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Research Article

Analysis of the Effectiveness of Proper Nutritious Diet in Prevention of Exercise-induced Fatigue

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Abstract: This current study focused on the potency of proper nutritious diet to alleviate and eliminate prolonged moderate-intensity Exercise Induced-Fatigue (EIF) for exercisers who vary in nutritional metabolism and supplement since they are engaged in different exercises. We performed a systematic literature review and logic analysis to investigate the effectiveness of proper nutritious diet in prevention of EIF, aiming at finding more evidence that may help exercisers recover from EIF.

Keywords: Exercise-induced fatigue, nutritious diet, proper exercise

INTRODUCTION

People attach more importance to exercise because staying active improves functions and general health of the body (Yang, 2011). But results are not always as expected. Instead, people often suffer from Exercise-Induced Fatigue (EIF) that impacts outcome of exercise. A growing body of evidence show that not only regular exercise but also a proper and nutritious diet are necessary to achieve good results. The fatigue occurs when the body is not able to hold at pre-set exercise intensity, which leads to reduced mobility. There are two types of EIFs, including CNS EIF (neurological disorder) and peripheral EIF (muscle fatigue). The EIF has been a great hindrance for exercisers to improve their performance. It is important to study the role of proper nutritious diet in prevention of EIF (Yongyong, 2013). Hence, this current study took an insight into exercise and diet to figure out the proper way for exercisers to supplement nutrition before and during exercise, which might help them alleviate and eliminate EIF and benefit more from exercise.

MATERIALS AND METHODS

Cause of EIF: The EIF occurs via the following main complex mechanisms:

- **Energy consumption theory:** A large amount of sources of energy such as ATP, CP and glycogen is consumed during exercise. EIF occurs when these sources are not rapidly supplemented.
- **Metabolite theory:** Metabolites such as lactic acid bacteria and amino acid that produce during exercise may stack in the body when they are not immediately eliminated.
- **Imbalanced internal environment theory:** Internal environment disorder such as imbalance of Ca^{+2}, K^{+2}, Mg^{+2} causes changes of levels inside and outside the cell membrane, which leads to musculoskeletal fatigue.
- **Decreased endocrine regulation theory (Zhou, 2010):** The impaired endocrine regulation causes changes in metabolism of substances and energy, reducing mobility of the body.
- **Protective inhibition theory:** The protective inhibition occurs in cerebral cortex when the levels of neurotransmitters (amino acids) such as 5-hydroxytryptamine change.
- **Reduced immunity theory:** The immunity disorder or impairment that occurs during exercise results in inhibition of mobility of the body.
- **Free radical theory:** Free radicals attack biological membranes such as cell membrane and mitochondrial, causing reduced membrane fluidity, ion and energy metabolism disorder and hence EIF.
- **Mutation theory:** The consumption of great deal of energy during exercise causes decrease in muscle strength and loss of nervous excitability and muscle motion. In conclusion, EIF is a sign of the above factors.

Nutritious food for prevention of EIF: Proper nutritious diet constitutes a safeguard for mobility and body health. Exercise promotes metabolism of substances and energy. Nutrients such as sugar, protein, inorganic salt and vitamin are good elements in diet that play important roles to regulate body functions, eliminate fatigue and promote recovery of exercisers.

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Sugar: During prolonged exercise, the body takes energy from sugar. Supplementation of sugar before and during exercise helps exercisers respond to high-intensity intermittent exercise in short term. During exercise, the levels of ATP and CP decline rapidly, which leads to fatigue. Studies show that supplementation of sugar inhibits production of free fatty acid and the reduction in free fatty acid inhibits production of 5-HT in brain, therapy minimizing EIF. The uptake of polysaccharide and disaccharide necessitates a process in which the sugar is turned into monosaccharide and absorbed via the intestine into the bloodstream and then participates in functioning in the form of glucose (Yang, 2008). Therefore, exercisers should supplement oligosaccharide and monosaccharide that are easy to uptake and utilize. The excessive sugar may result in increased insulin and transient low blood sugar, which impacts the effect of exercise. This shows that simply adding sugar before and during exercise is not ideal. The increase of glycogen storage in the body is important to improve the results, so proper nutritious diet is a critical method to prevent EIF. In a diet, grains-such as wheat, rice, millet, potato, broomcorn and corn-are packed with more sugar. One hundred gram of wheat-processed foods contains more sugar than equivalent amount of other foods, followed by rice-processed foods. These grains are essential substances for the body to function and also important source of sugar in the body, so foods made from wheat and rice are main source of energy in the dietary of exercisers. Most sugar in foods is polysaccharide. The monosaccharide and oligosaccharide are mostly found in fruits, mild and honey. A diet with more foods made from wheat and rice is effective to increase glycogen storage.

Protein: Exercisers should be highly concentrated during exercise, resulting in neurological fatigue. Protein is a essential nutrient to the body and increases muscle contraction and nervous excitability. The basic unit that constitutes protein is amino acid. During exercise, the body selectively utilizes amino acids. The branched chain amino acid can slow the tryptophan to enter the brain, reduce the generation of 5-hydroxytryptamine, maintain cerebral excitability and hence prevent CNS fatigue. Aspartic acid and aspartic acid can reduce the concentration of ammonia in the blood and reduce negative impact of amino acid poisoning. Oxaloacetic acid derived from aspartic acid can promote oxidation of fatty acid, decrease sugar consumption of the body and hence prevent EIF. The count of glutamine is the highest among free amino acids in the human body. It participates in protein synthesis, storage and detoxification of toxic ammonia and oxidation for energy supply, which is closely associated with mobility of the body. Supplementation of exogenous glutamine before and after exercise (Chang *et al*., 2014) increases the level of glutathione in myocardial tissue, strengthens oxidation resistance of the body, inhibits lipid peroxidation in cell membrane, prevents generation of malondialdehyde and hence prevents EIF. Food is a source of protein. Different foods vary in amount of proteins, as shown in Table 1.

Table 1: The content of proteins in foods

Food	Content (%)
Milk	3.2
Rice	8.6
Potato	1.8
Egg	12.2
Millet	9.6
Rape	1.9
Pork	16.7
Flour	9.8
Chinese cabbage	1.3
Beef	19.9
Corn	8.5
Sweet potato	2.2
Spinach	1.9
Fish	1.3
Tofu	18.6
Peanut	25.4
Mutton	15.4
Soybean	33.2

As shown in Table 1, foods such as meat, bean and peanut contain more proteins. But exercisers should eat more animal protein than vegetable protein. The quality protein accounts for about 30% of the total. Foods such as fish, beef and soybean are first choices of sources of quality proteins for exercisers. It is not recommended to eat a lot of peanut because it is high in calorie. Whey protein is quality protein found in milk. It contains free amino acids easy to be absorbed and utilized by the body. Also, milk contains glutathione (antioxidant) that can improve oxidation resistance of the body, protect structures such as cell membrane, sarcoplasmic reticulum, mitochondria and hence prevent EIF. The energy from protein keeps nitrogen balanced in the blood and helps the body restore mobility as soon as possible. Excessive protein intake increases the loads on liver and kidney, which makes the body prone to fatigue, affects metabolism of water, salt and fat and induces problems such as dehydration, decalcification and gout. Therefore, exercisers should get the habit of proper dietary and avoid excess protein.

Vitamin: The demand for vitamin is not necessarily much. But it is essential. Vitamin does not involve in exercise. Instead, it plays a role in regulation of physiological function and biological oxidation. In the process of exercise, exercisers are under high-intensity stress related to activities such as sensation, thinking and vision. Great deal of energy is necessary to ensure physical and neurological functions, so people are prone to EIF.

Vitamin A and vitamin B can protect vision and maintain normal functions of the nervous system. Problems such as functional disorder, blepharitis and visual fatigue will occur if both vitamins are inadequate. Vitamin C and vitamin E are important antioxidants in the body. Vitamin C participates in oxidation of protein, fat and sugar. It is a carrier of hydrogen in the body,

Table 2: Loss of vitamin during processing

Vitamin	Loss (%)
Vitamin A	Less than 40
Provitamin A	Less than 30
Vitamin D	Less than 40
Vitamin E	Less than 55
Vitamin C	Less than 100
Vitamin B	Less than 80
Vitamin B	Less than 75
Vitamin B	Less than 40
Niacin	Less than 75
Pantothenic acid	Less than 50

which participates in oxidation and reduction reaction of cells. Although vitamin C does not consume oxygen in the blood, it can regulate use of oxygen during metabolism. Vitamin B can not only promote storage of glycogen in muscles, but also accelerate decomposition of glycogen and phosphocreatine to release energy required by the body, thereby improving mobility of the body. Vitamin B deficiency causes problems such as insomnia, amnesia and muscle weakness (Chen, 2014), affecting the mobility of exercisers. Vitamin can be derived from foods. Different foods contain different types and amounts of vitamins. Since vitamin may break down under some conditions, it is important to choose suitable foods and process them in a correct method to achieve nutritious diet that helps maintain normal physiological activities. The losses of vitamins in different foods during cooking are shown in Table 2.

As shown in Table 2, proper cooking method is directly associated with the amount of vitamin in foods consumed by exercisers. Some foods such as wheat and rice lose vitamin during initial processing. But the lost part contains vitamin very important to the body. It is necessary to add some unprocessed foods such as corn and soybean in the diet to supply essential small amount of vitamin and keep balance of vitamin in the body.

RESULTS AND DISCUSSION

Endurance exercise: The metabolism is mainly aerobic during endurance exercises such as Marathon, long-distance cycling and swimming. In the late stage of endurance exercise, the depletion of glycogen makes exercisers prone to CNS fatigue and causes damage to self-metabolism, so exercisers should uptake energy based on their own conditions. Research has shown that multiple nutrition supplementations improve mobility of exercisers. The nutritional density and balance should be taken into account in smaller meals. Generally, the protein accounts for 13% of total calories. The fat accounts for 36%. The carbohydrate accounts for 56%. In the process of prolonged competition, the uptake of carbohydrate increases to 65% to maintain higher level of glycogen. In addition, exercisers should supplement with foods rich in iron, such as lean meat, eggs and green vegetables.

Vigorous exercise: Vigorous exercises such as throwing, weightlifting and wrestling require strong strength and neuromuscular coordination during exercise. Exercisers have to burst out immense strength in a short time. Vigorous exercise is characterized by high intensity and great oxygen consumption, so large amount of quality protein is required in the diet, accounting for more than 15% of the total amount of diet, more than 2 g/1 kg of weight. Meanwhile, exercisers need to consume large amounts of electrolytes such as K, Na, Ca and Mg. The vegetables and fruits in the diet should account for 15% of total calories.

Agile and skillful exercise: Agile and skillful exercises such as fencing, gymnastics, diving and table tennis require exercisers to be highly concentrated. These exercises also require people to coordinate their speed due to lack of periodicity. The diet for exercisers should be rich in protein, vitamin B and minerals such as Ca, P to ensure neural functions. Protein accounts for 13% of total calories. During the stage of weight regulation, protein should account for 80% of total calories. The amount of fat should be moderate, accounting for 32% of total calories. The intake of vitamin B is 4 mg daily. The intake of vitamin C is 140 mg daily. In addition, visual tension is high during competitive exercises such as table tennis and fencing, so the diet should be rich in vitamin A, with 7000 IU daily. The sources are foods made from poultry.

CONCLUSION

The mechanisms that cause EIF are complex and remain unknown. Different measures should be taken to prevent EIF. Scientific and proper nutritious diet not only maintains normal physiological functions, internal environment and mobility, but also alleviates fatigue and reduces severe of EIF. Scientific and proper nutritious diet incorporates many nutrients that are effective for exercisers. In brief, proper nutritious diet for exercisers not only effectively prevents EIF and helps recover from EIF, but also guarantees competitiveness of exercisers. It is important for exercisers to be aware of the significance of proper nutritious diet and maintain a scientific diet so that they can prevent EIF and improve results of exercise. How to prevent and eliminate EIF and improve resistance to fatigue and general health of exercisers still needs to be further investigated in the future.

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