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MEDICAL AND BIOLOGICAL ASPECTS OF PHYSICAL CULTURE AND SPORT

Course of lectures

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The course of lectures covers the basics of general pathology, clinical and paraclinical methods of examination, issues of sports medicine, hygiene, overexertion and recovery.

Lectures are prepared for English-speaking undergraduates of the Faculty of Physical Culture and Sports of the specialty 1-08 80 04 Physical culture and sport. Majoring in “Pedagogical activity in adaptive physical culture”.

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CONTENTS

INTRODUCTION

In everyday life, in amateur and high-performance sports, one of the most important factors contributing to the improvement of physical performance is motor activity. The combination of systematic physical activity with various climatic factors (mid-mountain, artificial hypobaric adaptation, hot, humid climate) increases the adaptive capabilities of those involved in sports.

Without understanding the normal course of biomedical and physiological processes and the constants that characterize them, specialists in the field of physical culture and sports cannot correctly assess the functional state of the human body and its performance in the conditions of motor activity. Knowledge of the physiological mechanisms of regulation of various body functions is important in understanding the course of recovery processes during and after strenuous muscle labor.

Thus, any coach and teacher for successful professional activity requires knowledge of the functions of the human body. Only taking into account the peculiarities of its vital activity can help to properly manage the growth and development of the human body, preserve the health of children and adults, maintain performance even in old age, rational use of muscle loads in the process of physical education and sports training.

Lecture 1
MEDICAL SUPPLIES OF SPORTS ACTIVITIES

Plan

1. Medical and life sciences, their methods, place and role in physical culture and sport.
2. Medical supplies of sports activities.
3. The structure of sports medicine system in the Republic of Belarus.

Medical and life sciences, their methods, place and role in physical culture and sport

Medical and life sciences represent a set of sciences that study the natural (biological) state of the person, both in stable and in pathological conditions. Among these are human anatomy and morphology – the science of the structure of the human body; physio*logy* – the science of human life and activities; *biochemistry* – the science of the biochemical composition of the human body and the chemical reactions occurring in it; *biomechanics* is the science that studies mechanical processes occurring in living tissues, organs and the human body as a whole. *Sports medicine* examines health and physical problems of people, who work out and practice sport; *sanitary science* studies the influence of the conditions of physical culture and sports activities on people's health; *preventive medicine* examines measures of the prevention of diseases that arise under the influence of the process of sports training or professional activities.

The study of these sciences is extremely important for experts in sports activities, teachers, coaches, consultants, since physical culture, sports are associated with anatomical and physiological features of the athlete's body. Knowledge about the development and maintenance of movement skills and qualities is important.

Biomedical sciences make it possible to study deeply the processes taking place in the body during sports activities and to influence the result, indirectly affecting various physiological systems.

In physical culture and sports activities the system of biomedical research methods has developed for studying: 1) organs – heart, lung, stomach, brain, etc.; 2) systems – bone-muscular, digestion, breathing, circulatory, nervous activity, neurohumoral regulation; 3) human body as a whole.

According to the usage purposes, biomedical research methods are divided into:

- *Diagnostic* – methods of examination the state of the body;
- *Prognostic* – methods of examination of possible results of physical and sports activity;
- *Rehabilitation* – methods of functional recovery of body systems after extreme physical and mental exertions.

They are used to select a particular sport for a child, determining children's abilities for different types of physical activity.

According to the nature of use, biomedical research methods are divided into groups of methods that determine the level of physical development of a person. This division is based on such indicators as height, body weight, vital capacity (VC), heart rate (HR), arm muscle, legs strength and back strength. Biomedical research methods are used in assessing the person's general level of fitness for various activities, which serves as the basis for determining his disposition to definite kind of physical and cultural activity, sports.

Biomedical research methods allow to determine the dynamics of human body development in the process of physical and sports activity; to identify natural mechanisms of formation and development of movement skills and qualities, their adaptation to physical and mental exertions; to learn about the functional capabilities of the body, mechanisms of their use and mobilization in the process physical and sports activities.

In addition, with the help of biomedical indicators, the power of physical activity, the intensity of training and competitive processes are determined. They help to control physical and sports activity so that it does not cause harm to health, but contributes to its strengthening, helps to build training process reasonably and determine the need for human physical and mental rest.

According to the analysis tools used, biomedical research methods are divided into organometrics (visual, tactile) and researches by the means of apparatus (anthropometry, spirometry, dynamometry, pulsometry, electrocardiogram, electromyogram, electroencephalogram).

It is prohibited to: 1) use those research methods that can harm a person; 2) perform experiments on living people without their consent; 3) use drugs and exercises that can cause harm to human health.

The use of biomedical research methods in physical culture and sports must meet the general scientific requirements: objectivity, verifiability, possibility of reply of results. Special principles of their application are considered unity of functional and structural changes in the human body. In physical and sports activities, the exercise principle is important, i.e. systematic repetition of movement acts. Training leads to functional and structural changes in the human body (growth of muscle mass, reinforcement of bones).

Currently, the body of the athlete is unable to withstand physical and mental exertions without the use of pharmacology, physiotherapeutic and psychological methods. Therefore, scientific-technical and medical directions are intensively created to solve the problem of increasing the efficiency of athletes' training activity.

Medical supplies of sports activities

Monitoring of the functional state of the body of people, who take up sports, is important and has a multistage organization.

1. Self-monitoring.

2. Monitoring of the trainer, physical education teacher, head and methodologist of the sports section.

3. Monitoring of the medical professions, representatives of sports medicine.

Providing services of medical monitoring and medical assistance for persons, who do sports, is based on two principles: 1) territorial, i.e. medical institutions at the place of residence and 2) profession-oriented, i.e. qualified specialists of sports medicine in the dispensaries of sports medicine.

Sports medicine is a separate specific field of medical science and practice, a branch of professional activity of doctors aimed at health maintenance and sports development. This doctors' professional activity is responsible for biomedical supply of training of persons engaged in sports. The main purpose of sports medicine is biomedical athletes' preparation for participation in competitions.

The main tasks of sports medicine:

1. Biomedical selection and admission to sports according to the capabilities of the body. Admission to sports and sports training based on health assessment.

2. Monitoring of functional readiness of the athlete's organism on the assessment of the specific work carried out by him and on the assessment of the reactions of the athlete's organism to the training and competitive work, correction of the dynamics of the level of functional readiness of the athlete. Stimulating the growth of training (increase of special working efficiency) of the athlete.

3. Prevention and treatment athletes' injuries and diseases, rehabilitation of athletes after suffered injuries and diseases, emergency care for injuries and emergency conditions of athletes. Monitoring of compliance of athletes with hygienic requirements, and the use of pharmacological drugs in sport.

The structure of sports medicine system in the Republic of Belarus

In the Republic of Belarus, the main institution, which defines activities in the field of sports, physical culture and tourism, is Sports and Tourism Ministry of the Republic of Belarus. It exercises control over the sports medicine system in the country. Sports medicine in our country is represented by the Republican Scientific and Practical Center of Sports, uniting the Center of Sports Medicine and the Research Institute of Physical Culture and Sports. There are sports medicine dispensaries in all regional centers, in certain cities and districts. In the Sports School of Olympic Reserve (SOR), there are medical rehabilitation centers, doctors of sports medicine work in sports faculties, in medical universities. Training of doctors of sports medicine in the Republic of Belarus is

carried out on the basis of the Belarusian Medical Academy of Post-Graduate Education (BelMAPO).

The dispensary is a specialized medical and preventive institution intended to ensure medical control of athletes, provide them with medical aids and organizational and methodological guidance for the physical education of the population.

Functions:

1. Dispensary observations of athletes, students of children's, junior schools, schools of the Olympic reserve, members of national teams.
2. Delivery of therapeutic and preventive care services.
3. Implementation of medical support of sports events.
4. Medical-sports consultations.
5. Study of causes of athletes' illnesses, sports injuries, development of methods of treatment and prevention.
6. Scientific work in the field of sports medicine.
7. Sanitation and preventive activity.

The work of SMD (Sports Medicine Dispensary) is carried out in contact with sports departments, scientific and medical institutions.

Medical monitoring of the state of health of people in the physical and recreational sphere is carried out mainly by health institutions (polyclinic) at the place of residence. Frequency – when required and with necessary in-depth examinations: anamnesis, surveying, examination, blood and urine tests, ECG, X-ray, tomography.

Lecture 2
PHYSIOLOGICAL MECHANISMS OF LIFE OF ORGANISM VITAL FUNCTIONS

Plan

1. Basic concepts of physiology and biochemistry of physical culture and sports.
2. The nervous system.
3. Analyzers.
4. Cardiovascular system.
5. The lymphatic system.
6. Respiratory system.
7. Digestive system and metabolism.
8. Excretory system.
9. Endocrine system.

Basic concepts of physiology and biochemistry of physical culture and sports

To organize a successful training process, it is important to know and understand the structure of the cardiovascular system, the structure of the cardiac cycle, and the biochemical processes in tissues and organs.

Any physical action is possible due to the processes of excitation in the tissues. The manifestation of excitement in the muscles is contraction, in the gland – secretion, in the nerve ending – the emergence and conduction of nerve impulses.

Regulation of the activity of organs and body systems is carried out by the humoral and neuro-humoral path. The humoral path is carried out by hormones produced by the endocrine glands.

Nervous system

The human nervous system is usually subdivided into central and peripheral, as well as somatic and autonomic (autonomous).

The central nervous system includes the brain and spinal cord, the peripheral – nerve formations that serve to connect the central nervous system with individual organs and tissues of the body (nerves, nodes, plexuses), as well as nerve endings that are located in organs (sensory or afferent, motor or efferent).

The brain is usually divided into five sections: 1) the medulla oblongata, where the centers of cardiac and respiratory activity, the vasomotor center are located); 2) the hindbrain, consisting of a bridge (formation connecting the cerebellum and medulla oblongata with the cerebral hemispheres) and the cerebellum; 3) the midbrain, consisting of the upper (posterior) and lower (anterior) sections; 4) diencephalon – thalamus (optic tubercle, hypothalamus, epithalamus, metathalamic); 5) the telencephalon, consisting of the right and left cerebral hemispheres.

Neurons - nerve cells with processes (long – axon, short – dendrite) enter into connections with the bodies of nerve cells through synapses, which ensures the interconnection of the CNS regions with each other.

Sensory nerve pathways begin with nerve endings – receptors that are excited by the action of stimuli. The body's response to the stimulus, which occurs with the participation of the central nervous system, is called a reflex. The path along which arousal moves during the implementation of a reflex is called a reflex arc. Reflexes are divided into unconditioned (congenital) and conditioned (acquired by the body during life as a result of individual experience).

At the heart of sports, applied and other exercises is a dynamic stereotype, i.e. a system of fixed, interconnected and consistently acting conditioned reflexes, each of which is a conditioned stimulus that prepares the body for the next reflex component of a complex motor act.

Analyzers

For a clear performance of physical exercises, it is necessary for the nervous system to receive messages from the outside world. Communication with the outside world is carried out through analyzers: olfactory, visual, auditory, gustatory, vestibular. Thanks to analyzers, changes occur in the activity of the cardiovascular, respiratory, endocrine systems when exposed to the body from the outside.

With the complex work of analyzers, athletes may experience: "feeling of water" among swimmers, "feeling of snow" among skiers, and among skiers – "sense of the track".

The most important feeling for an athlete is proprioception, or the ability to feel the position of the body, or rather the position of the muscles, without using vision.

The cardiovascular system

The cardiovascular system is represented by the heart and blood vessels. The vessels that bring blood to the heart are called veins, and those that carry blood to the organs are called arteries.

The heart is located in the left side of the chest and consists of four chambers: two ventricles and two atria. In the left ventricle, the aorta begins the systemic circulation, through which blood, enriched with oxygen, enters the organs and tissues, and then through the superior and inferior vena cava returns to the heart, to the right atrium. The small circle of blood circulation begins in the right ventricle, from there blood flows through the pulmonary artery to the lungs, where it is enriched with oxygen and enters the left atrium through the pulmonary veins.

There are valves between the ventricles and the atria that provide unilateral blood flow.

Functions of the cardiovascular system:

- transport (transport of oxygen, carbon dioxide, nutrients, metabolic products);
- integrative – combining organs and systems;
- regulatory;
- protective (participation in immune reactions, inflammation).

There are three phases in the work of the heart: 1) contraction of the atria and ventricles (systole); 2) relaxation of the atria and ventricles (diastole); 3) pause – the period in which the atria and ventricles are at rest.

The work of the heart is characterized by automatism, coordination and rhythm. Automatism means the ability of the heart to constantly contract due to the impulses that arise in itself, by coordination – the order in the reduction of its parts, by rhythm – the ability to carry out contractions at regular intervals

The stroke volume of the heart is the amount of blood ejected by the heart in one contraction (systole), which at rest is 60–70 cm^3, and when doing physical exercises, it reaches 150 cm^3 or more.

The activity of the heart is regulated by the central nervous system by the mechanism of unconditioned and conditioned reflexes. Impulses coming through the sympathetic nerves – increase the strength and heart rate, along the parasympathetic nerves – decrease. During exercise, muscle work increases, the maximum blood pressure increases, and the minimum decreases. These changes can be used to judge the degree of physical activity involved. For example, at rest, the heart rate is 50–60 beats / min. As the load increases (for example, when walking or running), the heart rate changes. When performing very intense exercise in untrained individuals, it increases to 220–250 beats / min, and in trained individuals – up to 180–200 beats / min.

The lymphatic system

The lymphatic system consists of lymphatic vessels and lymph nodes. Unlike the vessels of the cardiovascular system, lymphatic vessels have closed ends, that is, the intercellular fluid in the lymphatic system moves in one direction: back to the heart.

On its way, the lymph passes through the lymph nodes, where phagocytosis and recognition of a foreign one takes place.

Lymph nodes are superficial (inguinal, axillary, cervical, occipital) and deep (mesenteric, sternal). The largest lymphatic vessels: the right and left lymphatic ducts, the left and right jugular trunks, the left and right subclavian trunks, merge and flow into the subclavian veins.

Respiratory system

Breathing is the exchange of gases (oxygen and carbon dioxide) between the body and the environment through the respiratory system, which consists of the right and left lungs and airways.

The respiratory system includes the upper respiratory tract: nasal cavity, nasopharynx, oropharynx, oral cavity and lower respiratory tract: larynx, trachea, bronchi, lungs. The trachea is divided into left and right bronchus, which are further dichotomously divided into smaller bronchi and bronchioles. Bronchioles end with alveoli, vesicles entwined with blood vessels.

The lungs are located in the chest cavity and are surrounded by the pleura (two sheets: parietal and visceral).

The breathing process consists of external respiration, the transport of gases by the blood, and tissue respiration. External respiration consists in the exchange of gases between the air that fills the alveoli and venous blood. The transport of gases by the blood ensures the delivery of oxygen from the lungs to the tissues, and carbon dioxide from the tissues to the lungs. Oxygen participates in the body's oxidative reactions during metabolism. The resulting carbon

dioxide from the tissues enters the bloodstream, is carried to the lungs, and is removed from the body during respiration. During tissue respiration, gases are exchanged between blood and tissues, and the thinnest wall of the blood capillary is the "gateway" through which this exchange takes place.

Exercise leads to significant changes in gas exchange during breathing. At rest, only 30% of the oxygen brought in by the blood is taken up by the tissues. With physical exertion, this indicator increases to 60–80%, which ensures a better supply of oxygen to the body and removal of carbon dioxide, and increases the body's performance.

One of the characteristics of the functional state of the human body is the vital capacity of the lungs (VC) – the volume of air that a person is able to exhale after maximum inhalation. It is measured with a spirometer, normally for men it is 4000–4500 cm^3, for women – 2500–3000 cm^3.

Pulmonary ventilation is the volume of air passing through the lungs in one minute. At rest, the volume of air during exhalation averages 500 cm^3, and the number of breaths is 12–16 per minute. At rest, pulmonary ventilation is 6–8 l / min, and in well-trained people it can reach 10 l / min.

Breathing is regulated by reflex and humoral mechanisms. The humoral regulation of respiration is due to the action through the blood of a number of chemicals directly on the respiratory center located in the medulla oblongata.

When performing intense exercises for 1.5–2 minutes or more (for example: running for 3 km, skiing for 15 km, etc.), deterioration of health may occur in the form of fatigue and sensations of "suffocation" and "tightness in the chest". This condition, called "dead spot", is associated with temporary disorders of the nervous system, blood circulation, respiration, when the function of respiration and metabolism do not provide adequate muscle work. The body accumulates poisonous metabolic products that inhibit the activity of the central nervous system.

In the future, with the continuation of muscular work at the same pace, the person's well-being improves and efficiency is restored. This happens due to the fact that the body adapts to new conditions and moves to a new, higher level. The so-called "second wind" comes, which is accompanied by profuse sweating and deepening breathing.

With prolonged muscular work of significant intensity, the "dead spot" and "second wind" can re-occur several times.

Digestive system and metabolism

The organs of the digestive system include: the oral cavity, bounded in front by the lips and two rows of teeth, the tongue is in the oral cavity. Here, food is chopped and moistened with saliva, and the digestion process begins, the breakdown of simple carbohydrates. The papillae of the tongue contain taste buds.

Further, food enters the pharynx, esophagus and stomach. In the stomach, food is processed with gastric juice containing hydrochloric acid and pepsin, and

proteins are broken down. After that, food enters the duodenum, where the secretion of the pancreas, bile enters, and fats are broken down.

In the small and large intestines, nutrients and water are absorbed and metabolic products are excreted.

Nutrients entering the body (proteins, fats, carbohydrates, salts and water) provide energy, participate in the construction of new cells and tissues. Enzymes (chemicals) accelerate the course of chemical reactions associated with digestion, promote the breakdown of foods to a state in which they can be absorbed into the blood. Normal digestion contributes to the efficient functioning of the human body.

Assimilation (assimilation) and dissimilation (decay) of substances occur in all cells and tissues of the body. This process involves proteins, fats, carbohydrates, vitamins, mineral salts and water. Glucose as the main source of energy for the activity of the central nervous system is of great importance. With a sharp decrease in its content in the blood, convulsions, loss of consciousness and even death may occur.

The exchange of energy goes on continuously and flows between the individual parts and cells of the body, the body and the environment. The units for measuring the amount of heat energy are calorie (cal) and kilocalorie (kcal), which is determined by the amount of heat required to heat 1 liter of water by 1°C.

Basal metabolism is the amount of energy expended by the body in complete rest 12–16 hours after eating at ambient temperature 16–20°C. In an adult, it averages 1 kcal per 1 kg of body weight per hour and reaches 1300–1800 kcal per day.

During physical exercises, the more intensive and longer the work, the higher the amount of energy consumption. So, the cost of skiing for 10 km is about 900 kcal, overcoming the distance in running for 100 m – up to 20 kcal. For good nutrition, it is necessary that the daily diet contains 50–60 g of fats, about 80–100 g of proteins, 500–600 g of carbohydrates and a sufficient amount of vitamins (with an optimal quantitative ratio).

Excretory system

Removal from the body of various toxins formed as a result of energy decay is carried out through the excretory organs: kidneys, sweat glands, lungs and intestines.

The kidneys are the excretory organ through which water and mineral salts are excreted from the body (in case of excessive consumption). Urine is formed in the kidneys from the blood. About 800–900 liters of blood pass through the kidneys per day, and a person secretes up to 1,5–2 liters of urine.

Sweating is the process of removing metabolic products and water from the body through the sweat glands. It also regulates body temperature. With prolonged physical work (for example: long-distance running, sports games, etc.), the intensity of sweating increases.

Endocrine system

The endocrine glands include the thyroid gland, pituitary gland, adrenal glands, pancreas, gonads and other glands. They play an important role in the regulation of human life. The glands secrete secretions (hormones) into the blood, lymph and cerebral fluid.

When exercising, hormones mobilize body functions, increase metabolism, and participate in recovery processes. For example, the adrenal glands secrete adrenaline, a hormone that promotes the breakdown of glycogen in the liver and the flow of carbohydrates into the blood, increases the excitability of tissues, and enhances the activity of the heart.

Knowledge and understanding of the mechanism of energy conversion during muscular activity, the influence of hormones and other biologically active substances, ways to accelerate recovery processes form a training strategy for athletes and improve the result.

Lecture 3
FUNCTIONAL TESTS FOR ASSESSING ATHLETES' HEALTH

Plan

1. General and special physical performance.
2. Requirements for the testing procedure.
3. Functional tests.

The level of physical performance is one of the objective criteria of human health. The concept of physical performance is complex and determined by a number of factors: morphofunctional state of various organs and systems, mental status, motivation, etc. Therefore, a conclusion about the level of physical performance can be drawn only on the basis of a comprehensive assessment.

General and special physical performance

There are terms "general" and "special" physical performance. “Special” physical performance characterizes the athlete's ability to perform work specific to a particular kind of sport. For its assessment, specific tests are used that simulate an activity which is typical for a particular kind of sport (for example, exercises on a rowing machine for a rower). While the general physical performance is proportional to the amount of mechanical work that the athlete's body is able to perform for a long time and with a sufficiently high intensity.

The overall physical performance is limited by the delivery of oxygen to the myocytes and is highly dependent on cardio-respiratory performance. The level of general and special physical performance can differ significantly for the same athlete.

Requirements for the testing procedure

To ensure reliable results, on the basis of which the physical performance and fitness of an athlete can be reasonably assessed, it is necessary to fulfill a number of requirements for the testing procedure:

1. Provision of optimal microclimate in the testing room. A minimum of medical staff should be involved in testing. It is necessary to exclude the occurrence of sound, light and other signals that are not related to the study.

2. When doing work of extreme intensity or duration, motivation is important.

3. Before starting the testing, the subject should be given detailed instructions about his behavior during the test.

Functional tests

Functional tests started to be applied in sports medicine at the beginning of the 20th century. The first functional test used for the study of athletes was the SCIPE (State Central Institute of Physical Education) test, developed by D.F. Shabashov and A.P. Egorov in 1925. When conducting the test, the subject performed 60 step hops on the spot. The reaction of the body was studied according to the data of cardiac activity. Subsequently, sports physicians significantly expanded the arsenal of used tests, borrowing them from clinical medicine.

In the 30s, multi-stage functional tests began to be applied, in which the subjects performed muscle work of different intensity and nature.

Subsequently, more complex tests appeared, the performing of which requires special equipment (treadmill, bicycle ergometer, etc.).

Functional tests are various dosed activities and disturbing effects that allow obtaining objective data on the functional state of the physiological systems of the body.

There are one-stage, two-stage and three-stage (combined) tests.

In one-step tests, a uniform physical activity is provided.

In two-stage tests, a repeated activity is provided, usually the same, with short intervals for rest, during which the physiological response to the first activity is being determined.

Combined (three-stage) tests are intended to diagnose the adaptation of the circulatory system to various types of activities.

One-stage tests are used in mass examinations of people who are engaged in physical activity in the groups of general physical fitness and in health groups, as well as people entering the path of sports improvement to quickly obtain approximate information about the functional state of the circulatory system. They are also convenient when conducting medical and pedagogical observations. More significant changes in the function of the cardiovascular system cause two-stage tests, but their value is reduced by the common nature of

repeated activities. This disadvantage is compensated by the combined Letunov's three-stage test.

Indications for functional tests:

1) determination of a person's physical fitness for physical culture and sports, physical therapy;

2) examination of professional suitability;

3) assessment of the functional state of the cardiovascular, respiratory, nervous and other systems of healthy and sick people;

4) assessment of the effectiveness of rehabilitation and training programs;

5) predicting the likelihood of occurrence of certain deviations in the state of health during physical activity.

Requirements for functional tests:

1) the activities should be specific to the person who train;

2) the test should be carried out at the highest possible intensity for a particular subject;

3) the test should be standard and easily reproducible;

4) the test should be equivalent to the activity in living conditions;

5) the test must be harmless.

When testing the physical fitness of middle-aged and older people who are engaged in health-improving physical education and have chronic diseases of the cardiovascular system, care must be taken.

Absolute contraindications:

1) severe circulatory failure;

2) rapidly progressive or unstable angina pectoris;

3) the acute stage of myocardial infarction;

4) active myocarditis;

5) recent embolism;

6) vascular aneurysm;

7) acute infectious disease;

8) thrombophlebitis;

9) ventricular tachycardia and other dangerous rhythm disturbances;

10) pronounced aortic stenosis;

11) hypertensive crisis;

12) severe respiratory failure;

13) inability to perform the test (diseases of the joints, nervous and neuromuscular systems, which interfere with the test).

Relative contraindications:

1) supraventricular rhythm disturbances such as tachycardia;

2) recurring or frequent PVCs (Premature ventricular contractions);

3) systemic or pulmonary hypertension;

4) The heart aneurysm;

5) moderately pronounced aortic stenosis;

6) significant expansion of the heart;

7) uncontrolled metabolic diseases (diabetes, myxedema);

8) toxicosis of pregnant women.

Clinical criteria for termination of the test:

1) achievement of submaximal (indicator) age heart rate;

2) an attack of angina pectoris;

3) decrease in blood pressure by 20–30% of the initial level or the absence of its increase when increasing the activity;

4) a significant increase in blood pressure (more than 230/130 mm of mercury (mmHg));

5) an attack of suffocation;

6) severe shortness of breath;

7) severe weakness;

8) dizziness;

9) nausea;

10) severe headache.

Functional tests of the cardiovascular system's state include an assessment of blood pressure and pulse rate at various types of activities with an assessment of the dynamics of recovery.

To assess the type of cardiovascular system's response to physical activity, a number of criteria should be taken into account:

1. The absolute values of heart rate and blood pressure SBP (systolic blood pressure), DBP (diastolic blood pressure), AHBP (average hemodynamic blood pressure), PBP (pulse blood pressure).

2. The relationship of changes in heart rate and blood pressure.

3. Adequacy of changes in these indicators to the volume of physical activities.

4. Recovery time of heart rate and blood pressure, the dynamics of changes in indicators during the recovery period.

5. Outward signs of fatigue.

6. The specificity of the activity (the non-specificity of the activity aggravates the assessment of the results, especially among the representatives of complex coordination kinds of sports).

7. Determination of physical performance. There are direct and indirect, simple and complex health determination methods (PWC). Tests that are widely used: Rufier's test, Harvard step-test, Letunov's test, treadmill testing, tests with maximum activity, Novakki's test, Cooper's 12-minute test, determination of maximum oxygen consumption, determination of the body's anaerobic capabilities by the value of maximum anaerobic power (MAP).

Lecture 4
BASIC PRINCIPLES OF GENERAL PATHOLOGY

Plan

1. The concept of health and disease.
2. Cause of disease.
3. Pathogenesis.
4. Reactivity and resistance
5. Types of reactivity.
6. Immunity.
7. Sports pre-pathology and pathology.

The concept of health and disease

In order to define the "health" and "disease" categories, you must establish the "norm" category.

The World health organization (WHO) has proposed a definition of health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Health is characterized by: anatomical and functional integrity of the body, i.e. the absence of lesions; sufficient adaptability to the environment (physical and social), which is estimated by the value of morphological and functional reserves of organs and systems; sense of well-being.

Pathology (from Ancient Greek πάθος [pathos – suffering, disease], and λογία [logos – science]) is a science that studies the patterns of occurrence and development of diseases, individual pathological processes and conditions.

A pathological reaction is a reaction of the body that occurs in response to the action of pathological stimuli and leads to a homeostatic disruption.

A pathological process is a sequence of reactions that naturally occurs in the body to the damaging effect of a pathogenic factor.

It should be noted that the pathological process is the basis of diseases. The differences between the disease and the pathological process are as follows:

- the disease always has one main cause, and the pathological process is polyetiological (the disease can be caused by different reasons);
- the same pathological process can cause a different picture of the disease depending on the site of the lesion;
- the disease is often a combination of several pathologies
- processes;
- the pathological process may not be accompanied by a decrease in the body's adaptability and limited performance capacity.

A pathological condition is a relatively stable deviation from the norm that has a biologically negative value for the body.

A disease (from Latin morbus) is an alteration of the normal functioning of the body, caused by the action of emergency factors that lead to functional or

morphological changes. R. Virchow defines a disease as "life under abnormal conditions".

Pathogenic agents (extreme stimuli) cause illness in cases where the force of their influence exceeds the protective or compensatory capabilities of the body. A disease can occur as a result of:

- single exposure to pathogenic agents (flu, burn);
- repeated or prolonged exposure to pathogenic agents (gastric ulcer, as a result of prolonged stress; atherosclerosis and obesity in case of diet violation).

Factors that weaken the body's defenses:

- physical exertion;
- stress;
- state of psychological discomfort;
- violation of the work and rest schedule;
- breaking personal hygiene rules;
- poor nutrition;
- unhealthy lifestyle;
- bad habits (smoking, alcohol and drug use) etc.

The doctrine of the causes and conditions of diseases is called **etiology.**

The cause of the disease is a factor that causes the disease and gives it specific features. There are external (exogenous) and internal (endogenous) causes.

External causes include:

- mechanical – impact on the body of moving objects that cause bruises, sprains, tears, crushing of tissues, injuries, dislocations and fractures of bones, concussion of the brain;
- physical – exposure to high or low temperature, radiation energy, electric current, changing atmospheric pressure;
- chemical – exposure to chemical compounds (acids, alkalis, toxic substances, highly toxic substances);
- biological – the impact on the body of pathogens that cause infectious diseases;
- social – negative impact on the psyche of social factors.

Internal causes include:

- heredity – disposition to the disease (gallstone disease, bronchial asthma, etc.);
- body build (asthenic physique predisposes to the development of chronic lung diseases and tuberculosis, peptic ulcer disease and cancer of the gastrointestinal tract; hypersthenics are more likely to suffer from coronary heart disease, arterial hypertension, chronic liver and gallbladder diseases, calculous cholecystitis, urolithiasis).
- age (for early childhood, measles, rubella, mumps are specific; in old age, coronary heart disease, deminyelinating diseases, etc. develop.);

- sex (men are more likely to be diagnosed with chronic suppurative processes in the bronchi and lungs, coronary heart disease, duodenal ulcer; women-diseases of the thyroid gland, gallbladder, obesity).

Pathogenesis is the study of the mechanisms of disease development. The influence of the causal factor has an effect on the "trigger" of the disease, but the mechanism of disease development in different patients may differ.

There is a relative gradation of diseases into groups, taking into account the duration of their course:

- acute course (up to 15 days);
- subacute course (up to 45 days);
- chronic course (more than 45 days).

There are 4 main stages in the development of the disease (periods):

1. *Latent (hidden) periodis* the period from the moment of the beginning of the influence of the pathogenic agent on the body until the first signs of the disease appear. In the practice of infectious diseases, this period is known as "incubation". The duration of the hidden period varies from a few seconds (cyanide poisoning, trauma, etc.) to several years (lepra) and decades (AIDS). A distinctive feature of this stage is the absence of subjectively perceptible and visible violations of the healthy state.

2. *Prodromal period* is the period of time from the moment of the first symptoms of the disease to the full clinical picture of the disease.

This stage is characterized by the appearance of such non-specific symptoms as common ailment, weakness, headache, somnolence or insomnia, fever, lack of appetite, etc. In some nosological entities (hypertensive disease), the allocation of this period is conditional.

3. The peak of the disease (stage of the disease) characterized by the occurrence of specific illness symptoms, on the basis of identification which establishes the diagnosis.

4. The period of clinical outcome. The following possible clinical outcome:

- full recovery is a state in which all signs of the disease disappear;
- incomplete recovery is a state in which persistent residual effects stay behind after the disease;
- chronification;
- relapse is a return of the disease in the form of a new cycle;
- fatal outcome is death.

Reactivity and resistance

Reactivity (from Latin re + activus – active) – the property of the organism as a whole to respond to changes in life activity to the impact of the environment. This is as important an attribute of life as metabolism, growth, reproduction, etc.

Types of reactivity. The most common form of reactivity is biological form (species reactivity).

Biological reactivity is changes in the life activity of a protective and adaptive nature that occur under the influence of normal (adequate) environmental influences (irritations) for each animal.

Individual reactivity. Individual reactivity depends on heredity, age, and sex of the animal and human, as well as on nutrition, temperature, oxygen content, water, and other factors of the environment in which the organism lives. There are physiological and pathological individual reactivity of people and animals.

Physiological reactivity determines the presence of immunity and the possibility of developing allergic reactions in a healthy man; in these cases, we can talk about immunological reactivity.

Pathological individual reactivity develops in the case of the disease: it also depends on these factors and can manifest itself as specific and non-specific forms of response.

Age-dependent reactivity. There are three stages of changes in age-dependent reactivity during the individual life of the organism:

- hyporesponsiveness in early childhood;
- increased reactivity during puberty;
- decrease of reactivity in old age.

Immunity is an evolutionarily determined set of reactions of interaction between the immune system and biologically active agents (antigens). These reactions are aimed at preserving the phenotypic constancy of the internal environment (homeostasis) of the body. Their result can be various phenomena and immune responses, both protective and causing pathology.

In the human body, immune protection is provided by specific protection (production of antibodies to specific pathogens) and non-specific protection (natural resistance factors). Factors of non-specific protection are evolutionarily older. And they react to an encounter with foreign agents earlier than all the rest.

The factors of natural resistance include the following:

1. Natural barriers: skin, mucous membranes are the surfaces that first come into contact with infectious agents.
2. A phagocyte system that includes neutrophils and macrophages.
3. Inflammatory reaction.
4. The complement system (a set of serum proteins) that closely interacts with phagocytes.
5. Interferons.
6. A system of natural (normal) killers that do not have antigenic specificity (T-killers, K-cells).
7. Protective and adaptive mechanisms.

Depending on the mechanisms that form the body's immunity to pathogenic agents, there are two main types of immunity: hereditary and acquired.

Hereditary immunity (also inborn, specific, constitutional) is inherent in a particular animal or human species and is passed down from generation to generation by inheritance. For example, animals are immune to human chickenpox virus, serum hepatitis virus; humans are immune to bovine and canine distemper virus.

Inborn immunity can sometimes be overcome by weakening the general resistance of the body: radiation, splenectomy, starvation.

For example, chickens become susceptible to anthrax when their body temperature is artificially lowered.

Acquired immunity can develop after an infection or immunization. It is also strictly specific, but it is not inherited. There are passive and actively acquired immunity.

Natural actively acquired immunity occurs as a result of an infection.

Artificial actively acquired immunity occurs after vaccination and can persist for years (flu – 1–2 years) or decades (measles).

Passively acquired immunity occurs in the fetus due to the fact that it receives antibodies through the placenta, so the newborn in the first months of life is immune to infections suffered by the mother or against which she was vaccinated. This type of immunity is natural.

Artificial passively acquired immunity is created by introducing into the body immunoglobulins obtained from actively immunized people and animals. It is established a few hours after the introduction of immunoglobulins and persists for 3–4 weeks.

Sports pre-pathology and pathology

There are a number of typical pathological processes that occur after the action of certain damaging factors in all people. These are: local circulatory disorders, metabolic disorders in tissues, necrosis, inflammation, atrophy, hypertrophy, tumors.

In sport the following sports predpologala can be: acute and chronic overexertion, overworking, overtraining, chronic physiological overstrain of the central nervous system, chronic physiological strain cardiorespiratory system, chronic physiological strain of the digestive system, etc.

Specific sports pathology is chronic and acute overstrain of the musculoskeletal system, acute injuries of the musculoskeletal system in athletes: injuries to muscles, tendons and auxiliary joints, bone fractures.

Lecture 5
ACUTE AND CHRONIC FATIGUE IN SPORTS. METHODS FOR RESTORING ATHLETIC CONDITION

Plan

1. The nature of fatigue and recovery processes.
2. Causes and manifestations of overtraining.
3. Signs of overtraining (overexertion):
4. Overexertion of the cardiovascular system.
5. Means of restoring athletic condition.

Definition of "lassitude", "fatigue", "exhaustion", "endurance".

Lassitude – reduction in condition after performing physical or mental work.

Fatigue – subjective manifestations of fatigue that is shown by the refusal of further work, poor unstable mood.

Exhaustion – a condition of the body characterized by an extension of the duration of the recovery period, a feeling of constant fatigue. When athletes are exhausted, they maintain a sense of fatigue even after having a rest, they have sleep disorders, lethargy, poor health, lack of mood, neurosis, a sense of fear, disorders of the autonomic nervous system and endocrine system. Sports performance decreases, it is difficult to form new motor skills, there are difficulties in solving tactical objectives, tactical mistakes.

Exhaustion caused by training and competition is referred to as overtraining. The concept of" fatigue "is closely related to the concept of "endurance". In most cases, the reason for stopping work or reducing its effectiveness is increasing fatigue.

Endurance is manifested in the ability to resist increasing fatigue and in the ability to continue a given work.

The nature of the processes of fatigue and recovery

The process of fatigue is a set of changes that occur in various organs, systems and the body as a whole, during the period of physical work, which is characterized by a temporary decrease in performance, which is manifested in a subjective feeling of fatigue. The main types of fatigue are: mental, sensory, emotional, and physical.

Fatigue, depending on the number of muscle groups involved in the work, is divided into local, regional and global. The development of fatigue is associated with changes in all systems that ensure the performance of work: in the regulatory systems-the Central nervous system, the autonomic nervous system and the hormonal-humoral system; in the systems of vegetative support for muscle work-respiration, blood and blood circulation; in the muscles. A decrease in muscle contractility is associated with changes in the

neuromuscular synapse, electro-mechanical coupling, and in the mechanisms that ensure the interaction of the contractile proteins actin and myosin. If fatigue is a short-term, natural physiological process, a state of short-term functional disequilibrium that occurs after performing any amount of work, easily reversible and compensated by the body's own forces, then overstrain includes a more powerful shift in the vegetative balance that requires a long recovery time and has already prepared pathogenetic mechanisms.

Limiting factors for reducing performance are a decrease in muscle glycogen, adenosine triphosphate, creatine phosphate; an increase in the concentration of metabolites-lactic acid and hydrogen ions; insufficient oxygen supply.

There are 4 phases in the recovery period after the completion of physical work:

1) quick recovery,
2) slow recovery,
3) the supercompensation,
4) long-term (late) recovery.

Causes and manifestations of overtraining

Overtraining is a pre-pathological or even pathological condition of the body. The leading changes are violations of regulation and coordination in the activity of body systems, connection between the cerebral cortex and the underlying parts of the nervous system, both somatic and vegetative, the motor apparatus and internal organs. Overtraining is based on an overstrain of cortical processes, so the leading signs of this condition are changes in the Central nervous system, which occur as neuroses. Changes in the endocrine sphere, mainly the adrenal cortex and pituitary gland, also play an important role.

Secondarily, due to a violation of regulation, changes in the functions of various organs and systems may occur.

Etiological factors are:

1. Excessive training load;
2. Too busy competition schedule;
3. Insufficient time to recover from heavy loads.

Aggravating factors are the monotony of the training program, an increase in life stress factors – insufficient sleep and nutrition, travel, especially with the intersection of time zones, unfavorable psychological situations.

The best way to detect overtraining is to self-monitor the quality and nature of sleep, pulse stability, blood pressure, psychological state, and readiness to continue the training process.

Signs of overtraining:

1. Affective instability – unstable mood, increased emotional excitability;
2. Low mood;
3. Sleep disorders;

4. Increased fatigue, reduce of performance and learning abilities;
5. The deterioration of the machinery;
6. Neurotic hyperactivity;
7. A decrease in the activity;
8. Vegetative lability.

Acute and chronic overexertion can cause sudden cardiac death, acute liver and kidney failure, the development of DIC syndrome, and immunodeficiency. Almost always there are signs of overexertion of the cardiovascular system, which are manifested by myocardial dystrophy of physical overstrain, arterial hypertension, mitral valve prolapse.

Overstrain of the cardiovascular system

Overstrain of the cardiovascular system is a dynamic, actively developing, often clinically hidden, pathological process directly related to sports activity, a transition state between the norm and pathology, shifted towards the hidden, latent period of the disease development.

The pathogenesis of CCC overstrain is based on the mechanism of progressive autonomic dysregulation with loss of diastolic heart function without organic disorders.

Means of restoring athletic condition

Restoring athletic condition and normal functioning of the body after training and competitive loads is just as important as the regime of loads aimed at improving athletic performance. The body is a self-healing system, but the body's reserves and time for full recovery are not always enough.

There are three main groups of recovery tools: pedagogical, psychological and medical, which together make up the system for restoring athletic performance.

Pedagogical tools for optimizing recovery processes.

They are based on the impact on the recovery processes of means and modes of training and on the ability of the body to self-recovery already spent energy and functional resources during and after the loads. They include: a rational combination and sequence of loads; the correct combination of load and rest at all stages of training; switching to other types of muscle activity; variability of training tools, exercises, their rhythm, alternation, duration of rest intervals; a combination of specific and non-specific tools, static and dynamic loads, etc.

To reduce psychoemotional stress, psychological means are used, which are divided into psychological and pedagogical and means of correcting mental states. The latter include: hypnosis, autogenic training, aromatherapy, sugestia, art therapy.

Available psychological and pedagogical tools for the coach: individual approach, recreation organization, creating a positive microclimate in the team,

taking into account the psychological compatibility of sparring partners, neighbors in the hostel when settling, conversations, instilling self-confidence.

Medical means of restoring athletic performance can be used to increase all components of reactivity, resistance to various adverse environmental factors and stressful situations, and to relieve General and local fatigue.

Medicine has the ability to correct and improve the functionality of all body systems. The use of special means for regulating life in extreme conditions in order to increase the effectiveness of training, accelerate recovery, prevent overstrain and improve performance is physiologically justified and fundamentally different from stimulating doping effects, because it is not about the maximum mobilization and exhaustion of the body's functional reserves, but, on the contrary, about replenishing the nervous, energy, and plastic resources spent under heavy loads and creating their necessary reserve in the body. The basis for achieving effectiveness with the use of medical means is the normalization of the daily routine, specialized nutrition, hygiene, the use of physiotherapy, physical methods of exposure, the use of pharmacological preparations of plant and synthetic origin.

Physical means:

1. UV and IR Light exposure.
2. Electric Action – various options for electrical stimulation.
3. Wave action – in a wide frequency range (UHF).
4. Magneto -, cryotherapy, electrophoresis.
5. Hydrotherapy: shower, bath, sauna.
6. Manual therapy. - massage
7. Acupuncture
8. Oxygen therapy.

Pharmacological correction of performance involves the use of drugs of a non-doping nature and is currently predominant due to the relative ease of use, high efficiency, which is achieved in a short time.

The main groups of pharmacological drugs used in sports are: energizing and anabolizing agents, antihypoxants, antioxidants, nootropics, mental status regulators, adaptogens, vitamins and minerals, microcirculation regulators, immunocorrectors, and others.

When prescribing pharmacological agents, a number of complex processes and circumstances must be taken into account. It is necessary to assess the state of the body, indications and contraindications to the appointment of a specific drug, the planned main end result of pharmacological support, combine the appointment of drugs with the tactics of pedagogical work of the coach, and much more.

In recent decades, biologically active additives (BAA) have been widely used in food, which are a composition of natural and synthetic biologically active substances. They can be taken directly with food or introduced into food products in order to enrich the diet with biologically active substances.

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