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Impact of physical activity on the human body - the physiological basis of physical activity

Abstract

Physical activity, recreational sports as well as competitive sports effect the human body and cause uprising a physiological reaction of a body system. Changes that occur activity are mainly connected to the body homeostasis restoration. Observation of physiological reaction of body are very important tool that allows to analyze the preparation of the human body for carrying out activities. The large number of physiological changes have a short-term nature, but on the other hand some of them will last for a longer time effecting body's functioning.

The aim of this work was to show the basic physiological reactions of a human body as a easy tool for physical activity observation. Understanding of such reactions can be a useful tool in recreation and physical training.

Keywords: physical activity, physiology, VO_2max, hormonal balance

Introduction

Each movement performed by a person can be called physical activity, because according to the adopted assumptions, it is the work of skeletal muscles, along with changes occurring in individual human systems. For the body, physical activity is a stress factor, during which there is a disorder of homeostasis (balance), so one of the features of an efficient body is adaptation to the situation in which it finds itself. Adaptation to the prevailing conditions can be achieved through training, which increases physical performance. I case of such analyzes the main thing is to understand that every physical activity induces physiological changes. Through observation of those changes we can clearly show what type of human bod reaction we can see what physiological factors will change during this type of reaction. Exercise is a stressor for the human body. Various changes occur in the human body under the influence of stimuli. Some are very beneficial, while others lead to functional impairment of individual structures.

Physiological analyzes of physical activity are basing on a physical capacity of human body. Physical capacity is understood as the human body's ability to perform various types of physical work (Żołądź, 2001).

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One of physiological indicators of body reaction during activity is maximum oxygen uptake and blood lactic acid (LM). Those two parameters are considered as main indicators determining physical capacity. Maximum oxygen uptake, or VO2max, is the term for the highest oxygen consumption during one minute of physical activity. Blood lactic acid, on the other hand, measures the concentration of lactic acid in the blood, which is formed during anaerobic work (Traczyk, Trzebski, 2007).

Elevated LM levels indicate muscle fatigue broken down by intensity, there are: low-effort, moderate-effort and high-effort. When values of 30 to 40% of its value are recorded for maximum oxygen uptake, and myocardial activity oscillates at a rate of about 110 - 130 beats per minute, this type of activity is classified as a light-weight activity. During this type of work, the lactate threshold remains unchanged, and liver glycogen is the primary energy source. Moderate load activity is characterized by an increase in maximum oxygen uptake, to about 60 - 70% of its value, heart contractions are 150 - 160 beats per minute and muscle glycogen consumption occurs. There is a slight increase in lactic acid, blood glucose drops. Heavy load activity, where 90% of VO2max is utilized, increases lactic acid levels, and heart contractions are very common and approach maximum values (Sozański, 1999; Traczyk, Trzebski, 2007).

Completely different muscles work while running and others are involved during rowing. Another group of physical activity is distinguished, where the division is visible due to the number of muscles that is involved in the effort. When up to 30% of the muscles in the body are activated at work, this is known as local workout. When this threshold is exceeded, the activity takes on a general workout (Sozański, 1999).

Depending on the type of muscles work, the following types of physical exertion can be mentioned. The first is static effort, in which muscle tone increases, without changing its length, i.e. isometric contraction. With the dominance of eccentric contractions, there is talk of eccentric effort, where the muscles stretch under the influence of external force. The third type of muscle workout occurs when concentric contractions prevail, i.e. those where muscle fiber shortening occurs, this effort is classified as concentric (Sozański, 1999).

Every activity that the human body does has its energy cost. Depending on its consumption, a division of by energy expenditure has been introduced. The main factors determining the body's energy consumption are time, gender, and intensity (Nazar, 2001).

From the whole series of divisions that exist in terminology related to physical culture, in this work the division seems to be the most functional due to the length of physical activity to which the human body is exposed. Maximum short-term effort, characterized by a short duration, up to 60 seconds, where anaerobic work occurs (obtaining energy in the metabolism without using oxygen). An example would be sprinting at a distance of up to 400 meters. Short-term prolonged effort lasts from 1 to 15 minutes and, as in medium-length exercise (15 to 30 minutes), the lactate threshold is exceeded. Time over 30 minutes is included in the group of long-term efforts, in which the work of the body can last up to several hours (Sozański, 1999).

With this type of effort, the body uses aerobic work (oxygen is used to obtain energy in metabolism). Examples include marathon runs, cycling, swimming and their combination, i.e. triathlon (Sozański, 1999).

The impact of exercise on the body

When considering the impact of physical activity on the human body, one should look at the degradative activities occurring in the body's structures and notice the positive changes that occur under its influence. When assessing the intensity of effort, indyvidalization allways have to be remembered. Performance depends on many components, among age, sex, body build, and lifestyle. Activities that the average 20-year-old person does, and not cause any difficulty, may be impossible for a 60 years old person. The amount of oxygen that is supplied during exercises is closely matched to the needs of the body. During exercise, the phenomenon of oxygen debt occurs, which can be defined as the difference between the demand and the amount of oxygen supplied (Traczyk, Trzebski, 2007). This difference is initially compensated by anaerobic processes. Therefore, to increase the amount of air delivered to the respiratory tract, there is an accelerated breath and thus, oxygen deficiency is supplemented. Oxygen uptake increases linearly with its demand for maximum oxygen uptake. VO_2max is influenced by factors such as the condition of the respiratory and circulatory systems and the condition of muscles and blood. At the start of exercise, the rate of oxygen uptake increases practically from the very beginning, to stabilize after about 2 - 5 minutes, adapting to the changes that occur in the body.

Lungs ventilation (VE) increases almost immediately when the body is subjected to exercise. Initially, the phase of rapid growth of VE goes into a period of stabilization, which is associated with an increase in the concentration of carbon dioxide and hydrogen ions in the blood, as well as an increase in body temperature. During exercise, an increase in blood flow through the lungs, gas exchange increases. Carbon dioxide is removed from the respiratory tract, which is replaced by oxygen, which is necessary for the body's life processes. Muscle work is also increased breathing, which also undergo prolonged effort (Marecki, 2004).

With regular physical activity, the efficiency of the respiratory system increases, the frequency of inspirations decreases, and their capacity increases, which has a significantly positive effect on the functioning of the entire body (Czyżewska, 2010).

The circulatory system during physical activity also does not remain indifferent to stressors affecting the human body. Through the circulatory system, oxygen is supplied to the muscles, which is involved in their work. Blood flowing in the body has a transport function, provides glucose and free fatty acids. During physical activity, the speed of blood flow increases, mainly in muscle, skin and lungs. The level of blood pumped increases throughout the circulatory system, including the heart, which thanks to this process increases its minute volume (Table 1). In the circulatory system, the minute volume increases with oxygen deficiency. Depending on the training of the body, the minute volume of the heart (CO) takes values from

15 - 25 l · min-1 for non-training people, to over 40 l · min-1 in athletes practicing endurance disciplines. These data relate to cardiac output in maximal load. An increase in CO is possible by increasing the stroke volume (SV) as well as an increase in the number of cardiac contractions, which is worth mentioning, has the ability to work only in aerobic conditions, so his work also increases the need for oxygen in the human body. During exercise, myocardial contractions (HR) are an important cardiovascular response. In a healthy person, the correct HR value during physical activity should be, depending on age: HRmax = 220 - age. The frequency of heart contractions increases directly with the start of exercise, and within about 2 - 5 minutes it is stabilized to the amount required, due to the characteristics and intensity of the work performed by the body. With systematic endurance training, there is a significant reduction in HR. The reason for reducing the number of myocardial contractions is the increase in its ejection capacity, through which the cardiac output remains constant. As a result, the heart itself does not require much oxygen. A decrease in HR (with intense training) can be reduced by 5 - 8 min-1. After endurance work, a decrease in blood pressure is noted, not only immediately after training, but also at a later time, when performing everyday activities (Czyżewska, Górski, 2001).

Tab 1. Cardiac minute volume and blood flow (ml · min^{-1}) through various vascular areas (Czyżewska, Górski, 2001)

	REST		SUB-MAXIMAL EFFORT		MAXIMUM EFFORT	
CARDIAC OUTPUT	5800	(100%)	21000	(100%)	25000	(100%)
SKELETAL MUSCLE	1200	(21%)	14000	(66%)	22000	(88%)
HEART MUSCLE	250	(4%)	850	(4%)	1000	(4%)
VISCERA	1400	(24%)	1050	(5%)	300	(1%)
KIDNEYS	1100	(19%)	730	(3,5%)	250	(1%)
BRAIN	750	(13%)	950	(4,5%)	750	(3%)
SKIN	500	(9%)	3150	(15%)	600	(2,5%)
OTHER ORGANS	600	(10%)	620	(2%)	100	(0,4%)

Blood circulating in the human body consists of plasma, which is an aqueous solution and organic salts as well as blood cells. Plasma is a fluid in which morphotic elements of the blood are found, such as red blood cells (erythrocytes), white blood cells (leukocytes), and platelets. A significant part of the morphotic molecules are erythrocytes, they constitute about 95% of the cells. Platelets are second - 4%, while leukocytes are just 0.1%. During intense training, there is a change in the amount of plasma. In the first stage, its volume decreases, and then, in the post-workout period, to increase again. It is estimated that the absolute increase can be up to 560 ml. In the case of regular, intensive work, these changes take place permanently (Spodaryk, 2001).

Depending on the time in which the effort is made and its intensity, changes in the hormonal economy can be observed. This relationship is presented in Table 2.

Tab. 2. Hormonal balance changes that occur during one-time muscular exercise

	One-time effort			
Hormone	**Low intensity**	**Short-term submaximal**	**Long-term**	**Strength**
Growth hormone	↑↑	↑	↑↑	↑↑
Prolactin	↑↑	↑	↑	↑
ACTH	↑↑	↑	↑↑	↑↑
Cortisol	↑↑	↑	↑↑	↑↑
TSH	↑/0	↑	↑/0	?
T4 i T3	0	0	↑/0	0
ADH	↑↑	↑	↑↑	?
Aldostreon	↑	↑	↑↑	↑
ANP	↑	↑	↑↑	?
FSH and LH	↑/0	↑	↑/0	↑↑
Testosterone	↑	↑	↑/↓	↑
Estrogens	↑	↑	?	?
Progersteron	↑	↑	?	?
Parathyroid hormone	↑	↑	↑	?
Catecholamines	↑↑	↑	↑↑	↑↑
Insulin	↓	↓	↓↓	↓↓
Glukogon	↑	↑	↑↑	?

The main task of the digestive system is to take food, transform it, absorb nutrients, and expel unnecessary waste products. During prolonged and intensive activity digestive tract disorders may occur. Ailments can occur on its various sections. One of the most common undesirable gastrointestinal symptoms is the esophagus reflux, which may result in the physical activity undertaken by the athlete being interrupted. The degree of these ailments is affected by the nature, time and intensity of physical exertion. According to observations, these inconveniences are more common for runners compared to athletes from other sports.

Responsible for esophagus reflux is the fact that there are changes in the contractions of this section of the digestive system. This happens most often when their duration and frequency decreases. These changes can be observed with an oscillating effort of 70 - 80 VO2max. At this value, the process of delaying gastric emptying is also noticeable, which also does not remain indifferent to the problems of esophagus reflux. Changes in the small intestine are visible already during physical activity, oscillating at 50% VO2max (Stasiewicz, 2001).

Absorption of electrolytes and water as well as glucose is impaired. The next element in the digestive system is the large intestine, where due to motor activity, intestinal peristalsis increases, which facilitates the movement of fecal masses through them. Confirmation of this theory is also the observation of athletes

participating in long-distance runs in which diarrheal episodes occur very often. About 10% of respondents complained about these ailments (Stasiewicz, 2001).

During endurance exercise, there is a significant increase in anaerobic potential, and muscle resistance to fatigue increases. With systematic endurance work, lactate concentration during the post-workout period decreases. Blood supply in muscle tissue increases, this change is observed in both endurance and strength training. The increase in muscle mass in long-term exercise is not as spectacular as in the case of strength training, a slight increase can be observed. In addition, the contraction time of muscle fibers is significantly reduced. During work, ATP is the direct energy source for muscle contraction. When exercise begins, its amount lasts for a very short time, about 1-2 seconds. For muscle contractions to continue, this supply must be constantly renewed through various aerobic or anaerobic processes. Adenosine triphosphate can be obtained, among others by synthesizing phosphocreatine, which is the main energy supply in muscle, it is the fastest way to obtain ATP (Górski, 2010).

There is a large amount of glycogen in the muscles when, during prolonged exercise, its reserves are utilized, and muscle proteins break down. Proteins are used for energy production undergoing oxidation, providing about 15% of total energy for working muscles (Hubner-Woźniak, Lutosławska, 2000).

Summary

Analyzing the influence of physical activity and physical training on the body functioning we can clearly observe that most of the changes that occurs are directed to offset the impact of ongoing activity on intra-systemic homeostasis. Observation of physiological reaction of body are very important are a very important tool that allows you to analyze the preparation of the human body for carrying out activities. The large number of physiological changes have a short-term nature (especially hormonal disorders), however, it should be remembered that the rate of recovery may be very extended in time.

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