

Research Article

Study on the Assistant Effect of High Sugar Foods in the Long-distance Running Movement

Xiying Zuo

Department of Physical Education, Henan University of Traditional Chinese Medicine, Zhengzhou 450046, Henan, China

Abstract: The carbohydrate supplement can effectively reduce the decline of blood sugar in the long-distance running movement. In this study, it takes the common pattern of energy supply as the breakthrough point, by means of analyzing the characteristics of energy supply of long-distance running movement, as well as the interpretation of the influence of exercises on the metabolism of glucose, it discusses the function of supplying high sugar foods to improve the exercising capacity of athletes.

Keywords: Energy supply, high sugar foods, long-distance running

INTRODUCTION

The training time of long-distance running is long, with large energy consumption, the energy metabolism is mainly aerobic metabolism and the main material for supplying energy is carbohydrate. Sugar is the most important material for supplying energy for the human body, which can be involved in the synthesis of ATP in any sports occasions. During the period of training and competition, most of the energy that the runner's body needed is from endogenous sugar, which mainly is the muscle glycogen and hepatic glycogen.

The study proved that after long time movement, after having sugar material, the movement ability can be recovered, the concentration of blood glucose can be remained constant, which can delay the occurrence of sports fatigue (Pfitzinger, 2001). So in the long time of moderate intensity exercises, the amount of muscle glycogen is the key factor to determine the movement ability of long-distance athletes. However, the total amount of human endogenous sugar reserves cannot meet the demand of the movement and scientific supplement with sugar is very important for long-distance athletes.

MATERIALS AND METHODS

The general rule of energy supply during movement: The direct energy of human motion is ATP, but the reserve of ATP is limited, the amount of reserve in muscle cell, is only 4-6 mol/kg wet muscle, which cannot meet the needs of the body for its long time movement. So, ATP must have decomposition and synthesis at the same time, which can continue to supply the demanded amount for the muscle's activity (Saunders *et al.*, 2004). The energy required by the

synthesis of ATP comes from three ways: the decomposition of Creatine Phosphate (CP), glycolysis, aerobic oxidation of glucose, fat and protein. Namely, three energy supply systems during motion: phosphoric acid system, lactic acid energy system and aerobic oxidation system, the former two are in anaerobic oxidation energy forms, the latter is in aerobic oxidation energy supply form. These three energy supply systems have different features (Table 1).

Different sports, due to its intensity and duration of time, as well as different technical structure, the proportions of three kinds of energy systems occupied in different items are also not identical. Such as, during 800 m running, in addition to relying on phosphoric acid system, it also depends on lactic acid energy system with the synthesis of ATP. During 1500 m and 3000 m running, the resynthesis of ATP is implemented by anaerobic and aerobic system.

The characteristics of energy supply of each stage of medium and long distance running: According to the technical essentials, it can be divided into three stages to complete a long distance running, namely, occupying a favorable position, running on the way and sprinting to the terminal point (Tarnopolsky and MacLennan, 2000).

The characteristics of energy supply from starting to occupy a favorable position: When long distance running starts, due to the tactical demand of seizing a favorable position, firstly, within the body, it can use phosphoric acid system to supply energy rapidly. But due to the mobilization of ATP and CP in muscle with all the reserves, which can maintain the body to have strenuous exercise no more than 10 sec, however, the time of starting the medium long distance race and

Table 1: Characteristics of human skeletal muscle metabolism during exercise capacity and three kinds of energy system

Energy system name	Substrate	Reserves (mmol/kg)	ATP synthesis in quantity (mmol/kg)
Phosphoric acid system	ATP	4-6	
	CP	15-17	100
Lactic acid system	Muscle glycogen	365	250
Aerobic oxidation system	Muscle glycogen	365	13000
	Fat	49	Unrestricted

seizing the favorable position is 12-15 sec. Because the time is long, the movement is intensive, the supply of oxygen is insufficient, the body can motivate the muscle's glycogen to generate lactic acid under the anaerobic condition, to participate in energy supply, so as to keep the energy supply at the time.

The characteristics of energy supply of running on the way and sprinting to the terminal point:

Running on the way takes the longest time in the whole process of long distance running item. With the increasing exercise load of the athletes, as well as the large consumption of oxygen, it will result in the insufficient supply of oxygen, while the time of phosphate energy supply system is short, then it is mainly depended on lactic acid energy system, which consists of muscle glycogen that can produce lactic acid to generate ATP. But its energy supply time can only be maintained at about 2 min. Because the shortest period of time of running on the way in the long distance running item should be more than 2 min, if lactic acid energy supply system is more than a certain time, there will be a lot of lactic acid to be decomposed, which will result in the accumulation of lactic acid in the body too much and will affect the value of PH, undermining the body's acid-base degree, which will inhibit the further decomposition of sugar in body and block energy supply (Hyunchul *et al.*, 2001). In 1500 m running item, because the time of running on the way is between 4-5 min, the lactic acid energy system is inhibited to a certain extent, at this time, the aerobic oxidation system begins to supply energy, sugar and fat, protein will be transferred into H₂O and CO₂ energy

under the adequate supplying condition with oxygen, which can provide energy that running on the way is needed.

During Long distance runners have sprinting stage in the end, because the exercising intensity is large, the duration of time is between 10-20 sec, at this time, the majority of supplying energy is phosphoric acid system and lactic acid system. The body will consume a large amount of phosphate and muscle glycogen, with some enzymes involved in phosphoric acid system and glycolytic system, vitamins, trace elements, which will have a certain degree of consumption. At the end of running, with the increased consumption of sugar, it gradually changed into utilizing fat oxidation for supplying energy. Due to the oxygen consumption of fat oxidation is large, energy output power is less than that of aerobic oxidation of glucose for supplying energy, so the utilization of fat can only be occurred in the late stage of movement, but at the stage of accelerating, sprinting, it can still use glucose for supplying energy.

The content and distribution of sugar in body:

The amount of sugar in body is about 400~500 g, stored in the form of glycogen, whose decomposition can release about 2400000 calories for a long time of exercises, to exhaustion, it is about 2 h in the form of glucose to transport (Febbraio *et al.*, 2000). The body tissues and organs have different degrees of the storage with glycogen, which is mainly distributed in the liver and skeletal muscle. Liver glycogen is about 70~100 g, its concentration is about 250 mmol/kg, muscle glycogen is about 350~400 g, its concentration is about 80~100 mmol/kg, glucose in blood is totally about 5~6 g, its concentrations is about 4.2~6.6 mmol/L, which is in the movement form of sugar within the body (Fig. 1).

Effect of exercise on glucose metabolism: Sugar is an important energy material in the body, it can provide energy not only in the form of anaerobic glycolysis, but also can provide energy in the form of oxygen metabolism, within the body, the reserve of sugar is

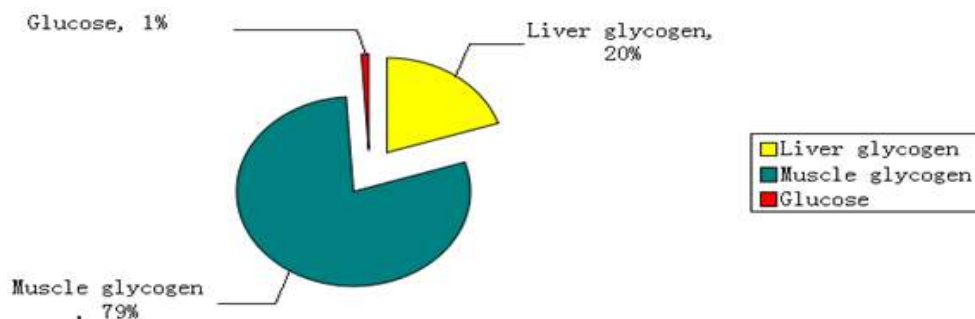


Fig. 1: The distribution of sugar in the body

Table 2: The concentration of blood glucose of each group before exercise in different time (unit: mmol/kg)

	½ h before exercise	1 h of having exercise	2 h of having exercise	3 h of having exercise	2 h after exercise
Group A	5.38±0.33	5.17±0.48	4.41±0.50	3.33±0.46	2.41±0.31
Group B	5.33±0.50	5.13±0.48	4.77±0.45	4.21±0.39	3.76±0.41

relatively limited, most of which is in the form of glycogen granules and distributed in liver and skeletal muscle, blood sugar is the form of sugar transported in the body. In the long period of movement, sugar often becomes the limited factor for the exercising capacity. Selecting two groups of long distance runners to have training contrast, runners in group A as the control group, who only have supplement of water without sugar in the training, while runners in group B are added with foods with low glycemic index such as chocolate, banana and so on. After the athletes in two groups having long-distance running training, it is found that the athletes in the control group-group A, who only have ate without sugar, the blood glucose has decreased dramatically, 2 h after exercise, it is significantly lower than that before exercise, two hours after exercise, the blood sugar continues to decline (Table 2).

Effects of exercise on muscle glycogen: During exercise, the utilization of muscle glycogen is affected by exercise intensity and duration of exercise greatly. The exercise with 75% VO₂max intensity to the exhaustion, muscle glycogen can be consumed from 80 to 95%; while exercise with 30% VO₂max intensity to the exhaustion, muscle glycogen is only decreased 15%; exercise with 90% VO₂max strength to the exhaustion, muscle glycogen is also decreased only 25%.

Effects of exercise on liver glycogen: The increasing degree of the decomposition speed of liver glycogen is positively related with the intensity of exercise, at the same time, the decomposition rate of liver glycogen is also related with the duration of exercise. When people have exercises in short time with high intensity, 90% of the output of glucose coming from the liver is from the decomposition of the liver glycogen, but due to the duration of motion is short, liver glycogen can be rarely empty. When the intensity of the exercise is relatively strong, after 40 min, the total proportion of the decomposition of glycogen accounted for the release of liver glucose is decreased gradually, while the proportion provided by gluconeogenesis is gradually increased.

Effects of exercise on blood glucose: During people have exercise, the glucose that skeletal muscle absorbed and utilized increased, the amount and intensity of exercise is related to the duration of exercising time and the sugar reserves of the body as well as the other factors. During the maximal oxygen uptake with intensity between 15~90% for 40 min of the movement,

with the intensity of exercise is increased, the amount that muscles absorb the glucose is increased, the main reason is that the blood flow of muscle is increased, which can promote the use of muscle to intake and utilize more glucose. But when the motion continues, the glucose absorption rate of skeletal muscle is gradually decreased, the declining rate and the concentration of blood glucose is paralleled.

RESULTS AND DISCUSSION

Sugar supplement before exercise: Long distance runners can have sugar supplement 2 to 5 min before exercise, which can delay the effect of insulin and be beneficial to the body's exercise; having sugar supplement 2 h before exercise, the supply of sugar can be absorbed by the synthesis of glycogen and be stored. As for exercise, it can increase the reserve of glycogen before exercise. It is generally believed that before training or competition, it can receive the best effect to have sugar supplement within 20 min, which not only can increase the adrenaline secretion, but also can make the insulin secretion decreased, so as to improve the capacity of exercise.

Sugar supplement during exercise: Long distance runners generally have sugar supplement in using small amount with multiple times, every 30 to 60 min, people can have sugar beverages or materials contained sugar that is easy for absorption, the content of sugar supplement is generally no more than 60 g/h or 1 g/min, which also should adopt and the absorption of monosaccharides and oligosaccharides. During the long time of exercise, because the decrease of blood glucose as well as the decrease of concentration, which can be thought one of the important factors of feeling fatigue. Moreover, during exercise, athletes have sugar supplement properly can raise the level of blood sugar, which can save the muscle glycogen, the depletion of muscle glycogen is reduced, which can prolong the movement time, thereby contributing to improving the movement ability.

Sugar supplement during exercise: The importance of long distance running athletes to have sugar supplement as soon as possible after having exercise lies in supplying the muscle glycogen synthesis raw material timely, so as to facilitate the early recovery of glycogen. The amount of sugar supplement should eat 50 g of sugar immediately after exercise, then every 1 to 2 h interval, having 50 g of sugar, who should have 200 g at least, the total amount of it can be up to 600 g in 24 h.

And the form of sugar supplement should use many kinds of sugar in mixed supplementary way. In the real long-distance race competition, sugar supplement is not only confined before and during match or after the match, which also should adopt the way of combination to supply sugar. Studies have found that before exercise and during having exercise, the combined sugar supplement can have better effect on sports ability than having sugar supplement alone.

CONCLUSION

Application of sugar supplement in sports has been more and more widely used with more and more attention. Reasonable sugar supplement can improve the body's sugar reserves, which can delay the appearance of exercise fatigue and promote the recovery of exercise, as well as improve the exercise capacity. To achieve this objective, we must consider the impact of sugar supplement on exercise capacity, which not only provide sugar supplement before exercise, during exercise and after exercise, but also should increase the intake of sugar in the usual diet during sports training. In addition, sugar supplement should also consider the appropriate osmotic

concentration, as well as the ideal sugar supplement combination.

REFERENCES

- Febbraio, M.A., J. Keenan, D.J. Angus, S.E. Campbell and A.P. Garnham, 2000. Preexercise carbohydrate ingestion, glucose kinetics, and muscle glycogen use: Effect of the glycemic index. *J. Appl. Physiol.*, 89: 1845-1851.
- Hyunchul, C., K. Junhi, L. Hankyung, S., Seungyun, Y. Jongdae *et al.*, 2001. The effect of creatine supplementation in anaerobic power and blood fatigue factors. *Res. Q. Exercise Sport.*, 72: 18-19.
- Pfitzinger, P., 2001. Speed for the long haul: The most effective workouts for distance runners. *Running Times*, 28: 14.
- Saunders, P.U., D.B. Pyne, R.D. Telford and J.A. Hawley, 2004. Factors affecting running economy in trained distance runners. *Sports Med.*, 34: 465-485.
- Tarnopolsky, M.A. and D.P. MacLennan, 2000. Creatine monohydrate supplementation enhances high-intensity exercise performance in males and females. *Int. J. Sport. Nutr. Exe.*, 10: 452-463.