Original Article

Study on the Characteristics of Energy Consumption and Metabolism during Exercise

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Abstract

Objectives: The objective is to study the characteristics of energy consumption and substrate metabolism during exercise. **Methods:** Sixteen female college students in a university in Wuhan province were selected as the control group, and 16 male college students were selected as the research group. The two groups of car exercise experiments with different intensity were carried out, and the energy metabolism of the body was analyzed by the gas substitution method. **Results:** Compared with the control group, the total energy consumption in the observation group was significantly higher, and the difference between the two groups was statistically significant ($P < 0.05$). The percentage of fat in the control group was significantly higher than that in the observation group ($P < 0.05$). There was no significant difference in fat oxidation between the control group and the observation group under the same exercise intensity ($P > 0.05$). Compared with the control group, the observation group was significantly higher glucose oxidation, and the two groups had a statistically significant difference ($P < 0.05$). **Conclusions:** In the process of exercise, the proportion of female fat supply is significantly higher than that of men, and the total energy consumption in the process of male exercise is more than that of women.

Keywords: Energy metabolism, fat oxidation, substrate metabolism

Introduction

Human life is a process of energy consumption, and muscle activity is one of the most active consumption of energy. The motion body is a process of material metabolism and energy metabolism. During exercise, the main substrates for energy metabolism are carbohydrates, lipids, and proteins. Carbohydrates are important energy resources for high-intensity exercise and long exercise.[1] In the form of glycogen, the muscles are stored in the muscle as an energy resource, and the sugar stored in the liver in the form of liver glycogen can be quickly mobilized when the body is needed. Relative to carbohydrates, lipids are the most important form of energy storage. Lipids are a simple and useful energy material. Lipids are stored inGlycerol 3-phosphate as a storage form, mainly composed of glycerol and three molecules of fatty acids, which are mainly stored in fat tissue, but they can also be found in muscle cells. The main form of storage of protein metabolism is muscle. Of course, proteins include various enzymes, skin hormones, hemoglobin, myoglobin molecules, and an important part of cell membrane. However, these substances will not be decomposed as energy materials.

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Quick Response Code:

Website: www.matrixscimed.org

DOI: 10.4103/MTSM.MTSM_12_19

Many researchers have explored energy metabolism from different angles and have gained some understanding.[2,3] However, most of the studies focus on the principles of energy consumption, measurement methods, and energy-related materials, energy supply systems, etc. Beside the amount of lipid oxidation, the amount of sugar oxidation, and the changes of their motion intensity and time during the process of exercise also has been reported. However, the main research subjects are professional athletes or small animals. There are few reports on the energy consumption and substrate metabolism of long-term exercise in general population. At the research level, exploring the characteristics of substrate metabolism during exercise is also an irreplaceable function for us to have a deeper understanding of human activity function and principles.

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How to cite this article: Li YY. Study on the characteristics of energy consumption and metabolism during exercise. Matrix Sci Med 2019;3:38-40.

Received: 12-06-2019, **Accepted:** 26-11-2019, **Published:** 03-02-2020

Overview

Different moving modes need different energy supply systems in energy supply, and different energy supply systems need different materials for energy supply. Gender differences may also cause different consumption of substances. As we all know, in short-time and high-intensity exercise, the energy supply of fat is very small, depending on the decomposition of high-energy phosphate and the supply of glycogen by anaerobic glycolysis. In short-time and low-intensity exercise, in addition to the use of high-energy phosphate, exercise also has a mild glycolysis at the beginning of exercise, mainly dependent on the oxygen-free energy of muscle glycogen, without changes in plasma-free fatty acid and blood glucose concentration.[4] It can be seen that in short-time exercise, the total energy consumption of the body is small, and the main energy participating substances are high-energy phosphate and muscle glycogen. The exercise of long and low intensity is mainly the energy supply of fat and sugar by aerobic metabolism, and the energy supply of free fatty acids will reach a higher level in exercise hours.

Methods

The subjects were 32 college students in H Province, of whom 16 were men and women. The subjects were in good health and had normal cardiopulmonary function. During the hour before the experiment, no physical activity or muscle fatigue was observed. The basic situation of the subjects was shown in Table 1.

In this study, we collected data on body energy expenditure and substrate metabolism in sports in recent years. The current research status of energy consumption and substrate metabolism on fitness shaping is reviewed and analyzed from the perspective of sports physiology.[5] In the process of analysis, we compare the current energy metabolism and substrate metabolism in exercise. The changes of fat consumption and glucose oxidation level in exercise were identified as the main contents of this article.

Results

From Tables 2 and 3, the consumption of sugar and energy supply of male and female students decreased with the prolongation of exercise time. The fat consumption and energy supply decreased gradually, while the total energy output was basically unchanged with time in 40-min movement. In the comparison of 0–10-min segment and 11–20-min segment, both male and female sugar consumption and energy supply were found to increase, and females rose more than boys. Moreover, women's sugar consumption and energy increase have a very significant difference. With the continuation of the exercise, the sugar consumption and energy supply of male and female students decreased after 20 min, and there was a significant difference between 21–30 min and 31–40 min.

Table 1: Basic table of subjects

Sex	*n*	Year	Height (cm)	Weight (kg)	BMI
Boy	16	20.50±0.53	181±0.04	73.50±5.53	22.42±1.12
Girl	16	20.75±0.71	164±0.05	53.88±3.40	20.03±1.07

BMI: Body mass index

Table 2: Changes of body sugar consumption and sugar supply energy with time during vehicle exercise ($\bar{x}\pm s$)

Time/min	Sugar consumption (mg/kg/min)		Sugar supply (J/kg/min)	
	Boy	Girl	Boy	Girl
0-10	22.40±7.41	16.99±9.24	375.07±124.11	284.48±154.80
11-20	22.90±7.30	21.10±9.17**	383.35±122.27	353.30±153.50**
21-30	21.83±5.96	19.54±8.92	365.48±99.84*	327.14±149.40
31-40	20.30±6.53**	18.43±8.4**	339.86±109.25**	308.63±148.06**

*P<0.05, **P<0.01

Table 3: Changes in body fat consumption, lipid oxidation, and total energy output over time during exercise ($\bar{x}\pm s$)

Time/min	Fat consumption (mg/kg/min)		Fat supply (J/kg/min)	
	Boy	Girl	Boy	Girl
0-10	7.55±3.51	7.98±3.77	284.48±132.36	300.60±142.20
11-20	7.77±3.63	6.94±3.79	291.47±136.63	261.63±142.95
21-30	8.51±2.96*	7.28±3.95	320.77±111.35*	274.31±148.73
31-40	9.21±3.11**	7.83±4.12**	347.02±117.25**	295.03±155.18**

Compared with the first 10 min, *P<0.05; **P<0.01; ***P<0.001;
Compared with boys, a means P<0.05; b means P<0.01; c means P<0.001

Conclusions

In the long-time continuous motion process, the metabolism of the body will be into a stable state and the total energy consumption level basically stable. However, as the duration of the movement increases, the metabolism of the body's substrate will change, which shows that the energy of sugar oxidation decreases gradually, while the proportion of fat oxidation supply and fat oxidation increases gradually. This law of change has also been confirmed in this study. During exercise, the proportion of women's fat supply was significantly higher than that of men, and the total energy expenditure of men during exercise was higher than that of women.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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