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Research on the Effect of Speed Strength Training in Track and Field on Enhancing Lower Limb Explosive Force

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Abstract: Objective: To study the effect of speed strength training on lower limb explosive force more accurately. Methods: 40 provincial athletes were selected and set up as experimental group and control group respectively. After adjusting some items and different strength exercise modes and intensities in daily training, tracking and comparative observation were carried out. Carry out systematic investigation and analysis. Results: Through experiments, it is proved that the speed strength training in track and field can greatly promote the explosive force of lower limbs.

Keywords: Track and field; Speed power; Lower limbs; Explosive force

1. Introduction

If athletes want to achieve good results in sports and competitions, they should improve the explosive force of lower limbs such as accelerated running in a short period of time. If errors occur in the process of power generation, they will verify the effect of subsequent actions. Therefore, it is necessary to carry out targeted speed strength training for athletes so as to enhance the explosive force of athletes' lower limbs and enhance the overall training results. In sports, the explosive force of lower limbs is a comprehensive expression of strength, running ability, reaction speed, body balance, coordination, flexibility and flexibility [1]. Especially in track and field, the explosive force of lower limbs is the basis of all physical qualities. This article has carried out a series of experiments and obtained some experimental data through some research and investigation. Through the comparison of experimental results, it has expounded in detail the research results on the strength training of track and field speed to enhance the explosive force of lower limbs.

2. Research Object on the Effect of Speed Strength Training in Track and Field on Strengthening Explosive Force of Lower Limbs

2.1. Experimental research objects

Taking a provincial professional athlete training base as the research object, the method of sampling was selected, professional athletes were randomly selected, and health tests were carried out. After 6 athletes with sports function injuries were excluded in the testing process, the total number of participants was 80. Among them, there are 40 male students and 40 female students. Most of the tested students are between 16 and 24 years old. The average age of the tested athletes is (19. 4 1.2) years old. The subjects were randomly divided into two groups, 20 males and 20 females in each group, and were recorded as experimental group and control group respectively [2]. Independent sample t test was carried out on the two groups of subjects, and there was no significant difference in age, height, weight, training years and other indexes recorded (P>0.05). And to ensure that the two groups of researchers have a balanced distribution of age, gender, physical health and other average detection conditions are basically the same, all physiological functions are normal, there is no obvious sports trauma, the exercise ability is normal and voluntary to accept the experiment

Table 1. Basic situation of athletes

Group	Experimental group	Control group
Number of people n	40	40
Average age	19. 4±1. 2	19. 4±1. 2
Height cm	173.6±1.4	173.6±1.4
Weight kg	45.5±4.1	45.5±4.1
Sex ratio	1: 1	1: 1
Training years	2-4	2-4
Physiological function	Normal	Normal

2.2. Experimental methods

Through literature review and data collation, theoretical speed training programs for the experimental group and the control group were formulated. In this study, athletes in the experimental group and the control group were trained three times a week (Tuesday, Thursday, and Saturday). The control group received the same routine traditional strength training. The training programs consisted of: (1) traditional warm-up (jogging warm - up, joint exercise, stretching), (2) traditional strength training, (3) stretching and relaxation (jogging, stretching), and the traditional strength training was divided into three parts of upper limb, trunk, and lower limb strength training, with each part having five movements [3]. The training plan of the experimental group consists of (1) action preparation training (core activation, dynamic stretching, action integration and nerve activation), (2) traditional and functional strength training, (3) rehabilitation and regeneration training (foam shaft fascia release and static stretching) [4].

Traditional and functional strength training should add 3 functional strength training actions on the basis of 2 excellent traditional strength training actions in the strength link of lower limbs. The functional strength training actions of each part are designed according to the requirements of the competitive characteristics of sports: the functional actions of strength training include drag resistance, unstable drag resistance, aiming at improving strength and stability; Core stability, core rotational explosive force action product response ability; The functional action of lower limb strength training is a fast telescopic compound strength training action, aiming at strengthening the athletes' ability of fast stride and take - off [5]. The training plan ensures that the training time and exercise load of the control group and the experimental group are close (controlled by the approximate number of groups, times and interval time between groups), and the training time of the two groups is 2h [6]. At the same time, athletes are guaranteed to eat normally, and will not undergo self-training during the experiment, which will last for 3 months. According to the principle of gradual and orderly progress, with the progress of the training plan, the athletes' training level is continuously improved, and the training process should also be gradually improved from easy to difficult [7]. This experiment takes 5 weeks as a training phase. In each phase, the training load of the two groups is gradually increased by increasing the intensity and difficulty of training actions and increasing the number of training groups.

Table 2. Training scheme of experimental group and control group

Control group			Experimental group		
Training content	**Number of groups x number of times**	**Interval**	**Training content**	**Number of groups x number of times**	**Interval**
Sitting dumbbell head flexion and extension	3×20 time	1min	Sitting dumbbell head flexion and extension	3×20 time	1min
Dumbbell speedboat	3×20 time	1min	Dumbbell speedboat	3×20 time	1min
Standing posture dumbbell side lift	3×20 time	1min	Standing posture dumbbell side lift	3×20 time	1min
Dumbbell weight-bearing sit-ups	3×20 time	1min	The upper leg of the side bridge bends before lifting the straight arm and swings back.	3×30 time	1min
One - legged and half - kneeling, throwing solid balls obliquely upward	3×20 time	1min	One - legged and half - kneeling, throwing solid balls obliquely upward	3×30 time	1min
Foot touching roll	3×20 time	1min	Foot touching roll	3×30 time	1min
Hopping on one foot	3×20 time	1min	Hopping on one foot	3×30 time	1min
Multistage frog leaping	3×20 time	1min	Multistage frog leaping	3×30 time	1min
Squat jump	3×20 time	1min	Turn over the hurdle to receive abdominal jump	3×30 time	1min
Duck walks	3×20 time	1min	Jumping box jumps deep into double-foot jumping fence frame	3×30 time	1min
Standing and lying support	3×20 time	1min	Single - and double-foot square fence, double-foot jump	3×30 time	1min
Jogging warm-up joint exercise stretching	2 time	10min	Jogging warm-up joint exercise stretching	2 time	10min
Jogging stretch	1 time	10min	Jogging stretch	1 time	10min
Rehabilitation and regeneration training	3×20 time	10min	Rehabilitation and regeneration training	1 time	10min

In addition to the most basic expansion and contraction, the basic movement forms of the lower limbs include: the cushioning action of the lower limbs, the stretching action and the whipping action. When the lower limb resists external force, it changes from an extended state to a flexed state, and the muscle makes concession contraction, which is called the buffering stage of the lower limb [8]. For example, the knee joint buffering angle and buffering time are usually taken as important basis for technical diagnosis when supporting the foot during running and taking off. Pushing and stretching is an active stretching process of lower limbs from a flexed state. Its purpose is to overcome external force to obtain a greater movement speed and is a continuation of buffering action [9]. The sequence and angle of the hip, knee and ankle thrusts are different for different events. However, the whipping action of the lower limb is to accelerate the braking of the lower limb from the proximal end to the distal end in turn in the process of overcoming the resistance and displacement of the lower limb when the lower limb is free from the limb, so that the movement end generates great movement speed and striking force [10]. Apart from sprints, the track and field events that exercise the explosive force of lower limbs are mainly jumping events, such as high jump, long jump, standing triple jump, etc.

According to the training intensity reflected by different forms of jumping exercises, and through consulting relevant literature, it can be seen that the main intensity factors that affect fast telescopic compound training are: (1) the time when one foot or both feet contact the ground, the shorter the time when contacting the ground, the greater the load intensity generated. (2) The higher the feet stand above the ground, the greater the load intensity will be [11]. (3) the area of the foot landing is inversely proportional to the intensity, the landing area is large and the intensity is small, while the landing area is small and the intensity is large. (4) There are also factors such as the direction and mode of movement (with or without reverse movement posture) that can also determine the magnitude of intensity (5) and the presence or absence of weight bearing.

2.3. Evaluation criteria

In terms of the evaluation principles of speed strength functional training, the following items can be referred to in " Speed Strength Functional Training":

(1) Principle of optimization: Functional training emphasizes motion screening, motion preparation, power chain training, core column strength and recovery and regeneration training of sports functions, aiming at better improving athletes' special abilities, reducing the incidence of injuries and improving athletic performance.

(2) Principle of gradual and orderly progress: each training must correspond to the training of the previous day and be connected with the content of tomorrow. According to the sequence of "stimulation - adaptation - improvement - re - stimulation - re - adaptation", the exercise ability and adaptability are continuously improved [12]. During training, the movement structure should change from easy to difficult, the load intensity from small to large, the training time from short to long, and the number from small to large.

(3) principle of pain-free training: compensatory movement is easy to occur in injury training, which breaks the existing technical dynamic setting and causes technical movement deformation [13]. FMS is mainly to determine the movement dysfunction, find the pain site or injury point that needs to be eliminated, and then formulate the methods and means to eliminate the movement dysfunction, which is also the logical starting point of functional training.

(4) Principle of action standardization: Action mode training is to enhance the control of nerves on muscles, improve the stability and flexibility of joints, reduce the compensation and promotion of actions and enhance the stability of single actions, so as to achieve the purpose of enhancing the transmission efficiency of power chain [14].

(5) innovation principle: scientific research achievements in various fields are constantly emerging, new methods are also emerging, and functional training methods are constantly updated with changes in training concepts, training equipment, equipment, instruments, etc

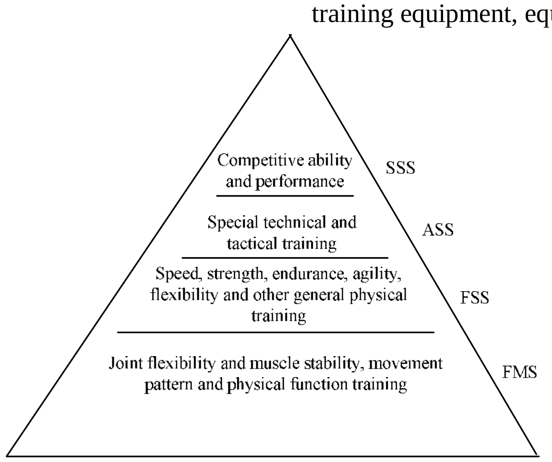

Figure 1. Evaluation level of athletes' training

The above evaluation grade is set by consulting the training plan and relevant theoretical knowledge of functional strength training for coaches, experts and senior physical fitness coaches of sports teams as the fundamental basis, providing scientific reference for the research of athletes' functional strength training, synthesizing the suggestions and opinions of experts and physical fitness coaches, and combining the functional strength training plan of previous documents, perfecting the experimental plan, and formulating a functional strength training plan suitable for young athletes[15]. In order to ensure the accuracy of the study, a motion capture system was installed on the lower limbs of the athletes during the experiment. In order to improve the accuracy of the capture process, and at the same time to expand the scope of motion capture, a simplified capture model was established to facilitate accurate lower limb motion capture. The modeling process is as follows:

$$\min_{0\le a_i\le c} W=\frac{1}{2}\sum_{i,j=1}^{l} y_i y_j a_i a_j K(x_i,x_j) -\sum_{i=1}^{l} a_i + b\left(\sum_{i=1}^{l} y_j a\right) \quad (1)$$

In the formula: $\min_{0\le a_i\le c} W$ represents the balance index for balancing the movement connection; y_i、 y_j represents the power index of physical fitness and exercise respectively; a_i、 a_j indicates the trace of movement respectively; $K(x_i,x_j)$ represents lower limb motor product difference; $y_j a$ represents a constant parameter of lower limb explosive force. The explosive force parameters of lower limbs can be identified by the above formula, and the process is expressed by the formula as follows:

$$F(\mathrm{u},\mathrm{v})=\frac{\mathrm{c(u)c(v)}}{4}\sum_{x=0}^{n}\min_{0\le a_i\le c} W\sum_{y=0}^{n}\mathrm{f(x,y)} \cos\frac{(2x+1)\mathrm{u}p}{16}\cos\frac{(2y+1)\mathrm{v}p}{16} \quad (2)$$

In the formula: $\mathrm{c(u)}$, $\mathrm{c(v)}$ indicates exercise intensity and explosive force respectively; $(2x+1)\mathrm{u}p$ A represents the trigonometric angle vector of human motion; $(2y+1)\mathrm{v}p$ is an important linear index to measure the curve standard of lower limb exercise explosive force. $\mathrm{f(x,y)}$ A represents the uncertainty error parameter. After the above relationship establishment and image recognition analysis, a simplified capture model can be established and expressed by the following formula:

$$\frac{Q(\mathrm{t})}{N(\mathrm{t})M(\mathrm{t})}=s_B F(\mathrm{u},\mathrm{v})\left[\frac{\mathrm{Q(t)}}{N(\mathrm{t})M(\mathrm{t})}\right]^{a}\left[\frac{K(\mathrm{t})}{N(\mathrm{t})M(\mathrm{t})}\right]^{1-a-k} -d_h\left[\frac{G(E)}{N\{T\}}+g\frac{Q(\mathrm{t})}{N(\mathrm{t})M(\mathrm{t})}\right] \quad (3)$$

In the formula: $N(\mathrm{t})$、 $M(\mathrm{t})$ presents the limit critical value of human lower limb joint and muscle movement. Only when the joint angle of human body is within the critical point can the calculation be made. $\left[\frac{K(\mathrm{t})}{N(\mathrm{t})M(\mathrm{t})}\right]^{1-a-k}$ represents the weighted critical motion margin coefficient; $G(E)$ represents the critical point coefficient of the capture range; $N\{T\}$ and $Q(\mathrm{t})$ represents the number of frames of influencing factors that affect the maximum explosive force; $-d_h$ is the limit resistance error coefficient, which indicates that the critical parameter is in the range of [45.9 - 52.3]. Through the above formula, the calculation model for evaluating the effect of lower limb explosive force is designed, so that the research results can be accurately and quickly calculated.

3. Analysis of Experimental Results

3.1. Experimental results

According to the " Chinese Youth Training Syllabus" - the " Basic Physical Fitness and Special Basic Motor Ability Scoring Standard" as the basis for the selection of physical fitness test indicators in this study, and assisted by functional motion screening (FMS) indicators, the students were tested for functional motion screening (FMS) before and after the experiment, mainly in order to know whether the students had sports injury, motion limitation and motion compensation before and after the experiment, and whether the functional motions had been improved after the experiment. In order to help arrange the experimental content reasonably and to evaluate the effect of functional physical fitness training. Test indicators are shown in the table.

Table 3. List of body shape and body function test indicators

Control group				Experimental group			
Category	Test index		Testing instrument	Category	Test index		Testing instrument
Body shape	Upper arm tension and relaxation (cm)	43±2.4	Flexible rule	Body shape	Upper arm tension and relaxation (cm)	43±2.6	Flexible rule

	Ham circumference (cm)	65.5±3.4	Flexible rule		Ham circumference (cm)	68.5±3.4	Flexible rule
	Lower leg circumference (cm)	40.2+±1.4	Flexible rule		Lower leg circumference (cm)	42.+±1.4	Flexible rule
	Percentage of body fat (%)	68	InBody570 body composition analyzer		Percentage of body fat (%)	72	InBody570 body composition analyzer
Body function	Step test (min)	3.15	Ke Dao TZCS-3 Bench Test Instrument	Body function	Step test (min)	2.78	Ke Dao TZCS-3 Bench Test Instrument
	Vital capacity body mass index(ml/kg)	24	Vital capacity tester, formula calculation		Vital capacity body mass index(ml/kg)	26	Vital capacity tester, formula calculation
Strength quality	Standing long jump (m)	2.76	Flexible rule	Strength quality	Standing long jump (m)）	2. 92	Flexible rule
	1min sit-ups (times)	70	Stopwatch, sponge pad		1min sit-ups (times)	75	Stopwatch, sponge pad
Speed quality	20m×5 turn-back run (s)	0.85	Stopwatch	Speed quality	20m×5 turn-back run (s)	0.76	Stopwatch
	Standing long jump (m)	2.56	Flexible rule		Standing long jump (m)	2.78	Flexible rule
	400m(s)	1.84	Stopwatch		400m(s)	1.71	Stopwatch
	5 left and right touch and run (s)	20	Stopwatch		5 left and right touch and run (s)	0	Stopwatch
Speed endurance	1min double shaking (times)	60	Stopwatch, rope skipping training	Speed endurance	1min double shaking (times)	70	Stopwatch, rope skipping training
Sensitive quality	Ten low center of gravity footwork (s)	1.24	Stopwatch, logo stickers	Sensitive quality	Ten low center of gravity footwork (s)	1.07	Stopwatch, logo stickers
	Hexagonal jump	0.81	Stopwatch, logo stickers		Hexagonal jump	0.54	Stopwatch, logo stickers
Flexibility quality	Body flexion in sitting position (cm)	1.45	Seat forward flexion tester	Flexibility quality	Body flexion in sitting position (cm)	1.61	Seat forward flexion tester

According to the above table, it is not difficult to find that the overall research data of the experimental group is generally higher than that of the control group, thus it can be explained that the addition of track and field speed strength training in the training process of the experimental group has a certain auxiliary effect on the athletes' lower limb ability, especially on the lower limb explosive force. At the same time, the lower limb explosive force and body coordination have high requirements on the athletes. In order to complete the test more intuitively, the body, sprint, long jump and other related sports and explosive force effects in track and field events are compared and tested, and personal factors such as the starting way of sprint and the sense of coordination of limbs will all affect the sports results. There is no essential difference between the standing triple jump and the standing long jump. First of all, the standing triple jump is not a single burst of strength, but the burst of strength in the process of continuous rapid jump, which is an important indicator to reflect the explosive force of athletes' lower limbs. The forward throwing solid ball requires the coordination and exertion of hip, knee, ankle and waist and abdomen to complete the movement, which reflects the athletes' ability to coordinate and balance the exertion. Different track and field events have different degrees to enhance the explosive force of lower limbs. According to the above documents, in order to pursue the effective period of significantly improving explosive force, a series of practices of functional motion screening were carried out in the control group and the experimental group. The contents of functional motion screening indicators are as follows.

Table 4. Functional action screening indicators

Serial number	Test content
T-1	Squat

T-2	Step over the fence
T-3	Straight Leg Squat
T-4	Shoulder flexibility
T-5	Active high leg lifts
T-6	Push - ups for driving stability
T-7	Body rotation stability

According to the above detection contents, the lower limb explosive force effects of athletes in the experimental group and the control group are compared and detected, and the specific detection results are as follows:

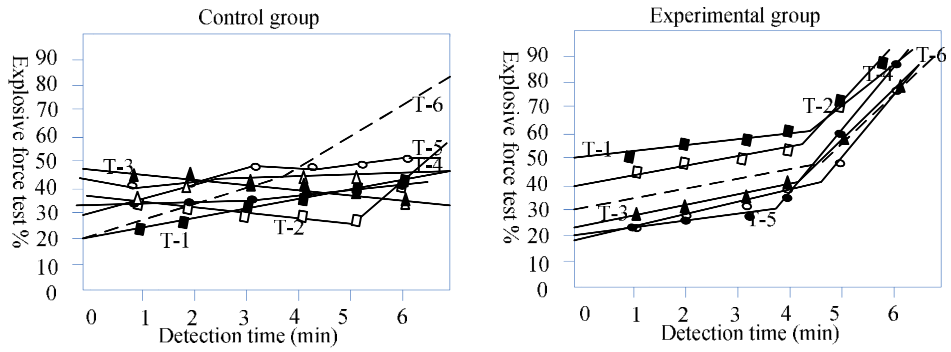

Figure 2. Comparison test results

It can be seen from this that the strength training of track and field speed can be carried out in a certain period and systematically followed up, which can gradually enhance the explosive force of lower limbs and further achieve the purpose of improvement

3.2. Discussion of results

The analysis of the two groups of data after the experiment shows that the efficiency shown by the track and field speed strength training method is incomparable to the traditional training method. From the above seven test results of the physical lower limb explosive power, it can be seen that the sports performance and explosive power of the control group are obviously inferior to those of the experimental group, which proves that the experimental group does not do any other useless work in the training process because it makes full use of the effective time and is closer to the sports characteristics of the test items to carry out targeted track and field speed theory enhancement training. In addition, from the observation of the muscle changes and sports forms of the two groups of athletes, it is found that the pre-stretching of the muscles of the athletes in the experimental group is followed by shortening and contracting, and the stored elastic potential energy increases the work efficiency, thus improving the sports performance. The driving stability push-up event requires athletes to complete the movements quickly, consistently and correctly from the preparation posture to the pre-swing and then to the ball release. It may be that the athletes' muscles are fatigued due to frequent exercises and cannot perform at their best level in the competition. Therefore, some indexes are difficult to show obvious effects compared with traditional strength training. However, the overall explosive force has obviously improved the effect on traditional indexes.

3.3. Experimental conclusion

The following conclusions can be obtained by following up the two groups of personnel through the above experimental methods and recording the investigation results:

(1) Track and field speed strength training has a certain effect on most of the athletes' body shape indexes (circumference) and has a significant positive effect on some body movement function indexes.

(2) Track and field speed strength training can promote athletes' physical function to a certain extent, which is conducive to improving athletes' respiratory system function, and has a weak improvement on athletes' cardiovascular function, thus promoting athletes' burst ability to a certain extent.

(3) On the whole, the functional strength training group and the traditional strength training group in this study can improve the athletes' special physical quality level, but the track and field speed strength training has a more

prominent positive impact on the athletes' speed endurance, sensitivity speed and lower limb explosive force index. In the research process, the overall coordination, multi-directional sensitivity and other composite quality indexes of the experimental group are obviously better than those of the control group under the traditional training.

(4) Through speed and strength training in track and field, the functional movement quality and lower limb explosive force of young athletes can be effectively improved, the lower limb weak link in sports can be improved, and the compensatory movement in sports can be reduced, thus laying a good foundation for the improvement of athletes' overall physical fitness.

4. Conclusion

By adding strength training of track and field speed to athletes' daily training, the changes of lower limb explosive force during sprint, long jump, high jump and other sports were observed and compared by grouping experiments. Through comparative observation, it is concluded that different track and field speed strength training programs have more or less enhanced athletes' lower limb explosive force, thus proving that this training method has played a certain role in the actual sports process. To sum up, speed strength training in track and field has a significant effect on enhancing explosive force of lower limbs.

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