.

The positive impact of the proposed complex program on the objective manifestations of metabolic

disorders is noted: the number of patients with hypertriglyceridemia in MG1 decreased from 35 to 19%, in the MG3 decreased from 36 to 24%. In the control groups, the number of patients with hypertriglyceridemia did not change during the intervention. The number of patients with low levels of HDL cholesterol at MG1 after the rehabilitation intervention decreased from 45 to 29%, in the MG3 decreased from 58 to 45%, whereas the number of patients with low HDL cholesterol observed in CG2 decreased from 47 to 44%, and in the CG4 same indicator decreased from 62 to 56%. The frequency of carbohydrate metabolism disorders decreased under the influence of rehabilitation from 45 to 29% in the MG1, in the CG2 decreased from 47 to 38%, in the MG3 decreased from 61 to 45%. In CG4, the number of patients with carbohydrate metabolism disorders did not change during rehabilitation.

Correction of MS components made it possible to achieve statistically significant positive changes in the structural and functional condition of the patients: as the improvement of myocardial contractile function was observed at the final stage of study in patients of MG1: particularly, an increase in the left ventricular ejection fraction was observed (Me (25%; 75%)) – in the males from 59,5 (57; 63) to 62,8 (59,8; 65,8)% ($p < 0,05$), in the females from 59 (56,5; 63) to 61,8 (59,3; 65,8) % ($p < 0,05$); after six months of rehabilitation in MG 1 a decrease in the incidence of myocardial ischemia episodes decreased by 26% ($p < 0,01$), and in the MG3 decreased by 24% ($p < 0,01$). In patients in the control groups, the corresponding indicators were not statistically significant.

According to the results of the bicycle ergometric test, after six months, the main groups observed an increase in the duration, load capacity, metabolic units and double product at the height of the load, indicating an increase in exercise tolerance by increasing the coronary heart reserve. 35% of patients have experienced angina pectoris under the influence of the proposed complex physical rehabilitation program in the MG1 ($p < 0,01$) and 25% patients of the MG3 ($p < 0,01$).

Improvement of clinical and functional parameters is reflected in the improvement of the quality of life of patients. At the same time, patients in the main groups observed an increase in indicators reflecting both the physical and mental components of health, while in the patients of the control groups the improvement of the mental health components was not so significant. The most pronounced positive dynamics were observed in groups of patients with II FC. Thus, the proposed complex program exerted a pronounced positive influence on the psycho-emotional sphere of patients with IHD and MS.

Conflicts of interest – If the authors have any conflicts of interest to declare.

References

- Ades PA, Savage PD & Toth MJ, (2000). High-calorie-expenditure exercise. A new approach to cardiac rehabilitation for overweight coronary patients. *Circulation*. 119, 2671-2678.
- Antonio Jesus Sanchez-Oliver, Christian Martin Garcia, Pablo Galvez-Ruiz & Jose Antonio Gonzales-Jurado. (2018) Mortality and economic expenses of cardiovascular diseases caused by physical inactivity in Spain. *Journal of Physical Education and Sport*, 18(Supplement issue 3), 1420 – 1426. DOI:10.7752/jpes.2018.s3210
- Cadilhac DA., Cumming TB., Sheppard L., Pearce DC., Carter R., & Magnus A. (2011). The economic benefits of reducing physical inactivity: An Australian example. *International Journal of Behavioral Nutrition and Physical Activity*, 8. <https://doi.org/10.1186/1479-5868-8-99>
- Chan, M. (2016). Defunciones prematuras por enfermedades no transmisibles. Centro de Prensa OMS, 3–7.
- Donald M. Lloyd-Jones (2010). Cardiovascular Risk Prediction: Basic Concepts, Current Status, and Future Directions. *Circulation*, 121, 1768–1777. <https://doi.org/10.1161/CIRCULATIONAHA.109.849166>
- Giada F., Biffi A., Agostoni P., Anedda A., Belardinelli R., Carlon R. & Zeppilli P. (2008). Exercise prescription for the prevention and treatment of cardiovascular diseases: Part I. *Journal of Cardiovascular Medicine*, 9(5), 529–544. <https://doi.org/https://dx.doi.org/10.2459/JCM.0b013e3282f7ca77>
- Giada F., Biffi A., Agostoni P., Anedda A., Belardinelli R., Carlon R. & Zeppilli P. (2008). Exercise prescription for the prevention and treatment of cardiovascular diseases: part II. *Journal of Cardiovascular Medicine*, 9(6), 641–652. <https://doi.org/http://dx.doi.org/10.2459/JCM.0b013e3282f7ca96>
- Hagberg LA., & Lindholm L. (2010). Measuring the time costs of exercise: A proposed measuring method and a pilot study. *Cost Effectiveness and Resource Allocation*, 8. <https://doi.org/10.1186/1478-7547-8-9>
- Harrison M. (2010). Valuing the Future: the social discount rate in cost-benefit analysis. Productivity Commission Visiting Researcher Paper. Available: <http://www.pc.gov.au/research/supporting/costbenefit-discount>
- Helena Poplawska, Agnieszka Dmitruk & Wojciech Holub (2019). Physical fitness and parent-reported health status and leisure time activity of Polish boys and girls with abdominal and peripheral obesity. *Journal of Physical Education and Sport*, 19 (Supplement issue 3), 867 – 875. DOI:10.7752/jpes.2019.s3125
- Roger VL., Go AS., Lloyd-Jones DM., Benjamin EJ., Berry JD., Borden WB., Bravata DM. & Turner MB. (2012). Heart disease and stroke statistics-2012 update: A report from the American heart association.

- Circulation*, 125(1), e2-e220.
- Volodymyr Vitomkiy, Iryna Hruzevych, SvitlanaSalnikova, AllaSulyma, Volodymyr Kormiltsev, YuriyKyrychenko, LarysaSarafinjuk (2018). The physical development of children who have a functionally single heart ventricle as a basis for working physical rehabilitation technology after a hemodynamic correction. *Journal of Physical Education and Sport*, 18(2), 614 – 617. DOI:10.7752/jpes.2018.02089
- Volodymyr Vitomkiy, Volodymyr Kormiltsev, Iryna Hruzevych, SvitlanaSalnikova, Yurii Shevchuk & YuliaYakusheva (2018). Features of the physical development of children with functionally single heart ventricle as a basis of the physical rehabilitation technology after a hemodynamic correction. *Journal of Physical Education and Sport*, 18 (Supplement issue 1), 421 – 424. DOI:10.7752/jpes.2018.s159