Molecular & Cellular Biomechanics

Tech Science Press

DOI: 10.32604/mcb.2022.018522

ARTICLE

Influence of Nutritional Supplementation and Sports Training on the Physical Fitness of Track and Field Athletes

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Received: 30 July 2021 Accepted: 13 September 2021

ABSTRACT

This study aims to understand the influence of nutritional supplementation and sports training on the physical fitness of track and field athletes. Twenty track and field athletes from Chongqing Normal University were supplemented with nutrition and trained for eight weeks. Water, sugar, and vitamins were supplemented. They were trained three times a week, two hours each time. One hour was for special track and field training, and one hour was for physical training. Before and after the experiment, the body composition, sports quality, and functional movement screening (FMS) of the athletes were tested. Compared with before the experiment, the muscle weight of the athletes increased, the fat-free weight increased ($p < 0.05$), the sports quality significantly improved, the endurance increased, the speed increased, the flexibility improved, the total score of FMS also increased significantly ($p < 0.05$). Nutritional supplementation and sports training can improve athletes' body composition and sports quality and enhance limb flexibility and stability, which has a positive impact on physical fitness. They can be applied in practical training.

KEYWORDS

Track and field athlete; nutritional supplementation; sports training; physical ability; endurance

1 Introduction

Track and field is a sport that includes field race, competition, and all-round competition [1]. It includes running, jumping, leaping, throwing, etc. and has high requirements for athletes' endurance, agility, etc. Athletes' physical fitness means ability of body movement. As the foundation of using techniques, physical fitness has a direct impact on sports ability, determines the athletes' competitive level, and plays an important role in the win or lose of the competition. Therefore, how to improve athletes' physical fitness [2] and quickly eliminate fatigue has become the focus of coaches and researchers. Two methods are generally used, namely, nutritional supplementation and sports training. Nutritional supplementation refers to the supplementation of various nutrients from outside according to the sports characteristics of different people [3] to meet the needs of body movements [4]. Sports training refers to applying reasonable load stimulation to the body to maintain and improve athletes' physical fitness level. The effects of nutritional supplementation and sports training on the human body have been widely studied. Walsh [5] stated that nutritional supplements such as probiotics, vitamin C and vitamin D can reduce infections in athletes and improve their immune health without side effects. Kim [6] found through

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researches that nutritional supplements such as caffeine, beta-alanine, and bicarbonate could help improve an athlete's strength and endurance, but the effects varied from athlete to athlete and depended on factors such as athletic characteristics and physical condition. Lappalainen et al. [7] have pointed out sports training is the safest strategy to increase skeletal muscle heat shock protein (HSP) and the use of antioxidants and nutritional supplements can also modulate skeletal muscle HSP levels. Cholewa et al. [8] studied 30 baseball players. Through 12 weeks of sports nutrition education intervention (SNEI), they found that the body fat of the players who received the intervention significantly reduced, their sports ability improved, and their nutritional status also enhanced. Shachar et al. [9] conducted sports intervention on 50% of 649 Israeli children and found that the self-control skills (SCS) of children in the experimental group increased significantly and their hostile thoughts and negative emotions decreased significantly. Wang [10] studied the influence of reasonable diet intervention on the competitive performance of middle and long-distance runners. Through the study of 40 athletes, they found that diet intervention was beneficial to adjust the body composition of athletes, increase the anaerobic capacity, and maintain a high hemoglobin concentration. Zinn et al. [11] studied the effect of the ketogenic diet on endurance athletes. After ten weeks of ketogenic diet, the subjects lost weight and improved their health, but they could not join high-intensity competitions. This study took twenty track and field athletes as subjects. In the eight-week experiment, the athletes were supplemented with nutrition and received sports training. The indicators of the athletes, such as body composition and sports quality, before and after the experiment were compared to understand the effect of nutritional supplementation and sports training on athletes' physical ability. This work makes some contributions to the improvement of athletes' physical ability and provides some theoretical support for research on nutritional supplementation and sports training in improving athletes' physical performance, thus contributing to the further development of the field.

2 Research Subjects and Methods

2.1 Research Subjects

Twenty male endurance track and field athletes from Chongqing Normal University were selected as subjects. They were healthy, free from serious diseases, and in good mental condition. They all knew the purpose and method of the experiment and signed informed consent. They aged 22 ± 1.45 years old. They were 183.21 ± 2.68 cm high and weighed 78.64 ± 6.12 kg. They have trained for 5.12 ± 0.87 years.

2.2 Nutritional Supplementation Methods

The difference between endurance sports and other sports is that its energy consumption is relatively stable in the short term, but the total energy consumption is very large because of the long duration. In endurance training, the human body consumes a lot of energy and materials and accumulates fatigue; therefore, it is necessary to supplement sugar timely to maintain the blood glucose level [12] and delay fatigue. Among the commonly used sugars, although glucose provides energy faster, it is easy to cause insulin reaction, and oligosaccharide is more conducive to maintaining the stability of blood glucose. Therefore, oligosaccharide is selected in this study. During exercise, the number of human respiration increases, and the amount of water loss also increases significantly, which is easy to cause dehydration [13]. Water loss is accompanied by salt loss. The loss of body fluid will cause blood concentration, leading to crick and weakness of limbs. Therefore, it is necessary to replenish water in time during training. Vitamin is essential to the human body. Although the demand for vitamins is not great it must be taken from the outside world. After a lot of training, the vitamin taken from the diet can not meet the needs of the human body; therefore, an additional supplement is needed, especially VB and VC. VC can reduce oxidative stress [14]. VP can prevent VC from being oxidized. VB1 is closely related to endurance exercise [15]. VB15 can improve the rate of oxidative metabolism.

During the experiment, the athletes ate a unified diet. They took meals one hour after exercise and trained again after two hours of rest. The composition of daily diet was 60%–65% carbohydrate, 13%–15% protein, 20%–30% fat, 500 g fruits, and 500 g vegetables. Before training, every athlete drank a bottle (500 mL) of water. During the exercise, every athlete drank half a bottle of water every 20 min. The supplement amount of water in a day was 3–4 L. Oligosaccharide at a concentration of 8% was the main sugar supplement. The daily vitamin supplement was 300 mg of VC, 50 mg of VP, 120 g of VB1, and 50 mg of VB15.

2.3 Sports Training Methods

Athletes trained three times a week, two hours each time. One hour was special track and field training, and one hour was physical training. Before training, they warmed up for ten minutes. After training, they relaxed for 10 min. The specific training contents are shown in Table 1.

Table 1: Content of sports training

Category	Action name	Load
Strength training	Barbell bench press	20 times/4 groups
	Push-ups with legs on the stool	12 times/3 groups
	Pull up with an elastic band	30 times/8 groups
	90-degree rotation jump in place	12 times/3 groups
	Multistage frog leaping	12 times/5 groups
Speed training	Lie prostrate and run after hearing the signal	One time/group × 3 groups
	100-meter count run	One time/group × 4 groups
	Fast rope skipping	60 times/group × 2 groups
	Count run with random little step *in situ*	One times/group × 2 groups
Agility training	Cross the hurdle horizontally and accelerate running	Three times/group × 2 groups
	Varied-direction accelerative run	Three times/group × 2 groups
Endurance training	15-min run	One group
	1500-meter run	Two groups

The specific training content of each day was arranged by the coach.

2.4 Test Indexes

(1) Body composition: the body composition analyzer (Shanghai Sanwei Medical Equipment Co., Ltd., China) was used. One hour after eating, the athletes wore underwear and stood barefoot in the sensing area. After the measurement, the experimenters recorded the relevant data, including muscle weight and fat-free weight.

(2) Sports quality: Sports quality indexes are shown in Table 2. The college males rating scale in *National Student Physical Health Standard* was provided as a reference.

Table 2: Index of sports quality test

Index	Item	Standard for full mark
Power	One-min pull-up	26 times
Endurance	1000-meter run	3'27"
Flexibility	Sit and reach	23 cm
Speed	50-meter accelerative run	6 s

The test methods of different items are as follows:

① One-min pull-up: The athlete held the rod, separated two hands to keep a same width as the shoulder, bent the elbows, pulled the body upward until the jaw at the same level as the rod or slightly above the rod, and moved downward until the arms completely extended. The test data were recorded.

② 1000-meter run: The test was conducted on a track and field. Regardless of the track, the athletes stood before starting running. Hands were not allowed to touch the ground. The experimenter whistled to indicate the start and used a stopwatch to time. The test data were recorded.

③ Sit and reach: The athlete sat on the cushion. The legs kept straight and stepped on the panel. Hands were put together and extended forward so that the upper body bent forward. The middle fingers pushed the cursor forward slowly until it could not be pushed. It was tested twice, and the better performance was recorded.

④ 50-meter accelerative running: The test was conducted on the track and field, two people for a group. They started after hearing the command. At the same time, the experimenters started timing. They finished timing after the athletes reached the finishing line. It was tested twice, and the better performance was recorded.

(3) Function movement screen (FMS) [16]: The FMS standard test suite (Beijing Yanding Sports Culture Corp., China) was used for testing. The specific content is as follows.

Deep squat: The athlete stood by keeping the spacing between his feet the same as the shoulder width and held the pole with both hands. The angle between the elbow and pole was 90°. The athlete squatted slowly, landed on the ground with heel, lifted the pole over the head as much as possible. Two knees were not allowed to evert. It was tested thrice, and the lowest score was recorded.

Hurdle step: The height of the hurdle was adjusted to the height of the middle point of the tibial tuberosity of the athlete. The athlete gently touched the bottom of the hurdle with the tiptoe, horizontally placed the cross pole on the shoulder behind the neck, straightened the waist and back, slowly crossed the hurdle, landed on the heel, and returned to the starting posture. It was tested thrice, and the lowest score was recorded.

In-line lunge: The toe of the rear feet was placed on the starting line of the test board, and the heel of the front feet was placed on the test board, keeping a distance of tibial length with the toe of the rear feet. The cross bar was vertically placed on the back, gently touching the head, thoracic vertebra, and sacrum. The hand that was not on the same side of the front foot held the cross bar behind the neck, and the other hand held the cross bar behind the waist. The cross bar was kept vertical with the ground. The rear knee was lowered to touch the board behind the heel of the front feet.

Shoulder mobility: The athlete put his feet together and clenched his hands. One hand moved to the back neck and stretched upward. The other hand moved to the back and stretched downward. The distance between the two fists was recorded. It was tested thrice, and the lowest score was recorded.

Active straight leg raise: The athlete lay on their back, with his arms on both sides of the body. The test board was placed under one knee. The other leg was lifted, and the initial posture of the ankle and knee remained unchanged. The cross bar was placed between the anterior superior spine and patella and was perpendicular to the ground. The two legs were alternated. It was tested thrice, and the lowest score was recorded.

Trunk stability push up: the athlete lay prone, with both arms standing on the ground. The thumbs of both hands were at the same level as the forehead. Both knees extended. The soles of the feet were perpendicular to the ground and lifted until the whole body was lifted. The spine was not allowed to swing. It was tested thrice, and the lowest score was recorded.

Rotary stability quadruped: The athlete put four limbs on the ground. The test board was placed between the two knees and hands. The spine was parallel to the board. The angle between the shoulder and hip joints and the body was 90°. The soles were perpendicular to the ground. The hands, knees, and feet all contacted the board. The shoulder was contracted, and the elbow and knee joint on the same side were stretched. The elbow joint touched the knee joint. The body was aligned with the board. The limbs of both sides were tested. It was tested thrice, and the lowest score was recorded.

The above indexes were tested before the experiment and one day after the experiment.

2.5 Statistical Analysis

In Excel2010, the experimental data were sorted out and expressed by $\bar{x} \pm SD$. The data were statistically analyzed in the SPSS18.0 software. The data before and after the experiment were compared using the paired samples *T*-test. The significance level was 0.05.

3 Results

The changes in body composition before and after the experiment are shown in Table 3.

Table 3: Comparison of body composition before and after the experiment

	Before the experiment	After the experiment
Muscle/kg	54.24 ± 6.12	54.98 ± 6.35*
Fat-free body weight/kg	56.28 ± 6.34	58.92 ± 6.09*

Note: *compared with before experiment, $p < 0.05$.

It was seen from Table 3 that the muscle weight of the athletes increased from 54.24 ± 6.12 kg to 54.98 ± 6.35 kg, and the fat-free weight increased from 56.28 ± 6.34 kg to 58.92 ± 6.09 kg. Compared with those before the experiment, $p < 0.05$, which indicated that the body composition of the athletes changed significantly (decreased fat and increased muscles) after eight weeks of nutritional supplementation and exercise.

The comparison of the FMS score is shown in Fig. 1.

It was seen from Fig. 1 that there were significant changes in four of the seven items of FMS after the experiment ($p < 0.05$): the score of the deep squat increased from 2.12 ± 0.88 points to 2.89 ± 0.42 points, the score of hurdle step increased from 1.83 ± 0.64 points to 2.46 ± 0.46 points, the score of in-line lunge increased from 2.22 ± 0.44 points to 2.88 ± 0.41 points, and the score of rotary stability quadruped increased from 1.58 ± 0.86 points to 2.21 ± 0.84 points. The scores of the other three items did not change significantly. Before and after the experiment, the total score of FMS was calculated. Before the experiment, the total score of FMS was 15.1 ± 4.57 points. After the experiment, the total score of FMS was 17.75 ± 3.98 points ($p < 0.05$). It showed that nutritional supplementation and sports training could significantly improve the FMS score of athletes.

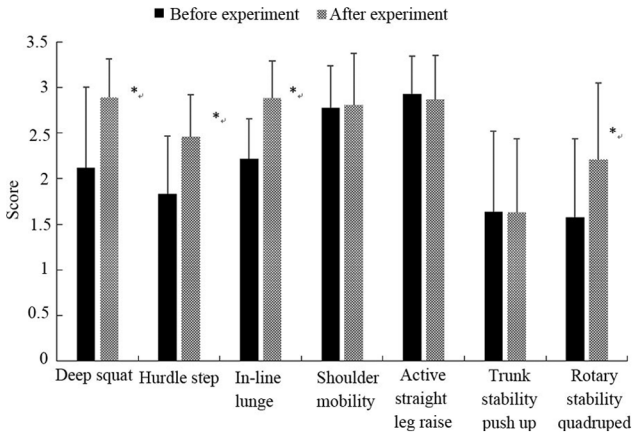

Figure 1: The FMS score before and after the experiment
Note: *compared with before experiment, $p < 0.05$.

The comparison of the sports quality is shown in Table 4.

Table 4: Comparison of sports quality

Index	Item	Before the experiment	After the experiment
Strength	One-min pull-up/time	31.26 ± 1.68	35.39 ± 2.07*
Endurance	1000-meter run/min	6.86 ± 1.21	6.52 ± 1.09*
Flexibility	Sit and reach/cm	13.88 ± 3.33	18.64 ± 3.08*
Speed	50-meter accelerative running	6.83 ± 0.54	6.32 ± 0.52*

Note: *compared with before experiment, $p < 0.05$.

According to Table 4, after the experiment, the number of one-min pull-ups increased to 35.39 ± 2.07 times, the time of 1000-meter run decreased to 6.52 ± 1.09 min, the result of sit and reach increased significantly, from 13.88 ± 3.33 cm to 18.64 ± 3.08 cm, the speed of 50 meters accelerated running became higher (6.32 ± 0.52 s). Compared with before the experiment, $p < 0.05$, i.e., the differences were significant. The above results demonstrated that nutritional supplementation and sports training could improve the strength and endurance of athletes.

4 Discussion

Under normal circumstances, the basic metabolism level of the human body is fixed, but during exercise, the basic metabolism of the human body greatly improves. Track and field sports can be divided into the strength type, speed type, and endurance type. Different types of sports have slightly different requirements for nutrition [17]. Strength-type athletes have faster protein metabolism and higher excitability of nerves and muscles; therefore, they need to supplement high-protein food. Speed-type athletes consume much energy and will produce a lot of acid in the body in a short time; therefore, they need to supplement rich and easily absorbed sugar. Endurance-type athletes consume a large amount of glycogen and are easy to be tired; in order to maintain the energy supply, they need to supplement fat, sugar, carbohydrate, etc. [18]. Also, for all track and field athletes, it is essential to supplement vitamins, protein, etc. In the aspect of nutritional supplementation, this study mainly considered the supplementation of sugar, water, and vitamins for athletes.

For track and field athletes, during sports training, energy substances are consumed in large quantities, which can easily cause fatigue accumulation; therefore, timely supplementation of sugar substances is needed. Timely supplementation of sugar can effectively maintain blood sugar levels and promote glycogen regeneration for athletes, water supplementation is helpful to avoid dehydration and maintain normal athletic ability, and vitamin supplementation can promote blood circulation and enhance physical strength.

It was found from the experimental results that the body composition of the athletes changed: the muscle increased, and the fat decreased. It showed that nutritional supplementation and sports training had a positive role in promoting muscle synthesis and improving body fat distribution. It was seen from Fig. 1 that the deep squat score of the athletes significantly improved. The score of deep squat reflected the flexibility of the human body's limbs and the stability of the trunk. The improved score of deep squat showed that the neuromuscular control ability improved. The score of the hurdle step also significantly improved, which showed that the flexibility and stability of the athletes' joints on both sides improved and the pelvis and core were more stable. The improvement of the score of in-line lunge indicated that the flexibility of lower limb joints and joint muscles strengthened. The improvement of the score of rotary stability quadruped indicated that the energy transfer capacity of the trunk improved and the trunk stability became stronger. It was found from the comparison of the sports quality that the speed and endurance of the athletes improved ($p < 0.05$). All the results demonstrated that the eight-week nutritional supplementation and sports training had a positive impact on the physical fitness of track and field athletes.

The research results verified the effectiveness of nutritional supplementation and sports training to improve the physical fitness of track and field athletes, indicating that the two methods were feasible for improving athletes' physical fitness. The results of the sports quality test and FMS test showed that nutritional supplementation and sports training could also improve the body's physical quality and reduce athletes' injury, which not only provides some reliable bases for the further study of the field of sports nutrition and sports training and some references for in-depth research in related fields. Nutritional supplementation and sports training can be extended to more sports to further improve athletes' competitive level and promote better popularity of sports in life and the improvement of physical fitness of all people.

5 Conclusion

Through eight weeks of nutritional supplementation and sports training, this study compared the changes in the physical fitness of twenty track and field athletes. The results suggested that, compared to before the experiment:

(1) The muscle content increased, and the fat-free body weight increased ($p < 0.05$);

(2) The scores of deep squat, hurdle step, in-line lunge, and rotation stability improved ($p < 0.05$);

(3) The total score of FMS increased significantly ($p < 0.05$);

(4) Different sports qualities significantly improved ($p < 0.05$).

The experimental results show that the method of nutritional supplementation and sports training has a significant effect on improving the physical fitness of track and field athletes. The method can be applied to the training of track and field athletes to improve their physical fitness and achieve better performance.

Funding Statement: The author received no specific funding for this study.

Conflicts of Interest: The author declares that they have no conflicts of interest to report regarding the present study.

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