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THE IMPORTANCE OF ENERGY SUPPLY IN BOXERS' TRAINING

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Annotatsiya. Ushbu maqolada bokschilarning sport tayyorgarligi jarayonida energiya ta'minoti tizimining fiziologik asoslari, energiya almashinuvi mexanizmlari, mushak faoliyatida ATP resintezi jarayonlari hamda mashg'ulot yuklamalariga mos ravishda energiya resurslarini boshqarish masalalari yoritilgan. Shuningdek, yuqori intensivlikdagi boks mashg'ulotlarida uglevodlar, yog'lar va oqsillarning metabolik roli, ularning energiya ishlab chiqarishdagi ulushi ilmiy asosda tahlil qilingan.

Kalit so'zlar: boks, energiya almashinuvi, ATP, anaerob glikoliz, aerob tizim, sport ovqatlanishi, jismoniy yuklama, metabolizm.

Аннотация. В данной статье рассматриваются физиологические основы системы энергообеспечения в процессе спортивной подготовки боксёров, механизмы ресинтеза АТФ, особенности энергетического обмена в условиях высокоинтенсивной мышечной работы, а также вопросы управления энергетическими ресурсами в соответствии с тренировочными нагрузками. Также анализируется метаболическая роль углеводов, жиров и белков в боксе.

Ключевые слова: бокс, энергообеспечение, АТФ, анаэробный гликолиз, аэробная система, спортивное питание, физическая нагрузка, метаболизм.

Abstract. This article examines the physiological foundations of the energy supply system in boxers' training, mechanisms of ATP resynthesis, energy metabolism during high-intensity muscular work, and management of energy resources according to training loads. The metabolic roles of carbohydrates, fats, and proteins in boxing are also analyzed.

Keywords: boxing, energy supply, ATP, anaerobic glycolysis, aerobic system, sports nutrition, physical load, metabolism.

The direct and universal source of energy for muscle contraction is the adenosine triphosphate (ATP) molecule. However, the ready reserves of ATP in muscle fibers are very limited and can only provide 2–3 seconds of high-intensity work. Therefore, in order to maintain the boxer's ability to work continuously, the ATP molecule must be constantly and in parallel resynthesized (resynthesized) in accordance with the laws of homeostasis. In boxing classes and competitive activities, this resynthesis process is carried out through three interrelated metabolic systems. The first is the anaerobic-alcatate (phosphagen) system, which provides maximum power in the shortest possible time due to the reserves of creatine phosphate in the muscle cell without the participation of oxygen and without the formation of lactic acid (lactate) as a submetabolite. In terms of its specific role in boxing, it is this system that provides unexpected and explosive blows in the ring, single powerful blows leading to a knock-out, rapid defense (dive, deflection), and intense attack corridors up to the first 8-10 seconds.

The second is the anaerobic-lactate (glycolytic) system, which, when the duration of the load exceeds 10-12 seconds and high intensity is maintained, the body begins to produce energy through anaerobic breakdown of glucose and glycogen reserves (glycolysis). As a by-product of this process, lactic acid (lactate) and hydrogen ions accumulate in muscle tissue and blood. In boxing, long-term and intense exchange of blows during the round, continuous pressure on the opponent, and activity at the end of the round rely on this system. However, the accumulation of hydrogen ions increases the acidity of the intracellular environment, leading to muscle fatigue and loss of punch accuracy.

The third is the aerobic (oxidative) system, which provides long-term energy through the deep breakdown of carbohydrates, fats and, to a lesser extent, proteins in the mitochondria in the presence of oxygen. Although the rate of energy release is low, its overall capacity is very high. Although modern boxing is predominantly anaerobic in nature, the aerobic system is the foundation of the overall combat strategy. It determines the rate of maintaining general tone during a 3-minute round, and most importantly, the restoration of creatine phosphate reserves during the 1-minute break between rounds and the utilization of accumulated lactate from the body. The main pathways of ATP resynthesis:

Phosphagen system (ATP–KF)

Anaerobic glycolysis

Aerobic oxidation system

Explanation:
The ATP-CF system works very fast, but its reserves are limited. Anaerobic glycolysis provides powerful energy, but lactate accumulation accelerates fatigue. The aerobic system produces slow, but long-term, sustainable energy.

2. Features of energy metabolism in boxing

The structural model of boxing is based on “interval loading”. Within each round:

5–10 seconds: maximum explosive action (ATP-CF)

20–40 seconds: combinations (anaerobic glycolysis)

low-intensity movements: recovery (aerobic process)

Physiological explanation:

Lactate accumulation is not only a sign of fatigue, but also an indicator of metabolic load. Highly skilled boxers have a high rate of lactate utilization (processing), which increases endurance.

3. Energy substrates and their role

Carbohydrates are the main source of fast energy. Muscle glycogen is critical in boxing. Glycogen depletion leads to a sharp decrease in speed and strength.

Fats are the main substrate at low intensities. Provides a large energy reserve in the aerobic system.

Proteins - have mainly a plastic function, but can be used as an energy source at the expense of catabolism during prolonged loads.

4. Physiological foundations of sports nutrition

Maintaining energy balance directly determines the athlete's performance.

Recommendations:

before training: complex carbohydrates (for glycogen reserves)

after training: fast-absorbing carbohydrate + protein (recovery)

fluid: maintaining electrolyte balance

Note:

B vitamins (energy metabolism), vitamin C (antioxidant protection), iron (hemoglobin synthesis) and magnesium (muscle contraction) are important cofactors in energy systems.

5. Energy management during training

The development of energy systems depends on the right combination of types of loads:

interval training → increases anaerobic power

strength training → develops the ATP-KF system

aerobic training → increases mitochondrial density

Note:

Incorrect load planning leads to overactivation of the sympathetic nervous system, increased cortisol, and "overtraining syndrome".

CONCLUSION

In the sports training of boxers, energy supply systems work in an integrated manner. The efficiency of ATP resynthesis mechanisms directly determines the sports result. Scientifically based nutrition, load periodization and recovery strategies significantly increase the functional capabilities of the boxer.

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