STATE HIGHER EDUCATION UNIVERSITY
"UZHHOROD NATIONAL UNIVERSITY"
MEDICAL FACULTY №2
INTERNAL DISEASES

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Guidelines to practical lessons

OK 42 PHYSICAL REHABILITATION, SPORTS MEDICINE

THE BASICS OF SPORT MEDICINE. INTRODUCTION TO SPORT MEDICINE (2 HOURS)

Topic 1

Module 1 “Sports Medicine”

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The guideline is composed according to medical students' educational qualification characteristics and professional training programs.

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CONTENT:

I. THE BASICS OF SPORTS MEDICINE. INTRODUCTION TO SPORTS MEDICINE

Sports medicine (SM) is a branch of medicine that includes the science of athletic nutrition and conditioning, preventing and diagnosing athletic injuries and increasing performance.

The American Board of Family Medicine (ABFM) states that "Sports Medicine is a body of knowledge and a broad area of health care which includes:

1) exercise as an essential component of health throughout life;
2) medical management and supervision of recreational and competitive athletes and all others who exercise;
3) exercise for prevention and treatment of disease and injury.

SM combines general medical education with the specific principles of sports science, exercise physiology, orthopedics, biomechanics, sports nutrition, and even sports psychology.

The goal of a sports medicine is to help people engage in exercise safely and effectively in order to achieve their training goals.

Sports medicine physician focuses on the medical, therapeutic, and functional aspects of exercise and works directly with athletes to improve their overall sports performance. Sports medicine physician qualified to treat different conditions, including: muscle, bones and joint injuries, concussion and other head injuries, chronic or acute illnesses (such as asthma, diabetes, or hypertension) and decide about nutrition, supplements, ergogenic aids, and performance issues, injury prevention and "Return to play" decisions in sick or injured athletes.

II. THE ORGANIZATION SERVICE OF SPORTS MEDICINE IN UKRAINE

The structure of the medical and physical training services consists of:

-Kyiv State Center for Sports Medicine.

-Regional, city, district medical and sports clinics.

-Division of Sports Medicine and others.

III. COMMON TERMS USE IN SPORT MEDICINE

Bioenergetics: the flow of energy in a biological system; the source of energy for muscular contractions.

Energy: the capacity to perform work.

Frequency: the number of training sessions expressed per day, per week, per month.

Intensity: the difficulty of the work. Intensity is the amount of weight or resistance used in a particular exercise.

Muscular Strength: the ability of the muscles to generate force.

Periodization: the systematic process of altering one or more program variable(s) over time to allow for the training stimulus to remain challenging and effective.

Progression: the selection of exercises, loads or resistances, order of exercises, and readiness of the athlete that are conducive to the athlete's training status and the demands of the activity. Progression in resistance training may be defined as the act of moving forward or advancing toward a specific goal over time until the target goal has been achieved.

Progressive Overload: the gradual increase of stress placed upon the body during exercise training.

Training: the process of preparing an athlete physically, technically, tactically, psychologically for the highest levels of performance.

Volume: the total amount of work performed. Sets and repetitions of an exercise combine to make volume. Training volume is a summation of the total number of repetitions performed during a training session multiplied by the resistance used (kg) and is reflective of the duration of which muscles are being stressed.

Volume-Load: the combination of volume and intensity. Volume-load is calculated as sets x repetitions x weight, or resistance used.

IV. THE BASICS OF STRENGTH AND CONDITIONING IN SPORT MEDICINE

These principles are the basic tenants of exercise science and are valid in designing any exercise program.

1. **Individuality Principle**. Every student-athlete responds differently to the same training stimulus due to many factors: fitness status; current health status and past injuries; genetic predisposition; gender and race; diet and sleep; environmental factors such as heat, cold and humidity; and motivation.
2. **Specificity Principle**. All training adaptations are specific to the stimulus applied. The specific physiological adaptations to condition are determined by various factors, including muscle actions involved, speed of movement, range of motion, muscle groups trained, energy systems involved and intensity and volume of training. In an attempt to perfect a specific skill or activity, the athlete must perform that skill or activity with proper body mechanics and correct technique.
3. **Overload Principle**. In order for an individual to achieve a certain training adaptation, the body must be stressed by working against a stimulus or load that is greater than that to which it is accustomed. Overload ensures improvement by challenging changes in resistance, terrain, movement complexity and many others. When more is demanded, within reason, the body adapts to the increased demand. Overload can be applied in duration, intensity or both.
4. **Progression Principle**. To achieve the desired training adaptations for a certain activity or skill consistently, the training stimulus must gradually and constantly increase. This implies that there is an optimal level and time frame for the overload to occur. Injury may result if overload increases too quickly or an athlete uses poor technique or improper muscle firing patterns. If overload progresses too slowly, improvements will be minimal or nonexistent. Rest and recovery must also be included in the progression, as consistent training volumes and/or loads can result in fatigue, a decrease in performance and/or injury.
5. **Variation. Variation**, or periodization, is the systematic process of altering one or more program variable(s) over time to allow for the training stimulus to remain challenging yet effective. The concept of periodization is to optimize performance and recovery. It has been shown that systematic variation of volume and intensity over several training cycles is most effective for long-term progression.

6. **Principle of Diminishing Returns**. Performance gains are related to the level of training experience of the individual. Student-athletes new to a conditioning program will experience large initial performance gains. In contrast, student-athletes that have strength trained over several years will make small strength gains over a long period of time. The principle of diminishing returns highlights the importance of being able to interpret performance results and understanding the individual student-athlete.

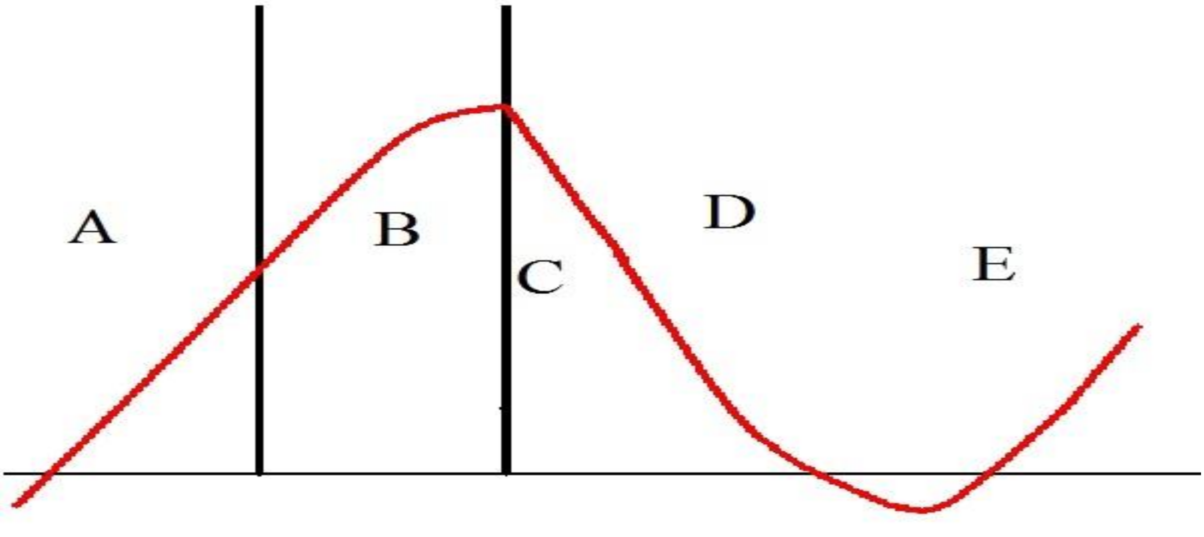
7. **Reversibility/Regression.** When the training stimulus is removed or reduced, the ability of the student-athlete to maintain performance at a particular level is also reduced. Also known as detraining, the decrease in performance is directly related to the inactivity of the muscles that have been atrophied from nonuse.

V. PHASES OF THE ORGANISM'S REACTIONS TO PHYSICAL ACTIVITY

In direct reactions to the exercise there are 5 phases:

Phases of the organism's reactions to physical exertion:

(The changes in heart rate)



Output level The load Relaxation response

A. **phase of conditioned reflex reactions** - that precede to the load, and are preparing the body for the next period of rapidly increasing demands on the metabolic substances, activity of the cardiovascular and respiratory systems.
B. **working phase of growth reactions** - which are observed during the physical activity - a level which reaches the shift of body functions, depend on the intensity and time.
C. **fast recovery phase** and **D - slow recovery phase** - cover the period from the end of physical activity until body changes will return to its original level.
E. "**Negative" phase reactions. -** is characterized by decrease of reactions. It is kind of the final part of the recovery period and, at the same time, phase, which means the transition to a new qualitative state of the organism and to his new level of functional abilities.

VI. THE PHYSIOLOGICAL RESPONSE TO EXERCISE

The physiological response to exercise is dependent on the intensity, duration and frequency of the exercise as well as the environmental conditions.

Muscle physiology. Classification of muscle fiber

Muscle fibers can be classified broadly as Type I (slow-twitch) or Type II (fast-twitch) with differing functional and metabolic characteristics. The type of muscle fiber recruited to perform a specific activity depends on intensity and duration of exercise. Most muscles contain both fast-twitch and slow-twitch muscle fibers; however, the ratio of fast-twitch to slow twitch muscle fibers varies in an individual.

Type I (Slow-Twitch) Muscle Fibers	Type II (Fast-Twitch) Muscle Fibers
• Produce less power • Recruited quickly and fire slowly • Need oxygen for energy • Resist fatigue and thus are recruited for endurance, longer duration activities (runner) • Sedentary persons have approximately 50% Type I, and this distribution is generally equal throughout the major muscle groups of the body.	• Can generally generate a great deal of force very rapidly. • Are recruited when a person is performing high-intensity activities (sprint, jump). • Can produce large amounts of tension in a very short time period, but the accumulation of lactic acid from anaerobic glycolysis causes them to fatigue quickly. • Type II fibers are subdivided into Type IIa and IIb fibers.

Muscular contractions

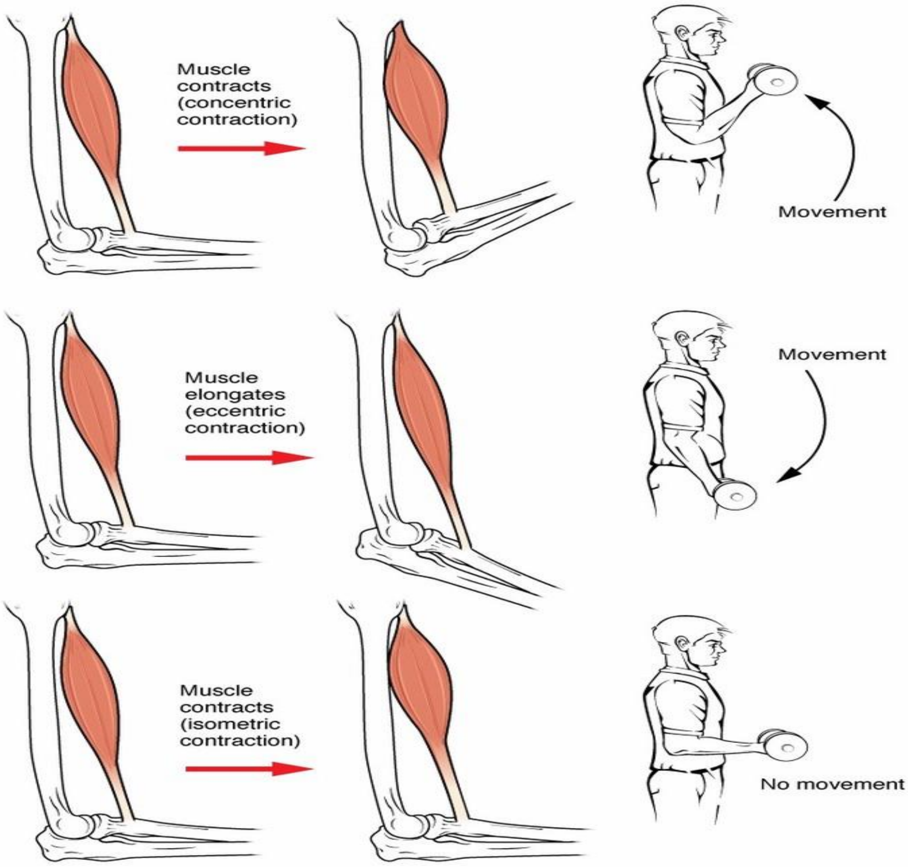
Isometric/Static contractions – is the production of muscle tension without a change in muscle length or joint or limbs and is not associated with any movement. Example: holding a weight in a particular position and postural stability.

Isotonic/Dynamic contractions – is a result in muscle length changes, producing limb motion. Specific types of dynamic contractions include concentric, eccentric, and isokinetic.

Concentric contractions result in muscle shortening as the muscle contracts, such as when a weight is being lifted. This is also known as positive work.

Eccentric contractions (negative work) produce muscle lengthening as the muscle contracts. In general, more fast-twitch fibers are recruited during eccentric contractions than during concentric contractions.

Isokinetic contractions are performed at a constant velocity: the muscular movement is performed at constant speed against a variable resistance. Isokinetic contractions generate force without changing the length of the muscle



Pulmonary ventilation

Pulmonary ventilation (Ve) is the volume of air exchanged per minute, and generally is approximately 5 **- 6 L/min** at rest in an average sedentary adult male; however, at maximal exercise, Ve increases **15- to 25-fold** over resting values (>100 L/min) because of a rise in tidal volume and respiratory rate to meet increased oxygen demands. Generally, increases in Ve are directly proportional to an increase in oxygen consumption (VO2) and carbon dioxide produced (VCO2).

Heart Rate

Normal resting heart rate (HRrest) is approximately 60–80 beats/min. With the onset of dynamic exercise, HR increases in proportion to the relative workload.

The maximal HR (HRmax) decreases with age, and can be estimated in healthy men and women by using the formula: **HRmax = 220 − Age**. There is considerable variability in this estimation for any fixed age with a standard deviation of ±10 beats/min.

Stroke Volume

Stroke volume (SV) is the amount of blood ejected from the left ventricle in a single beat. SV is equal to the difference between end diastolic volume (EDV) and end systolic volume (ESV). During exercise, SV increases curvilinearly with the work rate until it reaches near maximum at a level equivalent to approximately 50% of aerobic capacity. SV is also affected by body position, with SV being greater in the supine or prone position and lower in the upright position. Static exercise (weight training) may also cause a slight decrease in SV owing to increased intrathoracic pressure

Cardiac Output

Cardiac output (Q) is the amount of blood pumped by the heart each minute. It is calculated by the following formula:

Q (L/min) = Heart Rate (beats/min) × Stroke Volume (mL/beat).

Resting cardiac output in both trained and sedentary individuals is approximately **4–5 L/min**; however, during exercise maximal cardiac output can reach **20 L/min**. During dynamic exercise, cardiac output increases with increasing exercise intensity by increases in SV and HR.

Comparison of cardiac function between athletes and non-athletes

	Stroke volume (ml)	Heart rate (beats min_1)
At rest		
Non-athlete	70	70
Trained athlete	100	50
Maximum exercise		
Non-athlete	110	190
Trained athlete	160	180

Blood Flow

At rest, **15–20%** of the cardiac output is distributed to the skeletal muscles (resting blood flow to muscle is usually 2–4 ml 100 g muscle-1 min -1, but might increase to nearly 100 ml 100 g muscle-1 min -1 maximal exercise) with the remainder going to visceral organs, the brain and the heart; however, during exercise, **85–90%** of the cardiac output is selectively delivered to working muscles. Myocardial blood flow may increase four to five times with exercise, whereas blood supply to the brain is maintained at resting levels.

Blood Pressure

Systolic blood pressure (SBP) increases linearly with increasing work intensity, by **8–12 mm-Hg** per metabolic equivalent (MET), where 1 MET = 3.5 mLO2/kg/min. Maximal values typically reach **190 to 220 mm-Hg**. Maximal SBP should not be greater than **260 mm-Hg**. Diastolic blood pressure (DBP) either remains unchanged or only slightly increases with exercise.

Failure of SBP to rise or decreased SBP with increasing work rates or a significant increase in DBP is an abnormal response to exercise and indicates either severe exercise intolerance or underlying cardiovascular disease.

Postural considerations: In the supine position, SBP is lower. When the body is upright, SBP increases. DBP does not change significantly with body position in healthy individuals.

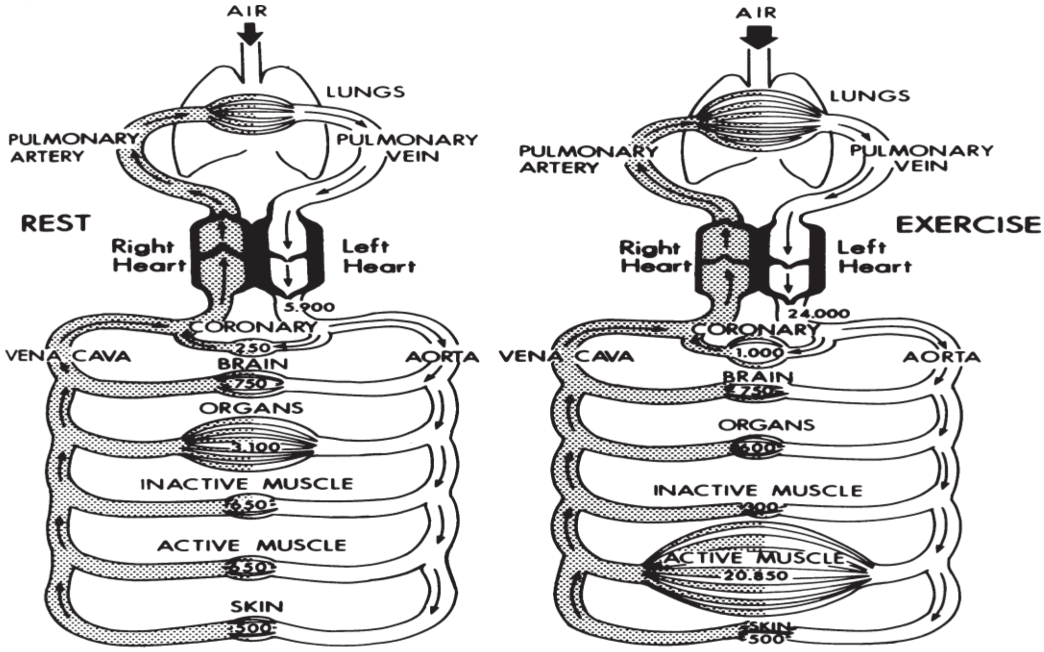
Effects of arm versus leg exercise: At similar oxygen consumptions, HR, SBP, and DBP are higher during arm work than during leg work.

In normotensive individuals, regular exercise does not appear to have a significant impact on resting or exercising blood pressure. In hypertensive individuals there may be a modest reduction in resting blood pressure as a result of regular exercise.

Blood volume changes

Total blood volume increases owing to an increased number of red blood cells and expansion of the plasma volume. Stored muscle glycogen increases. Number of leukocytes and platelets are increased in terms of physical activity ("myogenic leukocytosis" myogenic thrombocytosis).

The changes which occur in arterial pH, PO2 and PCO2 values during exercise are usually small. Arterial PO2 often rises slightly because of hyperventilation although it may eventually fall at high work rates. During vigorous exercise increased accumulation of lactic acid, which initially leads to an increase in PaCO2. However, this is counteracted by the stimulation of ventilation and as a result PaCO2 is decreased.



Blood lipids

Total cholesterol may be decreased in individuals with hypercholesterolemia. High-density lipoprotein cholesterol (HDL) increases with exercise training. Low-density lipoprotein cholesterol (LDL) may remain the same or decrease with regular exercise. Triglycerides may decrease in those with elevated triglycerides initially. This change is facilitated by weight loss.

Body composition

Total body weight usually decreases with regular exercise. Fat-free weight does not normally change. Percent body fat declines.

VII. BENEFITS OF REGULAR PHYSICAL ACTIVITY AND/OR EXERCISE

Improvement in Cardiovascular and Respiratory Function

1. Increased maximal oxygen uptake resulting from both central and peripheral adaptations
2. Decreased minute ventilation at a given absolute submaximal intensity
3. Decreased myocardial oxygen cost for a given absolute submaximal intensity
4. Decreased heart rate and blood pressure at a given submaximal intensity

5. Increased capillary density in skeletal muscle
6. Increased exercise threshold for the accumulation of lactate in the blood
7. Increased exercise threshold for the onset of disease signs or symptoms (e.g., angina pectoris, ischemic ST-segment depression, claudication)

Reduction in Cardiovascular Disease Risk Factors

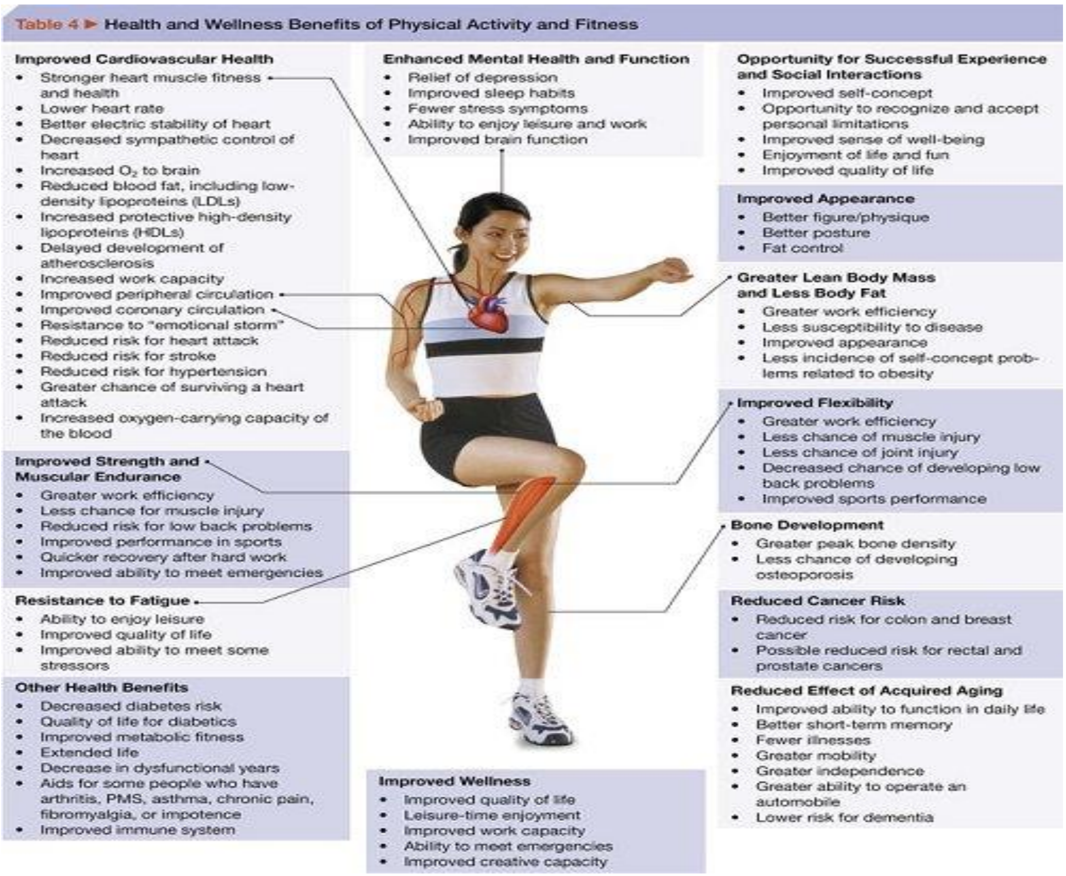
1. Reduced resting systolic/diastolic pressure
2. Increased serum high-density lipoprotein cholesterol and decreased serum triglycerides
3. Reduced total body fat, reduced intra-abdominal fat
4. Reduced insulin needs, improved glucose tolerance
5. Reduced blood platelet adhesiveness and aggregation
6. Reduced inflammation

Decreased Morbidity and Mortality

1. Primary prevention (i.e., interventions to prevent the initial occurrence)
2. Higher activity and/or fitness levels are associated with lower death rates from CAD
3. Higher activity and/or fitness levels are associated with lower incidence rates for CVD, CAD, stroke, Type 2 diabetes mellitus, metabolic syndrome, osteoporotic fractures, cancer of the colon and breast, and gallbladder disease
4. Secondary prevention (i.e., interventions after a cardiac event to prevent another)

Other Benefits

1. Decreased anxiety and depression
2. Improved cognitive function
3. Reduced risk of dementia
4. Improved sleep
5. Enhanced physical function and independent living in older individuals
6. Enhanced feelings of well-being
7. Enhanced performance of work, recreational, and sport activities
8. Reduced risk of falls and injuries from falls in older individuals
9. Prevention or mitigation of functional limitations in older adults
10. Effective therapy for many chronic diseases in older adults, coronary artery disease; cardiovascular diseases.



LIST OF QUESTIONS

1. Sports medicine (SM): definition, the goal of a sports medicine, sports medicine physician.
2. The organization service of sports medicine in Ukraine.
3. The basics principles in SM: Individuality Principle.
4. The basics principles in SM: Specificity Principle, Overload Principle.
5. The basics principles in SM: Progression Principle, Variation.
6. The basics principles in SM: Principle of Diminishing Returns, Reversibility/Regression.
7. Muscle physiology. Classification of muscle fiber.
8. Cardiorespiratory physiology.
9. Pulmonary ventilation.
10. Blood Pressure and Blood volume changes.
11. Blood lipids and Body composition.
12. Benefits of Regular Physical Activity and/or Exercise: Improvement in Cardiovascular and Respiratory Function.
13. Benefits of Regular Physical Activity and/or Exercise: Reduction in Cardiovascular Disease Risk Factors.
14. Benefits of Regular Physical Activity and/or Exercise: Decreased Morbidity and Mortality.
15. Benefits of Regular Physical Activity and/or Exercise: Other Benefits.

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SCHEME OF SERVICE OF SPORT MEDICINE