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Effects of Food Composition and Exercise Training on Body Weight Regulation and Physiological and Biochemical Mechanisms in Male Mice

Fenglin Peng,Shengnan Wang
Guangxi Normal University

Objective To explore the effects and the physiological and biochemical mechanisms of food composition and aerobic exercise on the body weight regulation among sub-adult and adult mice, with a view to the reference of exercise and diet in adolescents and adults.
Methods There are 72 sub-adult mice and 39 adult mice which were selected by the treadmill exercise pre-screening. They were engaged for a period of time to domesticate in accordance with the different exercise intensity, time and food compositions. During the domestication, the body weight and food intake were measured several times, and the digestibility was calculated. The mice were dissected after domestication, and the fresh weight of adipose tissue and internal organs were measured, which including the weight and length of digestive organs. Serum glucose, triglyceride, urea nitrogen and creatinine were measured by colorimetric method. The contents of creatine kinase(CK) and muscle glycogen(MG) and glucose transporter 4(GLUT-4) in serum were determined by ELISA, and the digestive enzyme activity was detected by colorimetric method.
Results 1.Sub-adult mice: food composition has no significant effect on many indicators, including body weight, major fat weight, the length, fresh weight and content weight of stomach, the fresh weight of heart, spleen and lung, the level of blood glucose, triglyceride and CK (P>0.05). But the food composition has a significant effect on the following indicators: the food intake, digestibility, the length, fresh weight and content weight of small intestine, cecum and colon, fresh weight of liver and kidney, the level of blood urea nitrogen and creatinine, the level of MG and GLUT-4 in muscle, the enzyme activity of intestinal brush border membrane sucrose, maltase and aminopeptidase-N (P<0.05). Aerobic exercise has no significant effect on the following indicators: the length and content weight of stomach, small intestine and colon, the weight and content weight of cecum, fresh weight of heart, spleen, lung and kidney, the level of serum triglyceride, urea nitrogen and CK, the level of GLUT-4 in muscle, the enzyme activity of intesyinal brush border membrane sucrose and aminopeptidase-N (P>0.05). But aerobic exercise has a significant effect on the following indicators: body weight, major fat weight, the food intake, digestibility, the fresh weight of stomach, small intestine and colon, the length of cecum, the fresh weight of liver, the level of blood glucose and creatinine, the level of MG in muscle, and the enzyme activity of intestinal brush border membrane maltase (P<0.05).
2.Adult exercise mice: food composition has no significant effect on the following indicators: the body weight, major fat weight, the length, fresh weight and content weight of stomach, small intestine and colon, fresh weight of heart, liver, spleen, lung and kidney, the level of blood glucose and triglyceride, and the enzyme activity of anterior intestinal brush border membrane sucrose, maltase and aminopeptidase-N (P>0.05). But the food composition has a significant effect on the following indicators: the food intake, digestibility, the fresh weight and content weight of cecum, the level of glood urea nitrogen and creatinine, and the enzyme activity of middle intestinal brush border membrane sucrose, maltase and aminopeptidase-N (P<0.05). The body weight changes with time significantly, but the magnitude of the change before and after exercise is less than 5%.
3.Sub-adult exercise mice vs adult exercise mice: with the increase of exercise time, the weight gain of sub-adult exercise mice was decreased significantly (P<0.001), and the weight of adult exercise

mice was also decreased significantly (P<0.001). Compared with adult exercise mice, the perirenal fat ratio, mesenteric fat ratio and the gonadal fat ratio in sub-adult exercise mice were lower than that of adult exercise mice(P<0.001), but the lean body weight ratio in sub-adult exercise mice was higher than that of adult exercise mice (P<0.001). The food intakes of sub-adult and adult exercise mice were significantly increased with time (P<0.001), the effects of food composition on the digestibility of sub-adult and adult exercise mice were associated with decreased movement with the increase of protein content in food. The length, fresh weight and content weight of stomach and colon were significantly lower in adult adult mice than in sub-adult mice (P<0.05). The fresh weight of heart, liver and kidney of sub-adult mice was significantly lower than that of adult mice (P<0.05). But fresh weight of the spleen was significantly higher in sub-adult mice than in adult mice (P<0.05). The levels of glucose, triglyceride and creatinine in sub-adult mice were significantly higher than those in adult mice (P<0.05). It was significantly lower in sub-adult mice than in adult mice that the enzyme activity of anterior intestinal brush border membrane sucrose and maltase and posterior intestinal brush border membrane aminopeptidase-N (P<0.05). However, the enzyme activity of middle intestinal brush border membrane sucrose of sub-adult mice was significantly higher than that in adult mice (P<0.05).

Conclusions 1.It was not affected for body weight and fresh weight of major fat in change of food composition in a certain range, aerobic exercise could control the excessive growth of body weight and weight of major fat of sub-adult exercise mice, but the body weight of adult exercise mice had no significant effects on regulation by food composition.

2.The food intake of sub-adult and adult exercise mice and the digestibility of sub-adult exercise mice were significantly changed with time. Influence of food composition on digestibility of sub-adult and adult exercise mice with exercise time showed that it decreased with the increase of protein content in food. Food intake of sub-adult and adult exercise mice increased with aerobic exercise in a certain range.

3.The changes of food intake and digestibility mainly rely on the regulation of the morphology and function of digestive organs. he changes of blood indicators showed that food composition and aerobic exercise had contribution on sub-adult and adult exercise mice to maintain good health, part of which has offset the metabolic changes caused by the high protein foods that was aerobic exercise, and high protein foods produced certain metabolic burden on the liver and kidney, but aerobic exercise can improve the metabolism of liver and kidney.

4.Aerobic exercise can increase the reserve of MG in muscle of sub-adult mice, the storage and transport of MG in muscle can be improved with the increase of starch content in food. In this study, aerobic exercise intensity did not cause muscle fatigue or injury.

5.The activity of the enzyme increased with the increase of the content of starch in food, which was not affected by aerobic exercise. Aminopeptidase-N activity was effected by aerobic exercise, which decreased in non-exercise state with dropping down protein content in food, but which did not show the same trend in the exercise state. It might be more regulated by the increase in protein demand under the exercise state.