БІОМЕХАНІЧНІ, ПЕДАГОГІЧНІ, МЕДИКО-БІОЛОГІЧНІ ТА ПСИХОЛОГІЧНІ АСПЕКТИ ФІЗИЧНОГО ВИХОВАННЯ ТА СПОРТУ

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PHYSIOLOGICAL REINFORCEMENT OF CARDIO TRAINING

Purpose of the study. *Cardio training plays an important role in maintaining a person's physical condition, strengthening the cardiovascular system, increasing endurance, and improving overall health. To get the most out of cardio training, it is necessary to follow the principles of proper loading, gradually increasing intensity and duration, and also paying attention to warm-up and cool-down. In this regard, the purpose of the study was to identify biochemical and physiological processes occurring in the human body during cardio loads in order to eliminate the negative consequences of such physical activity.*

Research methodology. *The methodology of this study utilized a theoretical approach: analysis of specialized literature on the organization of physical activity for people of different ages, the biochemistry of muscle activity, and sports cardiology; synthesis of collected information; form of tabular presentation of data.*

The scientific novelty of the research *consists in the identification of individual patterns of response to exercise (genetics, age, gender, metabolism) and the development of personalized training protocols that take into account modern genomics and bioinformatics, which allows for the transition from general recommendations to precise, scientifically based strategies for organizing physical activity aimed at health.*

Conclusions. *During aerobic exercise, the body uses a large number of muscles and systems. As a result, all metabolic processes are accelerated, including the heart rate, for which the body spends a large amount of oxygen, actively burning carbohydrates and fats.*

It is recommended to carefully select a cardio program according to the level of physiological readiness of the body for physical activity, age, and also environmental conditions.

Keywords: *cardio training, load, heart rate, health.*

Problem statement and connection with important scientific and practical tasks. The global processes unfolding at all levels of society are forcing a new perspective on the issues of public health and physical activity. Scientific and technological progress has affected all structures of social development, and therefore, all human activities are undergoing significant changes, striving to adequately reflect these developments. However, alongside this, a lack of physical activity is observed, resulting in disruptions to various functions of the human body, leading to the degradation of vital systems, weakening adaptive responses, and the development of various diseases, all of which, in general, reduce human performance. The relevance of increasing the physical activity of every member of society has been confirmed by numerous studies [5; 6; 7 and others].

Analysis of the latest research news and publications. Fitness training requires participants to possess certain morpho-functional and psychophysical characteristics that enable them to perform specific physical loads not only on the musculoskeletal system but also on the autonomic nervous system. Therefore, specialized fitness knowledge, covering not only physical but also physiological control, its content and methodology, is essential, as

is a comprehensive understanding of the nature of the cardio-physiological processes that occur as a result of active muscular activity [1; 2].

Cardio training is the fastest and most effective method for combating excess weight, correcting body contours, and shaping a beautiful figure. Furthermore, the wellness and recreational training in this type of fitness includes a whole range of wellness techniques that help not only lose weight but also develop endurance, strengthen the cardiovascular system, and cultivate the willpower to achieve desired results [8].

Cardio training is an essential part of any regular exercise program. From a medical point of view, cardiovascular exercise is a type of physical activity based on performing muscle movements using energy produced by the oxidation of glucose molecules by oxygen, or so-called aerobic glycolysis.

The main difference the trainings mentioned above, cardio and strength training, it is the oxygen consumption. The weight training to increase strength and muscle mass occurs without the participation of this important chemical element, so it is called anaerobic or oxygen-free.

However, the division into aerobic and anaerobic exercises is rather arbitrary. The first 8-12 seconds of the exercise, the oxidation of glucose, the main source of energy, occurs without the participation of oxygen. In this phase, loads of the greatest strength and speed are allowed (naturally, after a warm-up). Then the aerobic phase begins – with the use of oxygen: the intensity of the work gradually decreases, but the duration of the exercises can increase [5].

Therefore, in any exercise there are both phases, but only one of them always dominates. At the same time, almost any exercise can be made both aerobic and anaerobic. Thus, jogging lasting up to 20-60 minutes is an example of aerobic training. But if you use short intense runs of 10-12 seconds, the load turns into anaerobic [11].

Each of the loads has its advantages. Aerobic exercise actively burns fat, promotes muscle growth, trains strength endurance, accelerates metabolism, improves lung ventilation. Anaerobic training burns fewer calories, but its effect is extended over time [3].

Purpose of the study is to identify biochemical and physiological processes occurring in the human body during cardio loads in order to eliminate the negative consequences of such physical activity.

Research methodology. The methodology of this study utilized a theoretical approach: analysis of specialized literature on the organization of physical activity for people of different ages, the biochemistry of muscle activity, and sports cardiology; synthesis of collected information; form of tabular presentation of data.

The scientific novelty of the research consists in the identification of individual patterns of response to exercise (genetics, age, gender, metabolism) and the development of personalized training protocols that take into account modern genomics and bioinformatics, which allows for the transition from general recommendations to precise, scientifically based strategies for organizing physical activity aimed at health.

Presentation of the main research material to substantiate the obtained scientific results. This way, the main goal of cardio training is not so much muscle training as increasing the performance and endurance of the cardiovascular system. No less important are such positive changes in the body as fat burning and weight loss (due to fat oxidation and its conversion into energy), increased stress resistance and immunity. It has been scientifically proven that the changes that occur during such loads prepare the cardiovascular system for more complex and intense training [7]. Proper cardio training can reduce the risk of sudden cardiovascular diseases, especially after 40 years [8; 10].

At the same time, running used for burning fat is absolutely useless, since the fat burning process begins during moderate and low-intensity exercise, and for most people this is walking, in no case running, which for untrained people is not a high-intensity exercise, but an intense super-intensive one.

Of course, this type of training can create a negative calorie balance by using up glycogen stores, and in a person with a normal metabolism and the right approach to nutrition, this should lead to a decrease in fat stores. The key point is that the metabolism should not be slow, as in most people, but at least normal, and at best – accelerated. Most often, people with a slow metabolism, for one reason or another, resort to cardio training to lose weight.

There are cases when people spend an hour a day on cardio training seven days a week, and their weight remains the same. In such cases, the cardio regime is most often not optimal, and in some cases, it can lead to a fatal outcome, given the intensity of the training performed with physiological unpreparedness. At this time, the heart works at the limit of its capabilities, it is not ready for long-term work in overload mode. In an unprepared person, the pulse immediately increases and reaches maximum values, which harms the heart and leads to myocardial hypertrophy type D, when the walls of the heart thicken [12].

Without a proper running technique, the load on the knees and lower back increases, since running is ultimately a sequence of jumps – push, take-off, landing – continuing quite a large number of times. If we assume that an hour of running is 10 km, and each step is a jump of about 1 meter, then 10 km is 10 thousand jumps, the load of which not all joints can withstand without preliminary preparation.

To perform any work, the body can use two types of energy – fast and slow. By fast we mean ATP, creatine phosphate and glycogen, that is, anaerobic glycolysis and aerobic glycolysis, by slow – fat oxidation or aerobic lipolysis [4]. When performing any work, this process is provided with energy from the ATP reserve, which is enough for several seconds of work, then creatine phosphate begins to be consumed, which continues for another

10 seconds, then the mechanism of anaerobic glycolysis is activated, that is, work begins on glycogen (carbohydrates), but without the participation of oxygen.

If a person is well trained and their oxidative capabilities allow it, then glucose can be oxidized to carbon dioxide and water. This is essentially fast energy, but it is short-lived. This process is called aerobic glycolysis. So, marathon runners run precisely due to it, and this process occurs only in highly trained athletes.

In most ordinary people, energy expenditure occurs in the following order: first, ATP consumption in the cell is triggered; after creatine phosphate reserves are depleted, anaerobic glycolysis is triggered, followed by aerobic lipolysis (fat breakdown). In conditions of low blood glucose levels during prolonged physical exertion, the body switches to using fats as the main source of energy, which stimulates lipolysis. The breakdown of fats is accompanied by the release of energy, which is consumed by striated muscles during high-intensity and prolonged exercise. Fats break down into triglycerides and free fatty acids. The latter are the main source of energy that ensures muscle work. When they are oxidized, energy molecules of ATP are released. However, activation of lipolysis occurs secondary. First of all, working muscles consume glucose as the most accessible source of energy. As carbohydrates are consumed, free fatty acids formed during lipolysis are connected to the energy supply.

The more trained a person becomes, the faster the body starts to break down fat. Therefore, when doing fitness, as well as sports, it is recommended to gradually increase the load from time to time. As soon the muscles get used to certain exercises, the sooner it is useful to change the training program.

Knowing the principles of the close connection between carbohydrate and lipid metabolism allows you to correctly create a training and nutrition program taking into account the set goals in order to start lipolysis.

Classic examples of aerobic exercise include running, cycling and treadmills, active team games, walking and swimming for a total of 20 minutes to 1 hour, not including warm-ups. During aerobic exercise, the body uses a large number of muscles and systems. As a result, all metabolic processes are accelerated, including heart rate, for which the body uses a large amount of oxygen, actively burning carbohydrates and fats.

The intensity of the training being performed is determined by the number of heartbeats. For this purpose, the concept of maximum heart rate is introduced – the maximum number of heart beats per minute that a person can achieve with maximum physical exertion. This is a certain individual value that depends on age, gender, level of physical fitness, general health, as well as factors such as emotions and ambient temperature. Doctors do not recommend approaching these pulse values, and even more so exceeding them, since after overcoming them, a person begins to suffer damage to the heart, often irreversible [9; 14].

Nowadays, there are several formulas for calculating the maximum heart rate (MHR: Table 1):

Table 1

Formulas for calculating the maximum heart rate

Authors	Maximum heart rate
Haskell-Fox formula	220 – age
Londery-Meschberger formula	206,3 – (0,711 × age)
Tanaka's formula	208 – (0,7 × age)
Miller's formula	217 – (0,85 × age)
Robergs-Landwehr formula	205,8 – (0,685 × age)
Jackson's formula	206,9 – (0,67 × age)

The most popular of these is considered to be the Haskell-Fox formula, presented by the authors back in 1970 [13]. However, time does not stand still, and this problem is still being studied. At the same time, researchers consider the calculation of the maximum heart rate from a gender point of view (Table 2).

Table 2

Formulas for calculating the maximum heart rate taking into account age and gender

Authors	Maximum heart rate
White's formula	Men: 202 – (0,55 × age)
	Women: 216 – (1,09 × age)
Ball State University Formula	Men: 214 – (0,8 × age)
	Women: 209 – (0,9 × age)
Astrand's formula	Men: 220 – age
	Women: 226 – age
Marta Gulati's formula	Women: 206 – (0,88 × age)

Based on this indicator, pulse zones are calculated for different types of training. To determine the individually required zone/corridor, you should calculate the percentage of the maximum heart rate. So, for fitness training, in which maximum fat burning occurs, the pulse corridor is 60-70% of the maximum heart rate.

The choice of a specific cardio load depends on the physical condition of the person and their goals. However, any cardio training is only beneficial if performed correctly: the training should begin with a warm-up and end with stretching exercises. During cardio training, you must constantly monitor your pulse.

To select a specific load and achieve the desired results, it is necessary to calculate the optimal heart rate (HR): for training the cardiovascular system, the recommended HR is 50-60% of the maximum allowable values; for burning fat, the optimal HR is 60-70% of the maximum HR; intense strength training and endurance training require a HR of 70-80% of the maximum allowable values. At the same time, any training should last from 30 minutes (initially) to 1 hour as the body's fitness increases and require regularity (three or more times a week) and a constant increase in load.

The optimal time for cardio training combined with weight loss is the evening, preferably between 5 and 7 p.m., when the metabolic rate is highest [9]. But if the goal is to train endurance, it is recommended to exercise in the morning. At the same time, you should know that during this period of the day the metabolic rate is the lowest, which means that it will be more difficult for the body to withstand physical activity.

Conclusions of the study and prospects for further scientific research. Therefore, during aerobic exercise, the body uses a large number of muscles and systems. As a result, all metabolic processes are accelerated, including the heart rate, for which the body spends a large amount of oxygen, actively burning carbohydrates and fats.

It is recommended to carefully select a cardio program according to the level of physiological readiness of the body for physical activity, age, and also environmental conditions.

Before choosing a cardio program, especially if there are health problems, it is advisable to consult a doctor.

To increase the efficiency of cardio training, it is suggested to use an interval training mode, alternating periods of high and low intensity.

It is also recommended to vary the types of cardio programs and their sequence to avoid getting used to the effects of physical activity on the body.

In the future, it is planned to study the influence of cardio training on the psychophysical state of various contingents of fitness enthusiasts by age, gender, and characteristics of professional activity.

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ФІЗІОЛОГІЧНЕ ОБҐРУНТУВАННЯ КАРДІОТРЕНУВАННЯ

Мета дослідження. *Кардіотренування відіграє важливу роль у підтримці фізичного стану людини, зміцненні серцево-судинної системи, підвищенні витривалості та покращенні загального стану здоров'я. Щоб отримати максимальну користь від кардіотренувань, необхідно дотримуватися принципів раціонального навантаження, поступового збільшення інтенсивності та тривалості, а також приділяти увагу розминці та заминці. У зв'язку з цим метою дослідження було виявлення біохімічних та фізіологічних процесів, що відбуваються в організмі людини під час кардіонавантажень, з метою усунення негативних наслідків такої фізичної активності.*

Методологія дослідження. *У методології цього дослідження було використано теоретичний підхід: аналіз спеціалізованої літератури з організації фізичної активності для людей різного віку, біохімії м'язової активності та спортивної кардіології; синтез зібраної інформації; форма табличного представлення даних.*

Наукова новизна дослідження *полягає у виявленні індивідуальних закономірностей реакції на фізичні навантаження (генетика, вік, стать, метаболізм) та розробці персоналізованих протоколів тренувань, що враховують сучасну геноміку та біоінформатику, що дозволяє перейти від загальних рекомендацій до точних, науково обґрунтованих стратегій організації фізичної активності, спрямованої на здоров'я.*

Висновки. *Під час аеробних вправ організм використовує велику кількість м'язів і систем. У результаті прискорюються всі метаболічні процеси, включаючи частоту серцевих скорочень, для чого організм витрачає велику кількість кисню, активно спалюючи вуглеводи та жири.*

Рекомендується ретельно підбирати кардіопрограму відповідно до рівня фізіологічної готовності організму до фізичної активності, віку, а також умов навколишнього середовища.

Ключові слова: *кардіотренування, навантаження, частота серцевих скорочень, здоров'я.*

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