

REVIEW / PRACA POGLĄDOWA

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**THE IMPORTANCE OF PHYSICAL ACTIVITY IN THE PREVENTION  
OF ACUTE CORONARY SYNDROME**

**ZNACZENIE AKTYWNOŚCI FIZYCZNEJ W PREWENCJI  
OSTREGO ZESPOŁU WIEŃCOWEGO**

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**S u m m a r y**

Acute coronary syndrome (ACS) includes patients with ST segment elevation myocardial infarction (STEMI), without ST segment elevation myocardial infarction (NSTEMI) and unstable angina (UA). Angiographic research proved that the main cause of ACS is the damage of unstable plaque in the coronary artery. In the result of research analysis, the largest cardiology societies in the world classified the phenomenon of hypokinesia as one of the most important risk factors in coronary heart disease (CHD). "The

Golden mean" against the epidemic of ACS is to create a new view pointing to prevention. Positive role of physical activity in the prevention of ACS is associated with decreased risk factors for atherosclerosis (ATH), such as hypercholesterolemia, hypertension, diabetes, obesity, and stress. Promoting regular physical activity of moderate intensity plays an important role in preventing and reducing the risk of CHD mortality mostly due to ACS.

**S t r e s z c z e n i e**

Ostry zespół wieńcowy (OZW), obejmuje chorych z zawałem serca (ZS) z uniesieniem odcinka ST (STEMI), ZS bez uniesienia odcinka ST (NSTEMI) i niestabilną chorobą wieńcową (UA). Badania angiograficzne udowodniły, że główną przyczyną OZW jest pęknięcie niestabilnej blaszki miażdżycowej w tętnicy wieńcowej. W wyniku analizy badań, największe towarzystwa kardiologiczne na świecie, zaliczyły zjawisko hipokinezy, do najważniejszych czynników ryzyka chorób niedokrwiennej serca (ChNS). "Złotym środkiem" w walce z epidemią OZW jest kreowanie

nowego spojrzenia, wskazującego na prewencję. Pozytywne znaczenie aktywności fizycznej w prewencji OZW jest związane z obniżeniem czynników ryzyka miażdżycy (ATH) takich jak: hipercholesterolemia, nadciśnienie tętnicze, cukrzyca, otyłość, oraz stres. Promowanie systematycznej aktywności ruchowej o umiarkowanym nasileniu, odgrywa istotną rolę zarówno w zapobieganiu ChNS, jak i zmniejszaniu ryzyka zgonu spowodowanego głównie OZW.

**Key words:** exercise, acute coronary syndrome, rehabilitation, prevention, coronary heart disease

**Słowa kluczowe:** wysiłek fizyczny, ostry zespół wieńcowy, rehabilitacja, prewencja, choroba niedokrwienności serca

Coronary heart disease (CHD) is characterized by atherosclerotic changes of epicardial coronary arteries, which lead to impairment of regional myocardial perfusion by with a specific coronary artery. The

consequence of this situation is the occurrence of local imbalances between supply and demand for oxygen, leading to local ischemia. Clinical manifestations include a spectrum of outcomes ranging from

asymptomatic ischemia, through stable angina and up to acute coronary syndrome (ACS). The term ACS covers the hazardous manifestations of coronary artery disease which include unstable angina, acute myocardial infarction and sudden cardiac death. Due to the existence of different therapeutic concepts depending on the electrocardiogram image, a division is made to distinguish myocardial infarction with ST segment elevation (STEMI) and myocardial infarction without ST elevation (NSTEMI) [1, 2, 3].

The incidence of CHD increases with age and cardiological events are cause of death with patients over 50 years of age. Autopsy research investigations proved that approximately 90% of people between 80 to 90 years of age had coronary atherosclerosis diagnosed, and the symptoms of coronary artery disease (CAD) could be seen within approximately 30-40% of the population [4].

It is known that the use of physical activity with patients who manifest CHD improves their quality of life, delays the progress of the disease, reduces the risk of ACS and shortens the treatment time of already occurred incidents. [5,6] Despite the advantages, over 50% of adults in developed countries are characterized by a stationary lifestyle. According to the epidemiological prognosis, it is anticipated that in year 2020) the ACS will be a fundamental cause of death within world's population. [2]

## HOW CAN PHYSICAL ACTIVITY HELP WITH REDUCING THE RISK OF ACS?

Through health training adaptive mechanisms are activated, acting against arteriosclerotic changes within particular systems and metabolic processes [7, 8, 9, 10].

**Myocardium.** Physical exercise reduces tension within sympathetic nervous system and in reverse increases tension within parasympathetic nervous system. At the same time after 8-10 weeks of regular endurance training resting bradycardia emerges (HR < 60BPM), resting blood pressure decreases by several mmHg, the volume of circulating blood increases, ventricular filling time is extended, cardiac volume growth is observed, diastolic function improves and vascular resistance is reduced. These adaptive changes yield in improvement of hemodynamics – the risk of turbulent blood flow is reduced and there is an increase of stroke volume. They also have a hypotensive influence. The cardiac electrical stability improves,

what is particularly important at patients with diagnosed cardiac arrhythmias [8, 11].

**The vascular system.** Regular physical activity has essential influence on sympatho-adrenal system (SAS), thus the concentration of catecholamines in blood is reduced and the activity of the sympathetic nervous system decreases. In addition the carotid baroreflex is modified and the secretion of NO<sub>2</sub> by the endothelium increases. Physical training is also associated with increased levels of atrial natriuretic peptide (ANP) in blood what composes as a counterbalance for RAA system and catecholamines activity during exercise. These changes have a positive effect on the long-term slowing of central and flexible arteries stiffening, have a hypotensive effect and may significantly affect the reduction of the psychological factor levels (stress, anxiety, depression, personalities type A and D) [11, 12, 13, 14].

**Coronary circulation.** After-training adaptation includes: coronary arteries diameter increase, vascular resistance reduction, myocardial perfusion increase and angiogenesis stimulation through lowering of the pH, hypercapnia and hypoxia. These adaptive changes bring reduction in risk of myocardial ischemia, including the ACS during activities of daily living [8, 11].

**Lipid metabolism.** Numerous researches demonstrated influence of physical activity on lipid profile modification. It was stated that the decrease was present within concentration of total cholesterol (TC), LDL cholesterol (LDL-C) and triglycerides (TG). Increase was observed within the fraction of HDL cholesterol (HDL-C). These changes may be a result of reduction in TC and TG synthesis, increased activity of enzyme lipoprotein lipase and increase in apolipoprotein A1 (Apo A-1) serum concentration associated with HDL-C. Lipid profile changes described above reduce the availability of substrates required for the formation of the arteriosclerotic plaque [15].

**Carbohydrate metabolism.** As a result of regular physical activity concentration of insulin in plasma decreases and tissue insulin resistance is lowered. It is associated with reduction of insulin secretion through Langerhans islets of the pancreas and it's better bonding by the peripheral cellular receptors. Contraction of skeletal muscles causes the movement of glucose transporter (GLUT4) to sarcolemma of muscle fibers, what facilitates the glucose uptake from

the blood stream producing the hypoglycaemic effect [16]. This situation induces a reduction in formation of reactive oxygen species (ROS) by deactivating various metabolic pathways: autoxidation, glycation, sorbitol. It also causes a decrease in activity of protein kinase C and nuclear factor kappa B. Protein kinase C inhibits the expression of growth factors such as endothelin-1 and vascular endothelial growth factor (VEGF), what in effect improves vasodilatation. Deactivation of nuclear factor kappa B brings out the anti-inflammatory activity in endothelium [17].

**Morphology of the peripheral blood.** A number of researches show the influence on peripheral blood counts modification. An increase in circulating blood volume was observed (even up to 15-20%). Concentration of hemoglobin and 2,3-bisphosphoglycerate (it lowers the affinity of hemoglobin to oxygen) increases within erythrocytes, what favors transport of oxygen into tissues. Decrease in concentration of fibrinogen and factor VII follows, causing loss of procoagulant platelet activity. Subsequently a stimulation of tissue plasminogen activator (TPA) synthesis and reduction of its inhibitor (PAI-1) concentration are achieved. These changes result in increased fibrinolysis and reduce blood viscosity. [8,18]

**Mediators of inflammation.** It was demonstrated that endurance training reduces the concentration of C-reactive protein (CRP) thus creating anti-inflammatory activity. Interleukin 6 (IL-6) is produced within skeletal muscles, what stimulates the synthesis of cytokines: interleukin 10 (IL-10) and interleukin 1 receptor antagonist (IL-1ra), what in turn inhibits the pro-inflammatory activity of tumor necrosis alpha

factor (TNF-alpha) (which is responsible for inflammation within the enlarged visceral adipose tissue). [8]

## WHAT ARE THE RECOMMENDATIONS FOR PHYSICAL ACTIVITY IN THE PREVENTION OF ACS?

Positive effects of health training are reinforced by rational programming of all components of physical activity: recommended type of exercise, their frequency, duration and intensity [8].

**Type of training.** Among recommendations for physical activity within the prevention of CHD, the dynamic effort, endurance effort and aerobic training are valued most. Dynamic health training engages

large muscle groups and is based on isotonic contractions of muscles combined with the change in length of muscle fibers [8, 19]. Endurance training increases the individual ability to perform submaximal (85% HRmax without CHD, 70% of maximum heart rate with CHD) as well as the maximal exertion. Within the mentioned types of training it is possible to prolong the exercise time with a similar load or increase the workout difficulty with specified HR. Adaptation to submaximal exercise is associated with a smaller product of HR and RR for a given exercise, what indicates lesser myocardial demand for oxygen for a given level of work [10, 20]. The most popular endurance exercises include: march (walks), running, cycling, swimming, cross country skiing, canoeing or rowing. Endurance exercise is an important part of many sports games: (tennis, basketball, soccer, etc.), recreational activities (dance) and the activities of daily living. According to recent reports, endurance training should be supplemented with resistance exercises and flexibility shaping exercises [8, 19]. Overcoming of physical resistance delivers increase in strength and the ability to increase muscle mass thus improving the capability to increase physical activity. This has also a positive effect on the basal metabolic rate and can help in everyday activities amongst elderly people [10]. The use of resistance exercises in health training with patients suffering ACS involves the use of isolated short-lived loads and the appropriate intensity, usually not exceeding 50% of maximum strength [8].

**Frequency of training.** Regularity within application of cardioprotective physical activity is a priority. It would be optimal to perform exercises daily, but an absolute minimum should be no less than three times a week. Long-term and regular training leads to a direct and beneficial cardiac- and vaso-protective changes. Adaptive processes within the circulatory system which are successively taking place appear not only during exercise, but are also maintained during rest and during the intervals between following training sessions [6, 8]. There is also a positive meaning in a proven fact, that regular physical activity significantly reduces the risk of myocardial infarction during a single strenuous exercise [8, 19]. Moreover it was indicated that at patients with advanced ACS regular physical activity may effect with myocardial hardening by ischemia. What subsequently reduces the risk of sudden cardiac death during the following acute ischemic event. [21] The basic principle when using a regular model of

activity is a practice of alternating the various forms of movement, tailored to individual preferences, location and season. This flexible approach significantly increases the motivation to regular training [8].

**The duration of training.** Another important parameter of health activity is the duration of a single session. The acceptable range is about 20-60 minutes. However there are opinions that the people who are not able to cope with the continued efforts by tens of minutes, can perform the exercises of shorter duration (8-10 minutes) several times a day. It seems that the form of training, its duration and frequency are less important than a total dose of exercise per week, related with specific overall energy expenditure, minimum of which is set at 1000kcal/week [9, 10, 19].

**The intensity of training.** The intensity of the effort given is essential both for the effectiveness of physical exercise and safety of the training individual. In the majority of recommendations, moderate physical activity is promoted—up to 60-75% of the maximum heart rate (HR max). [19] It should be noted that HR must not exceed the upper limit since this could increase the risk of coronary pain or even call out the myocardial infarction. The best practical method of estimating the intensity of exercise is HR measurement during or shortly after training:  $HR_{max} = 220 - \text{age (years)}$  [8, 19].

**Physical capacity.** Another important factor, which also points out to have a correlation with severe myocardium incidents, is individual physical fitness. It increases with taking up regular aerobic physical activity, and is characterized by the ability to undertake a long-term and moderate-intensity exertion while saving continuity of oxygen metabolism [6, 7, 10]. Physical capacity of the elderly is leveled at about 2/3 total available at youth. An important parameters for marking the application of physical fitness are both, resting HR and dynamics of post-workout adaptation (restitution) of HR to resting HR (HRR) [9]. It was also found recently, that the level of physical capacity is the most important indicator of mortality risk compared to other prevalent risk factors for CHD [8].

Within the framework of the American program: Community Healthy Activities Model Program for Senior II (CHAMPS II), which promotes activity in the high-risk ACS group, it was found that older people, despite the lower initial performance in physical activity, reached greater increase in physical efficiency compared to younger ones. [22] It also turned out that patients starting from hypokinetic state gained the

greatest benefit, but afterwards as the exertion increased the effects appeared at a slower pace [8]. In summary, after a year of training older adults aged 65-90 showed an increase in energy consumption by 46% [22].

In Poland, the most extensive experience in this issues has (is owned by the) Department of Social and Preventive Medicine, Medical University in Lodz. The results of extended scientific observation e. g. within the framework of The Integrated Prevention of Noncommunicable Diseases Programme (CINDI) WHO, empowered the scientists from Lodz to formulate the guidelines concerning physical activity in the primary prevention of cardiovascular diseases. The current directions include: endurance exercises performed at least three times a week, lasting about 20-60 minutes with moderate intensity (40-60%  $VO_{2max}$  or 60 -75% of HR max) and with energy consumption per session at a level about 200-300kcal, with minimum 1000kcal per week (optimum at above 2000kcal). This should be supplemented with at least two sessions of resistive exercises (10-15% of total training time) per week. It is also recommended for the major part of training to be preceded with 5-10 minutes lasting warm-up exercises including general development exercises and to be finished with 10-15 minutes lasting calming exercises [6, 8, 9, 10].

Recommendations and guidance on the type and intensity of physical activity should be provided by a qualified personnel. Physician and physiotherapist bear the task of developing a comprehensive prevention. Before carrying out a systematic physical activity within the group of high-risk ACS patients it is advised to carry out a screening examination followed by control tests. The goal of these examinations is the overall assessment of the patients health status, including determining of contraindications, global CHD risk estimation and cardiac diagnosis with evaluation of physical capacity levels. All this includes measuring of blood pressure, resting ECG and conducting an endurance test with physical capacity assessment [8, 19].

## SUMMARY

All of the above-mentioned evidence clearly show the undeniable benefits of keeping an active lifestyle. [8] The basis of any modification of activities is the awareness of what needs to be changed. Therefore if we already have the knowledge how important a to our

health and life is physical activity, should we proceed to implement an effective modification of our lifestyle. Following the legacy of our ancestors, we should retrace the mankind ascribed immemorial and instinctive need of movement. Aristotle claimed: "Nothing destroys the body as much as a long-lasting physical inactivity". Centuries later King Stefan Batory's court physician Wojciech Oczko accompanied him and wrote: "The motion will replace any other drug, but no drug is to replace the motion" [9].

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