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Original article

Research on the promotion effect of nutritional supplements on the physical function of tennis players

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Abstract: As a nutritional supplement, caffeine exists in many sports drinks, but how caffeine promotes the somatic function has not been clear. To study the promoting effect of caffeine on the physical function of athletes, 20 tennis players from the P.E. Scientific College of Harbin Normal University were randomly divided into group A, in which tennis players drank caffeinated drinks, and group B, in which tennis players drank decaffeinated beverages. The physical functions of the two groups were compared through grip strength, speed, endurance, and tennis test. According to the research results, there was no significant difference in the grip strength between the two groups, but the speed endurance and muscle endurance of group A were higher than those of group B ($P < 0.05$). In the tennis test, the average speed, maximum speed, and maximum ball speed of group A were also better than those of group B. The experimental results show that caffeine can promote the speed and endurance of athletes and can improve the physical function of athletes; therefore, it can be taken as a nutritional supplement for athletes and further applied in the sports field.

Keywords: nutrition supplement, tennis player, physical function, speed, endurance

1. Introduction

With the popularity of sports, the use of nutritional supplements has bee n more and more extensive. For athletes, during exercise, due to the metabolism and consumption of the body, the demand for some nutrients or nutritional ingredients increases, which cannot be satisfied by the ordinary diet in a timely and effective manner, but nutritional supplements can supplement these deficiencies, such as protein, sugar, amino acid, etc. (1). The use of nutritional supplements in athletes has become more and more common (2). The effect of different nutrients on the physical functions of athletes has also been widely concerned by researchers. Mónica et al. (3) conducted a questionnaire survey on 13 sports athletes. They found through the Chi-square test and logical analysis that 64% of 244 athletes took nutritional supplements and the prevalence of micronutrient deficiency was low. Horvath et al. (4) studied the effect of taurine on muscle function in mice and found that taurine supplementation could enhance the anti-fatigue ability and strength recovery ability of the muscle. Mcnaughton et al. (5) studied the use of sodium bicarbonate. They found that it had an improvement effect on high-intensity intermittent exercise and skill training when the dosage was 300 mg·kg and athletes could effectively improve PH value or blood bicarbonate by taking sodium bicarbonate to maximize the motion effect. Guo (6) explored the anti-fatigue effect of jujube polysaccharide in rats and found through the experiment that the mice which took jujube polysaccharide had longer useful time for weight-bearing, higher glycogen content *in vivo*, and lower blood lactic acid and blood urea nitrogen content. Tennis has higher requirements for the physical functions of athletes. In the process of tennis training, there are a lot of running and jumping movements, and the demand for athletes' energy reserve is

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also relatively great; therefore, the somatic function of athletes needs to be promoted. Caffeine is a common component of daily drinks, and it is also commonly seen in sports drinks. However, there are few studies on how it can improve and affect body functions, especially in the study of human body test. Therefore, this paper took tennis players as the research subjects, conducted a detailed study on caffeine, and analyzed its impact on athletes' physical function. The present study aims to provide some theoretical references for the further application of caffeine in exercise training.

2. Nutritional Supplement Caffeine

Caffeine is one of the most important drugs in the world (7, 8) and also the main component of daily drinks (9). It has a high content in and various energy drinks such as coffee and tea. It is a kind of methyl xanthine and a central nervous stimulant, which has been used in the nutritional supplements of athletes. According to the International Olympic Committee, the upper limit of caffeine in urine is 12 μg/ml. After oral administration of caffeine (below 10 mg/kg body weight) in healthy adults, the absorption is fast and complete, with 100% bioavailability. It is mainly metabolized in the liver, and only 0.5% - 3.5% is discharged from the urine. When the plasma concentration exceeds 30 mg/L (150 mM), toxic reactions will occur, such as insomnia, polyuria, muscle twitch, arrhythmia, etc., but it has no obvious toxicity in normal physiology.

3. Research Methods

3.1 Research subjects

Taking 20 tennis players from the P.E. Scientific College of Harbin Normal University as the research subject, they were randomly divided into a caffeine supplement group (group A) and a non-caffeine supplement group (group B). There was no significant difference in the general data between the two groups.

All the subjects understood the intention and process of the experiment, signed the informed consent, were in good health, had no major disease or cold recently, did not exercise violently the day before the experiment, did not take caffeine or other supplements, and did not have the habit of drinking or smoking.

3.2 Experimental materials

Group A drank caffeine containing beverages. Caffeine tablets (200 mg/tablet) produced by PRO-LAB Nutrition Inc. were used. Caffeine tablets were ground into powder according to the dose of 6 mg/kg body weight and added to distilled water. Group B drank the distilled water without caffeine.

3.3 Experimental methods

3.3.1 Speed endurance test

After taking breakfast in the school canteen, the two groups of athletes took a rest for 30 minutes at the experimental site. Then they took the prepared drinks. After one-hour rest, they took the speed endurance test. First, they did a simple warm-up for five minutes. Then, they did cycling exercise on the Monark 839E power bicycle until exhausted, and the time to exhaustion of every athlete was recorded.

3.3.2 Muscle endurance test

After eating breakfast in the school canteen, the two groups of athletes took a rest for 30 minutes at the experimental site. Then they took the prepared drinks. After one-hour rest, the muscle endurance test was carried out. First, they took a simple warm-up for five minutes. Then they did the bench press once on Ariel Computerized Exercise System (ACES) with their largest strength and then continued the bench press movement. The athlete was judged as exhausted when the strength of the bench press was smaller than 70% of the strength of the largest strength. The maximum endurance of push-up and pull-down of every athlete was recorded.

3.3.3 Tennis sports test

After eating breakfast in the school canteen, the two groups of athletes took a rest for 30 minutes at the experimental site. Then they took the prepared drinks. After one-hour rest, the one-to-one simulated tennis math was carried out. The average speed and maximum speed of each athlete were recorded by GPS. Moreover, the maximum ball speed was recorded in the match.

3.4 Statistical analysis

The data were recorded and sorted out in Excel and statistically analyzed in SPSS17.0. The results were expressed by $\overline{x} \pm s$ false. The difference analysis used t-test. $P < 0.05$ indicated that there was a statistical difference.

4. Research Results

4.1 Speed endurance test results

The comparison of time to exhaustion between the two groups is shown in Figure 1.

According to Figure 1, on the power bicycle, the time to exhaustion of group A was 853.17 ± 152.77 s, and that of group B was 780.56 ± 146.85 s. By comparison, the time to exhaustion of group A was significantly longer (9%) than that of group B. The difference between the two groups was statistically significant ($P < 0.05$). It showed that caffeine was effective in improving the speed endurance of athletes and could prolong the time to exhaustion.

4.2 Muscle endurance test results

The comparison of muscle endurance between the two groups is shown in Figure 2.

According to Figure 2, when pushing upward, the maximum endurance of group A was 197.68 ± 49.85 ft-lb, and that of group B was 186.24 ± 33.67 ft-lb, $P < 0.05$, i.e., the difference was statistically significant, which showed that the maximum push-up endurance of athletes who drank caffeine significantly improved; when pulling down, the maximum endurance of group A was 332.94 ± 92.76 ft-lb, that of group B was 291.87 ± 64.37 ft-lb, $P < 0.05$, i.e., the difference was statistically significant, which showed that the maximum pull-down endurance of the athletes significantly improved under the influence of caffeine.

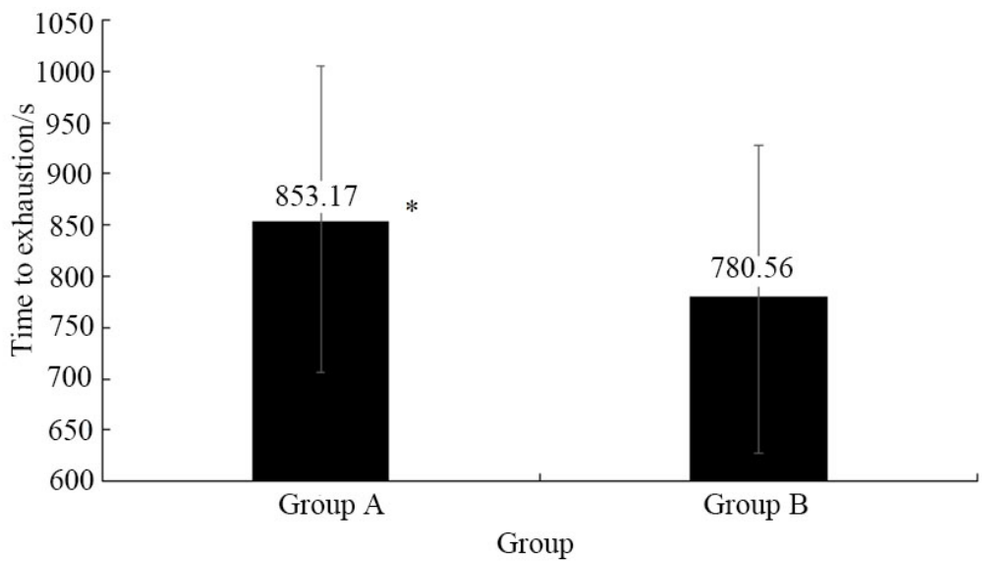

Figure 1. Comparison of time to exhaustion
* $P < 0.05$ compared with group B

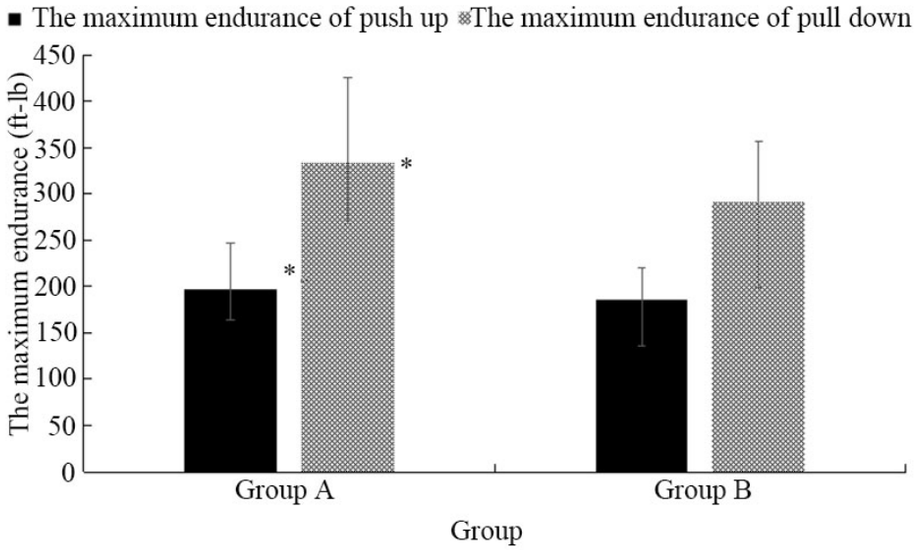

Figure 2. Comparison of muscle endurance
* P < 0.05 compared with group B

4.3 Tennis test results

The comparison of the average and maximum speed between the two groups in the tennis test is shown in Figure 3.

According to Figure 3, in the tennis competition, the average speed of group A and B was 0.28 ± 0.12km/h and 0.12 ± 0.21 km/h respectively, P < 0.05, i.e., there was a statistically significant difference, which showed that the average speed of

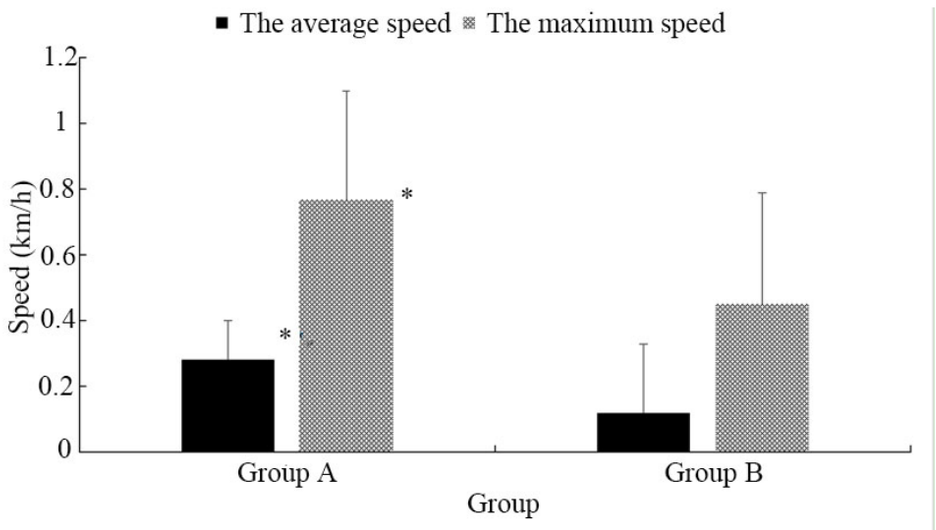

Figure 3. Comparison of speed
* P < 0.05 compared with group B.

athletes who took caffeine drinking was significantly higher in the process of the competition; the maximum speed of group A was 0.77 ± 0.33 km/h and 0.45 ± 0.34 km/h respectively, $P < 0.05$, i.e., there was a statistically significant difference, which demonstrated that the maximum speed of athletes greatly enhanced under the influence of caffeine.

The comparison of the maximum ball speed is shown in Figure 4.

It was seen from Figure 4 that the maximum ball speed of group A reached 131.48 ± 3.27 km/h, while that of group B was 124.26 ± 4.16 km/h ($P < 0.05$) in the tennis competition. It showed that the players' physical function improved under the influence of caffeine, which significantly improved the tennis ball speed and enhanced the sports performance.

5. Discussion

Tennis is a relatively high-intensity sport, and the metabolism and consumption of nutrients will rapidly increase in the process of exercise. The first is glucose metabolisms. During exercise, the skeletal muscle will take glucose from the blood as the source of energy, and it can supplement sugar in the form of liquid, solid or semi-solid; lipid metabolism is also very important in exercise, especially in endurance exercise, endogenous triglyceride is an important energy source, which can accelerate lipid decomposition; protein metabolism also provides a lot of energy, which is mainly supplemented by whey protein intake (10). Also, the movement of the body is also affected by inorganic metabolism, such as water, sodium, potassium, etc. (11).

The results of this study demonstrated that the performance of group A was better than that of group B in terms of speed endurance and muscle endurance; after drinking caffeine, the speed endurance and muscle endurance of athletes became greater, the average speed and maximum speed also improved, and the maximum ball speed was larger in the tennis competition.

It was seen from the results that caffeine could improve the endurance and speed of the body. During exercise, the metabolism of sugar and fat provides the necessary energy for exercise. First of all, from the perspective of fat metabolism, after athletes ingest caffeine, it accelerates lipolysis through promoting catecholamine production (12). It binds with adenosine receptors on adipocytes to increase the concentration of CA-MP and promotes the hydrolysis of

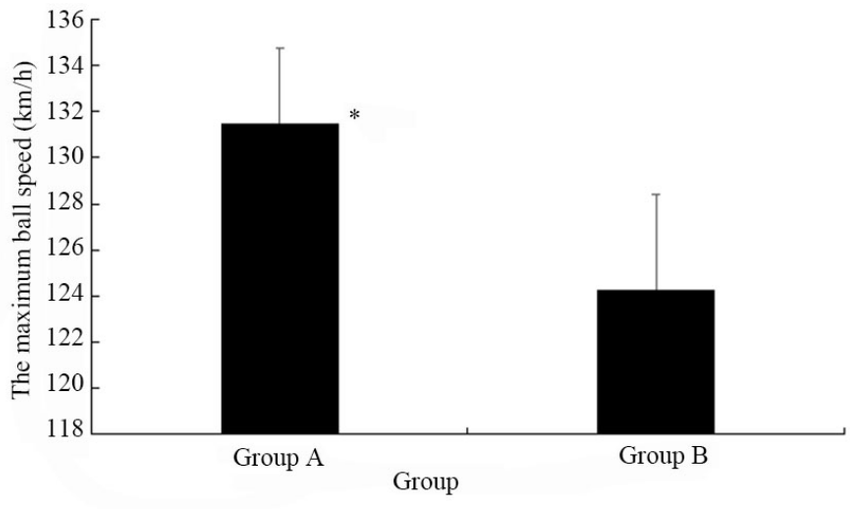

Figure 4. Comparison of the maximum ball speed
* $P < 0.05$ compared with group B.

triglycerides to release free fatty acids, which improves the utilization rate of fat. From the perspective of glucose metabolism, due to the improvement of the utilization rate of fat, glycogen is saved, which prolongs the time to exhaustion.

6. Conclusion

In this study, 20 tennis players were selected as the research subjects, and the effects of caffeine as a nutritional supplement on the functions of athletes were studied.

The results revealed that the speed and endurance of athletes improved after drinking caffeine, which indicates that caffeine has a role in promoting functions of athletes and can improve their sports performance. The experimental results of this study verified the positive function of caffeine in promoting the somatic function of athletes. Caffeine can be taken as a supplement for athletes and further applied in practice.

Acknowledgement

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