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Supplemental Support for Energy Yield During Supramaximal Exhaustive Sporting Events

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Abstract

When training athletes, it is often required to know the biochemical processes leading to the formation of high-energy compounds and increasing the coefficient of efficiency at the time of their formation. This will require taking into account the maximum desired duration of each workout, and the type of nutrients used to meet the needs of energy expenditure during the workout. In this article, the ways of energy production during the different exercises, and some trainings preferable for perfect energy production are represented. The paper also provides information on various factors limiting speed of athletes and suggests the ways to overcome some of these limits.

Keywords: Training sessions; Supramaximal exhaustive running; Endurance; Energy expenditure; Maximal oxygen uptake.

1. Introduction

It is known that for energy production, the sprinters use more the anaerobic energy pathway, and endurance athletes - aerobic pathways. In this regard, it is interesting to observe the aerobic and anaerobic energy yield during supramaximal exhaustive sporting events. For this purpose, first of all for athletes engaged in anerobic short-time sporting events, such as swimming, high jump, long jump, 100m run, 25m swimming and so on, must be prescribed training that increases the abilities of anaerobic energy production and, in parallel, develops aerobic breakdown of nutrients to rise maximal oxygen uptake. To eliminate the factors limiting the development of high speeds in athletes, coaches had better know the most effective ways to solve the problems mentioned, and this review helps to achieve the set goals.

The athletes` coach would better to be aware about the basic biochemical processes the body uses to produce the energy in the muscles, because energy expenditure can be minimized if training model is well chosen and organized. Training must be specific to the muscle fibers involved in exercises [1]. There are some rules determining the types of training sessions for athletes, and additionally, you should remember that the gains are lost when training overload is removed.

There are three main energy systems providing the body with ATP: one aerobic and two anaerobic (non-lactate, or creatine phosphate pathway and lactate way) [2]. It is known, that in aerobic pathway, when decomposing carbohydrates to the final products, 12% less O_2 is consumed than in decomposing other substances, namely proteins and fats. Therefore, the same amount of absorbed O_2 provides more energy when occurs the breakdown of carbohydrates, than the breakdown of fats and proteins. Therefore, in cases of O_2 deficiency, particularly during a race, ATP formation in the body of athletes is primarily due to the breakdown of carbohydrates [3].

However, the body stores of carbohydrates are very limited. Therefore, after depletion of carbohydrates in the body, ATP production occurs at the expense of the breakdown of fats. For example, during a marathon,muscle glycogen allows body to cover the distance just during 80 minutes. During the marathon, carbohydrates cover 75% of the ATP requirement. The rest is paid for fatty acids. In general, during the marathon, carbohydrates cover 75% of the ATP requirement [4]. The rest is paid for with fatty acids [4]. Ergo, it is clear that in order to increase the endurance of athletes, it is more expedient to increase their reserves of carbohydrates, namely glycogen in the muscle and the liver. Additionally, as any prolonged sport work requires aerobic energy production which is preferably paid for by fatty acids, it is advisable to involve athletes in exercises which increase the rate of fat mobilization in the body. For this, the athlete is assigned aerobic workout. This type of training includes overcoming ultra-long distances of 30 and 40 km. By the way, proteins meet only 5-10% of a muscle's ATP requirement, ergo they are primarily intended for use in plastic purpose, not for energy formation [5].

During rest and moderate work the oxygen supply fully meets the needs of the tissues, which is why ATP is formed aerobically. For athlets, aerobic path is activated during the first minute, for ordinary people this path is activated relatively late, approximately, in 5 minutes. The mechanisms of creatine phosphate (non-lactate anaerobic path) and lactate (anaerobic) pathways are activated during maximal and submaximal or in other words, at very intensive anaerobic physical activity, for example during the sprint race.

The non-lactate path lasts for about 10-30 s, the lactate path –from 30 sec up to 5 minutes. An increase in the duration of running pushes anaerobic processes into the background and enhances aerobic processes instead. It should be noted however, that during the race (competition), all ATP generating pathways operate at maximum power. The role of each system in the formation of ATP depends on the length of the race.

If during the exercise60% of ATP is formed in non-lactate and lactate pathways, i.e. anaerobically, this exercise is called anaerobic. If during the exercise 70% of ATP is produced aerobically, this training is called aerobic exercise. Running 1000 meters, is a mixed type of training [6]. The anaerobic sporting events belong to supramaximal exhaustive trainings, which samples might be high jump, long jump, 100m run, 25m swim, weight lifting and so on.

The said above shows that the aerobic mechanism of energy production mainly depends on factors listed below: 1) O2 delivery to tissues, 2) the glycogen storage in the liver and muscles. In 1.5-2 months after the start of the athlete's training, these indicators begin to increase. This increases the activity of oxidative enzymes, maximal oxygen uptake, quantity of hemoglobin and myoglobin, with quantity, size and strength of mitochondria and rises an endurance of athletes. The capillary volume and, accordingly, the amount of entering the muscle O2 increases relatively later. All these prevent an increase in the pyruvic acid and lactic acid (lactate), because these factors accelerate the aerobic oxidation of pyruvate. This helps the athlete to train much longer.

Intense exercise doubles the amount of creatine phosphate in the muscles, and triples the amount of glycogen. Thanks to these changes, the high-level sprinters can continue exercise even if their lactic acid is 30 mmol / L. In untrained people the buffering systems are depleted when a lactate level in the blood is only 12 mmol / L. This phenomenon is associated with 50% increase of blood buffer systems in athletes'compared to the untrained people [7].

At sprint race for a distance of 100 m, ATP is formed anaerobically. Start and the first meters run at the expense of creatine phosphate. The remaining distance is covered at the expense of the creatine phosphate and lactate pathways simultaneously. The lactate way produces 50% of ATP needed for this race. The breakdown of glycogenat sprint race for a distance of 100 m is 1000 times greater, than at rest. However, even when the athlete is exhausted, muscle glycogen stores are not depleted completely. The absolute amount of ATP in the muscles changes little, whether in training or at rest, but when the athlete reaches the point of exhaustion, the creatine phosphate drops to zero.

For energy production in the 200m race, creatine phosphate is also used simultaneously with the lactate pathway, but the lactate pathway is used more. At 150th m of this running, creatine phosphate is depleted and running speed drops by 10%, after which the aerobic path starts.

The 400m race has already provided both by aerobic and anaerobic ways: creatine phosphate, lactate and aerobic pathways.10% of this race (start and finish) is provided by creatine phosphate, 60% - by lactate, 25% - by the aerobic way.

Among the factors, that reduce the race speed, the following can be distinguished:1) the deficiency of creatine phosphate, 2) the decrease in pH by lactate. Ergo, if the athlete neutralizes his blood pH, the race speed may increase. For this, first of all alkalic liquid may be taken when pH lowers (such juice is much more useful during competition and seems to be more needed closer to finish line). Additionally, since histidine is the single amino acid with strong buffering properties at physiological pH, histidine-rich compounds should be added to athletic supplements immediately prior to competition. Second, diet rich in methionine is beneficial for synthesis of creatine phosphate. Since vitamins of B group, namely B_6, B_9, B_{12} participate in methylation reactions in the body, needed to transfer methyl group from methionine to creatine they must be added to the athelets diet too (these supplements are useful during training period). The common energy drinks enriched with glucose are not recommended to athelets; the reason is that glucose increases insulin secretion, and insulin works more to store nutrients than to deplete them, resulting in decrease of speed during the competition.

To increase the speed of athletes`, it is recommended to activate the aerobic path during training sessions too. In the table are represented the energy sources and limiting factors at some training sessions. The data on the duration of energy consumption are also presented [8].

Table. Energy expenditure in some short-time sporting events

Primary energy source:	**Are used stored ATP (2-3 s), and creatine phosphate**
Activity duration:	About 7-12
Type of sessions:	High and long jump, 100m run, 25m swim, weight lifting
Advantage of these sessions:	Produce much energy in a short time
Factors limiting sessions:	Initial concentration of high energy phosphates, such as ATP and creatine phosphate

The scientists disclosed, that the energy release among the sprint athletes is different only during the second half of the exhaustive supramaximal run [9]. This means, that the coaches should pay more attention to improving athletes' endurance and their ability to increase speed in the second half of the run. Since the main limiting factor in the second half of the run is the accumulation of lactate in muscles and blood, it would be advisable to look for ways of rapid alkalization of blood in this period of time.

2. Conclusion

During exhaustive supramaximal sporting events an athlete's endurance depends on the availability of carbohydrate reserves and the ability to quickly accumulate macroergs for rapid inclusion in the decay process. The high initial concentration of high energy phosphates, such as ATP and creatine phosphate play a decisive role in winning sports. Additionally, in so far as the energy release among the sprint athletes is different only during the second half of the exhaustive supramaximal run. Ergo, it would be better the coaches to try rise athletes' increase speed in the second half of the run and for that purpose, seek for ways alkalization of blood.

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