Висновки. Таким чином, серед факторів, які детермінують рівень реалізації функціональних резервів спортсменів високого класу, які спеціалізуються у видах спорту з переважним проявом витривалості найбільший рівень значущості мають аеробна потужність та ефективність використання ресурсів аеробного енергозабезпечення.

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METABOLIC EFFICIENCY IN SKILLED ATHLETES AT REST AND DURING INTENSE EXERCISE

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Significant energy expenditure due to intense physical activity increases the metabolism of skilled athletes both during physical activity and in their recovery period. During intense training, total daily energy expenditure

(TDEE) can exceed 10,000 kcal (Burke et al, 2015). The body's predominant choice of energy substrates and the rate of their oxidation in the working muscle is influenced by many factors, primarily the duration and intensity of exercise, the athlete's fitness, and nutrition. The intensity of physical activity largely determines the choice of substrates for energy. The higher the intensity of work, the more important role in energy supply processes are played by carbohydrates (Shils&Shike, 2006).

Recently, the term "metabolic efficiency" has come into use, meaning the ability to most effectively use fat as an energy substrate both at rest and during exercise, thus saving glycogen stores (Seebohar, 2014). It is believed that this type of metabolism allows one to save carbohydrates to perform high-intensity work. Most often, the respiratory exchange ratio (RER) is used to assess the use of oxidation substrates, which allows determining the contribution of carbohydrates and fats to the energy supply (Carpenter, 1964). Thus, the value of RER can be considered an informative indicator of metabolic reserves of the athlete.

Therefore, it is of scientific interest to study the efficiency of athletes' metabolism. The aim of this study is to determine the efficiency of metabolism in skilled athletes at rest and during exercise of increasing intensity.

In our study 99 incremental exercise tests were performed in 90 male national– and international-level athletes (age 16-35 y.o.) of sports related to endurance (biathlon (n = 40), triathlon (n = 4), rowing (n = 13), canoeing (n = 12), modern pentathlon (n = 12), and combat sports (boxing [n = 14], taekwondo [n = 4]). The data obtained were analyzed using methods of mathematical statistics: mean values method, correlation analysis.

In this study, the average value of RER at rest in skilled athletes was 0.81 ± 0.10, which corresponds to the use of 65% of energy from fat, while the range of confidence interval (0.79– 0.83) shows that the contribution of fat to production energy at rest ranges from 58-71%.

The average values of RER when reaching the anaerobic threshold (AT) level were 0.96 ± 0.07, which indicates a 14% contribution by fat to energy supply. The range of RER oscillations at the level of AT (0.95-0.97) is smaller compared to at resting state and corresponds to a 10-17% contribution of fat to energy production. The standard deviation of the fat utilization rate when reaching the AT was equal to the average value, which indicates a large variability in the values of this indicator.

It is traditionally believed that 100% of energy at the level of VO_{2max} is provided by carbohydrates [1, 2]. Our average data (1.09 ± 0.09) confirms this fact, but there were some athletes for whom RER when reaching their VO_{2max} was 0, 96-0.99, and in some cases 0.93, which indicates a possible contribution of fat to energy production even during high-intensity exercise. For the VO2max level, the value of the quadratic deviation Qf is associated with isolated recorded cases of VO2max achievement with RER of less than 1.

In order to determine whether these differences in muscle metabolism affect the metabolic reserves and performance of athletes, we performed a correlation analysis. We found that athletes with higher use of fat as an energy substrate at rest tend to more intensively use fat for energy at AT and VO_{2max}: The RER resting value has a reliable relationship with RER_{AT} ($r = 0.52$, $p \leq 0.05$) and RER_{VO2max} ($r = 0.52$, $p \leq 0.05$). An even greater reliable relationship was found between the RER_{AT} and the RER_{VO2max} ($r = 0.86$, $p \leq 0.05$).

In addition, there is a relationship between resting metabolic efficiency and VO_{2max} ($r = – 0.26$, $p \leq 0.05$). Athletes with higher metabolic efficiency at rest have the advantage of using different sources of energy during intense muscular activity. In the case of efficient use of fat as a substrate of energy at rest, the share of their contribution to energy supply remains significant (up to 37%) even when reaching the AT.

Therefore the study found a link between RER and the use of energy substrates at rest and when achieving AT and VO_{2max} in the athletes. The largest range of RER differences is registered at rest. Thus, the coefficient of variation was 12.3%, 7.3% and 8.3%, respectively, at rest, when reaching AT and VO_{2max}. The variability at the level of AT and VO_{2max} is lower, as the contribution of carbohydrates to energy production increases, but the differences in the use of fat between groups with different metabolic efficiencies persist. It should be noted that for untrained people at rest is characterized by RER 0.85, which corresponds to the use as energy substrates of 49% carbohydrates and 51% fat (Shils&Shike, 2006). In athletes at rest, the RER averaged 0.81 ± 0.10, which reflects the use of 65% of energy from fat. Such differences indicate a greater efficiency of metabolism of skilled athletes at rest.

Increasing the efficiency of metabolism in skilled athletes at rest plays a significant role during intense exercise, as evidenced by the established in this study a significant correlation between RER at rest and when achieving AT and $VO_{2\ max}$ (for both $r = 0.52$, $p \leq 0, 05$). This fact indicates the importance of increasing the contribution of fat to energy for the more efficient use of glycogen stores during intense and especially long-term muscle activity.

It is clear that creating conditions for maintaining the efficiency of metabolism is one of the ways to increase metabolic reserves and possibly increase the special performance of skilled athletes, as well as to increase the duration of intense exercise and delay the manifestations of decompensated fatigue during training and competition. As the data obtained in the study indicate a close, reliable relationship between metabolic efficiency at rest and during exercise of varying intensity, the determination of respiratory exchange ratio is appropriate to assess the metabolic reserves of qualified athletes.

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