

Research on the Impact of Functional Training on the Hurdling Performance of High School Male Athletes

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Abstract

Hurdling is a sport that places extremely high demands on athletes' physical condition and techniques. Athletes are required to possess excellent specific qualities such as good functionality, enabling them to accurately cross obstacles while running at high speed. Based on this, this paper uses the methods of literature review, expert interviews, experiments, and mathematical statistics to study the impact of functional training on the hurdle race performance of high school male athletes and explore functional training methods suitable for high school male athletes. The research findings are as follows: 1. After functional training, the special physical quality indicators of the experimental group for hurdle race were significantly improved and were better than those of the control group, indicating that functional training can comprehensively promote the development of special physical qualities for hurdle race. 2. After the experiment, there was a significant difference in the 110-meter hurdle race performance between the experimental group and the control group, proving that functional training has a significant effect on improving the special performance of hurdle race. 3. The technical evaluation scores of the experimental group for hurdle race were significantly improved, with a significant difference from the control group, indicating that functional training helps students master hurdle race techniques and improve the accuracy and coordination of movements.

Keywords

Functional Training; High School; Male Athletes; Hurdling Performance

1. Introduction

Hurdling is a sport that places extremely high demands on physical literacy and technical proficiency. Athletes are required to precisely clear obstacle hurdles while running at high speed, which demands excellent coordination, speed, strength, and endurance. In current hurdling training for high school male athletes, although diverse training methods such as core strength training and lower limb strength

training are widely used, they still struggle to meet the comprehensive development needs of students' coordination, speed, strength, and endurance^[1]. There is an urgent need for a training method that can comprehensively improve physical fitness and hurdling performance. Many studies have shown that high school male students are in a critical period of growth and development, with rapidly developing physical qualities, making it a golden period for functional training^[2]. Functional training refers to exercises that involve changing rhythm, speed, and direction. Compared with traditional training methods, functional training uses multi-joint linkage and three-dimensional movement patterns, which are more consistent with the mechanical characteristics of human movement. It can effectively improve kinetic chain transmission efficiency, optimize energy transfer, reduce local joint loads, minimize energy consumption, and significantly enhance students' physical qualities such as coordination, speed, strength, and endurance. Using functional training as a training intervention to develop special training plans for high school male hurdlers and systematically explore the promoting effect of functional training on their hurdling performance has high practical value. This study aims to investigate the impact of functional training on the hurdling performance of high school male athletes, explore functional training methods and strategies for them, assist coaches in formulating more effective training plans, and provide scientific guidance and suggestions for their hurdling training.

2. Research objects and methods

2.1. Research objects

This paper takes the impact of functional training on the hurdling performance of high school male athletes as the research object. 10 male hurdling athletes in the second year of high school are selected from each of Guangzhou No. 89 Middle School and No. 6 Middle School as the experimental subjects.

2.1. Research Methods

2.2.1 Literature Review Method

The sources of literature retrieval and review include CNKI, Web of Science, Google Scholar, libraries, and other types of literature and online data, which lay a theoretical foundation and research direction for the development of this study.

2.2.2 Expert Interview Method

Interviews were conducted with relevant experts on topics such as "the applicability of functional training in youth hurdling training", "the weight of key indicators in hurdling technical scoring standards", and "the rationality of training load and cycle arrangement in experimental design". Combined with the guidance of expert coaches (see Table 1 for expert information), the recorded content was sorted and analyzed to optimize the experimental protocol, adjust the difficulty gradient of func-

tional training, and verify the scientific interpretation of results.

Table 1. Basic information of relevant experts

Serial number	Name	Professional title	Work unit
1	Wu**	Professor	Guangzhou Sport University
2	Dong**	Professor	Guangzhou Sport University
3	Liu**	Associate Professor	Guangzhou Sport University
4	Yuan**	Professor	Guangzhou Sport University
5	Li*	Associate Professor	Guangzhou Sport University

2.2.2 Experimental Method

2.2.2 .1Experimental Objectives

Explore the impact of functional training on the hurdling performance of high school male athletes, and provide a scientific basis for improving their hurdling performance.

2.2.2.2 Experimental subjects

Ten male hurdling athletes were randomly selected as samples from each of Guangzhou No.89 Middle School and No.6 Middle School. The students were randomly divided into two groups, the experimental group and the control group. According to the regulations of the National Student Physical Health Standard 2022, before the experiment, the age, height, weight and training age of the two groups of students were investigated first to ensure that there were no significant differences in the basic situations of the two groups of students.

Table 2. Comparison of basic situations of two groups of students (N = 20)

Indicators	Experimental Group(X±SD)	Control Group(X±SD)	t	p
Age (years)	14.15±0.36	14.36±0.27	0.707	0.127
Height (cm)	171.27±2.28	171.04±1.85	0.423	0.194
Weight (kg)	53.16±1.85	52.48±2.17	0.678	0.118
Training years(years)	0.53±0.03	0.63±0.07	0.473	0.122

Before the start of the experiment, conduct assessment tests on the experimental subjects for hurdle - specific physical fitness indicators and 110 - meter hurdle - specific indicators.

Table 3. Comparison of Hurdle-specific Physical Fitness of Two Groups of Students before the Experiment (N = 20)

Indicator	Experimental Group(X±SD)	Control Group(X±SD)	t	p
100m(s)	13.38±0.09	13.33±0.07	0.610	0.171
Squat(kg)	45.04±0.26	45.83±0.37	0.438	0.126
Weighted Lunge(kg)	7.27±0.63	7.33±0.84	0.623	0.149
Sit-and-Reach(cm)	13.13±1.36	13.18±1.06	1.305	0.079

According to Table 3, the comparison of special physical fitness for hurdling between the two groups before the experiment showed that the average 100m running performance of the experimental group was 13.38 ± 0.09 s, and that of the control group was 13.33 ± 0.07 s; the squat performances were 45.04 ± 0.26 kg and 45.83 ± 0.37 kg, respectively; the weighted lunge performances were 7.27 ± 0.63 kg and 7.33 ± 0.84 kg, respectively; and the sit-and-reach performances were 13.13 ± 1.36 cm and 13.18 ± 1.06 cm, respectively. The P values for all indicators were greater than 0.05, indicating no significant differences in all aspects between the two groups before the experiment.

Table 4. Comparison of Hurdling Performance of Two Groups of Students before the Experiment (N = 20)

Indicator	Experimental Group ($\bar{X} \pm SD$)	Control Group ($\bar{X} \pm SD$)	t	p
Swinging leg attacking the hurdle on the side of the hurdle (points)	75.58 $\pm$ 1.85	75.41 $\pm$ 1.74	0.937	0.178
Crossing the hurdle on the side of the lead leg (points)	77.16 $\pm$ 1.72	76.96 $\pm$ 1.47	0.998	0.121
Running over hurdles (points)	75.37 $\pm$ 2.37	75.19 $\pm$ 2.48	0.876	0.138
110m hurdles results (s)	18.33 $\pm$ 0.28	18.30 $\pm$ 0.19	0.727	0.152

The three indicators of attacking hurdle on the side of the swinging leg, clearing hurdle on the side of the lead leg, and clearing hurdle during running were used to evaluate students' hurdling techniques. It was found that the scores of the two groups were very close before the experiment, with average 110m hurdling performances of 18.33 ± 0.28 s and 18.30 ± 0.19 s, respectively. The p values were also greater than 0.05, indicating no significant differences in hurdling performance and technical evaluation between the two groups before functional training.

2.2.2.3 Experiment Time and Place

The three indicators of attacking hurdle on the side of the swinging leg, clearing hurdle on the side of the lead leg, and clearing hurdle during running were used to evaluate students' hurdling techniques. It was found that the scores of the two groups were very close before the experiment, with average 110m hurdling performances of 18.33 ± 0.28 s and 18.30 ± 0.19 s, respectively. The p values were also greater than 0.05, indicating no significant differences in hurdling performance and technical evaluation between the two groups before functional training.

2.2.2.4 Experiment Hypotheses

Hypothesis 1: Functional training can effectively improve the development level of

hurdlings-specific physical fitness.

Hypothesis 2: Functional training can effectively improve the hurdling standard-reaching performance.

Hypothesis 3: Functional training can effectively improve the technical evaluation performance.

2.2.2.5 Test Methods and Bases for Experimental Test Indicators

According to the research needs of the paper, by referring to the Scoring Standard for Track and Field Hurdling Techniques, Experimental Research on the Influence of Functional Training on the Hurdling Techniques of 110m Hurdle Second-level Athletes, and reading a large number of literature as reference standards, and combining the guidance of relevant expert coaches, 100-meter run, squat, weighted lunge, and sit-and-reach are finally selected as the hurdling-specific physical fitness indicators, and attacking the hurdle from the side of the swinging leg, crossing the hurdle from the side of the take-off leg, and crossing the hurdle during running are selected as the 110-meter hurdling-specific quality test indicators.

Table 5. Test Methods for Experimental Group Test Indicators

Test dimensions	Test indicators	Test content	Test method
Special physical fitness for hurdling	speed	100-meter dash	Use a standard track and field runway, and use electronic timing equipment to measure the time it takes for athletes to complete the 100-meter run, accurate to 0.01 seconds.
	power	Squat (maximum strength) Weighted Lunge	Record the maximum weight (kg) that an athlete can lift.
	flexible	Sit and Reach	The athlete is in a sitting position, and the maximum horizontal distance (cm) between the fingers and the thighs is measured.
Hurdles special achievement	110-meter hurdles	The time to complete the 110-meter hurdles	Test on a standard hurdle track. Set up 10 hurdle racks with a height of 0.914 meters. Use an electronic timing device to measure the results, accurate to 0.01 seconds. The scores are independently given by three different coaches according to the <i>Scoring Standard for Track and Field Hurdling Techniques</i> , and the average score (with a full score of 100 points) is taken.
Hurdling technique performance	Swinging leg attacking the hurdle on the side of the hurdle	Bend the knees and swing forward, actively press down, land on the forefoot, and shift the center of gravity forward	Scoring focuses: movement coordination, rhythm control, and body
	Crossing the hurdle on the side of the lead leg	Bend the knees and abduct outward, fold the thighs and calves tightly, and use the thighs to lift the hips to the front of the body.	

Running over hurdles	Attack-stride movement coordination, upper body tilt, and coordinated arm swinging	balance.
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Adopt the Scoring Standards for Track and Field Hurdling Techniques[3] (Chinese Athletics Association, 2018). The scoring is carried out from three dimensions: movement coordination (40%), rhythm control (30%), and body balance (30%), with a full score of 100 points. The three scorers are all national-level track and field referees with more than 10 years of experience in refereeing hurdling events.

2.2.2.6 Experimental Variables

The independent variable of this study is different training methods. The experimental group adopts functional training, and the control group adopts the traditional training plan.

The dependent variables are the changes in hurdling technical level and relevant special physical fitness indicators for hurdling.

The irrelevant variables include potential influencing factors that are not controlled, such as the training environment, coaching methods, and individual psychological states. Their interference effects are minimized as much as possible through random grouping and baseline testing.

2.2.2.7 Experimental Procedures

Before the experiment, evaluate the special indicators for hurdling and other relevant special physical fitness for hurdling of the athletes in both groups to understand the baseline level of the experimental subjects.

During the experiment, select a certain number of high school male hurdling athletes as experimental subjects and divide them into an experimental group and a control group. The experimental group receives functional training intervention, while the control group follows the traditional functional training plan.

After the experiment, re-evaluate the special indicators for hurdling and other relevant special physical fitness for hurdling of the athletes in both groups to compare the changes before and after the experiment.

2.2.2.8 Experimental Intervention

The control group adopts the traditional training plan, such as strength, speed endurance, flexibility, and special hurdling technique training. The experimental group adds functional training methods to each training session.

2.2.3 Mathematical Statistics Method

Use statistical software to organize, conduct descriptive statistics, and perform T-tests on the collected data. Based on the impact of the special indicators for hurdling and other special physical fitness for hurdling before and after the experiment in the experimental group and the control group, draw conclusions about the effectiveness of functional training.

3. Research Results and Analysis

3.1. Comparison and Analysis of the Scores of Relevant Test Indicators

of the Two Groups of Students before and after the Experiment

3.1.1. Comparison of the Special Physical Fitness for Hurdles, the Special Performance in Hurdles, and the Technical Performance in Hurdles of the Experimental Group before and after the Experiment

Table 6. Comparison of Hurdle-specific Physical Fitness, Hurdle-specific Performance, and Hurdle Technique Performance before and after the Experiment in the Experimental Group (N = 20)

Category	Indicator	Before the experiment ($\bar{X} \pm SD$)	After the experiment ($\bar{X} \pm SD$)	t	p
Special physical fitness for hurdling	100 m (s)	13.38 $\pm$ 0.09	13.08 $\pm$ 0.10	2.895	0.001
	Squat (kg)	45.04 $\pm$ 0.26	48.82 $\pm$ 1.48	2.714	0.004
	Weighted lunge (kg)	7.27 $\pm$ 0.63	10.32 $\pm$ 0.37	2.614	0.002
Hurdles special achievements	Sit and Reach (cm)	13.13 $\pm$ 1.36	17.43 $\pm$ 1.15	2.308	0.006
	110m hurdles results (s)	18.38 $\pm$ 0.28	17.82 $\pm$ 0.09	2.112	0.028
	Swinging leg attacking the hurdle on the side of the hurdle (points)	75.58 $\pm$ 1.85	81.23 $\pm$ 1.26	2.547	0.007
Hurdling technique performance	Crossing the hurdle on the side of the lead leg (points)	77.16 $\pm$ 1.72	82.45 $\pm$ 1.51	2.418	0.014
	Running over hurdles (points)	75.37 $\pm$ 2.37	80.12 $\pm$ 1.53	2.376	0.011

As shown in Table 6, the special physical fitness for hurdling, special hurdling performance, and hurdling technical performance of the experimental group all significantly improved before and after the experiment. The 100m running and hurdling performance of the experimental group showed significant acceleration; the improvement in squat and weighted lunge performances indicated a significant enhancement in special strength quality; the improvement in flexibility was reflected in the increase of the sit-and-reach distance from the original 13.13 $\pm$ 1.36cm to 17.43 $\pm$ 1.15cm. Through significance testing, the p values of all physical fitness indicators were <0.05, showing that the improvement level had significant statistical significance. In terms of experimental hurdling technical performance, the scores of attacking hurdle on the side of the swinging leg, clearing hurdle on the side of the lead leg, and clearing hurdle during running increased respectively, with p <0.05, indicating that after 3 months of special targeted functional training, the special physical fitness for hurdling of the experimental group achieved significant breakthroughs, and the hurdling technical performance also significantly improved, with an overall better performance.

3.1.2. Comparison of Special Physical Fitness for Hurdling, Special Hurdling Performance, and Hurdling Technical Performance of the Control Group Before and After the Experiment

Table 7. Comparison of Hurdle-specific Physical Fitness, Hurdle-specific Performance, and Hurdle Technique Performance before and after the Experiment in the Control Group (N =

20)

Category	Indicator	Before the experiment ($\bar{X} \pm SD$)	After the experiment ($\bar{X} \pm SD$)	t	p
Special physical fitness for hurdle events	100m(s)	13.33±0.07	13.18±0.09	0.937	0.171
	Squat (kg)	45.83±0.37	47.32±1.27	1.001	0.087
	Weighted Lunge (kg)	7.33±0.84	8.55±0.47	1.087	0.077
	Sit and Reach (cm)	13.18±1.06	15.96±1.00	0.562	0.126
Hurdling special achievement	110m hurdles results (s)	18.30±0.19	18.12±0.11	0.876	0.1208
Hurdling technique performance	Swinging leg attacking the hurdle on the side of the hurdle (points)	75.41±1.74	77.36±1.47	1.016	0.147
	Crossing the hurdle on the side of the lead leg (points)	76.96±1.47	79.52±1.38	0.483	0.394
	Running over hurdles (points)	75.19±2.48	76.44±1.64	0.769	0.189

As shown in Table 7, compared with the special physical fitness for hurdling and hurdling techniques after the experiment, the 100m performance and special hurdling performance of the control group also improved to varying degrees, but the improvement was less than that of the experimental group and not significant ($p > 0.05$). The 100m running performance of the control group improved from $13.33 \pm 0.07s$ to $13.18 \pm 0.09s$, with a reduced improvement range, and the growth was not obvious compared with the improvement range of the experimental group. The improvement range of the squat performance of the control group was also not obvious, increasing from $45.83 \pm 0.37kg$ to $47.32 \pm 1.27kg$. Although the squat performance of the control group improved to some extent, it had no statistical significance. The sit-and-reach distance of the control group was not obvious, and the flexibility improved to some extent, but the improvement was not significant, with no statistical difference. The scores of attacking hurdle on the side of the swinging leg, clearing hurdle on the side of the lead leg, and clearing hurdle during running in the hurdling technical performance of the control group improved to some extent, but the improvement range was not obvious. This part shows that after three months of training, the special physical fitness for hurdling and hurdling techniques of the control group improved to varying degrees, but the experimental group showed more obvious progress and more convincing improvement range after targeted functional training.

3.2. Comparison and analysis of the scores of relevant test indicators of the two groups of students after the experiment

3.2.1. Comparison of the Hurdling-specific Physical Fitness of the Two Groups of Students after the Experiment

Table 8. Comparison of Hurdle-specific Physical Fitness of Two Groups of Students after the Experiment (N = 20)

Indicator	Experimental group ($\bar{X} \pm SD$)	Control group ($\bar{X} \pm SD$)	t	p
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100 m(s)	13.08±0.10	13.18±0.09	3.869	0.005
Squat(kg)	48.32±1.48	47.32±1.27	4.780	0.000
Weighted Lunge(kg)	10.32±0.37	8.55±0.47	3.858	0.006
Sit and Reach(cm)	17.43±1.15	15.96±1.00	2.994	0.014

After a 3-month systematic training period, the students were retested according to the same test requirements, and the data on special physical fitness for hurdling of the two groups of students were statistically summarized, with results shown in Table 8. In the 100m project test, the average time for students in the experimental group was 13.08±0.10s, while that for students in the control group was 13.18±0.09s; in the squat project test, the average squat weight for students in the experimental group was 48.32±1.48kg, while that for the control group was 47.32±1.27kg; in the weighted lunge project test, the average weighted lunge weight for students in the experimental group was 10.32±0.37kg, while that for the control group was 8.55±0.47kg; in the sit-and-reach project test, the average sit-and-reach distance for students in the experimental group was 17.43±1.15cm, while that for the control group was 15.96±1.00cm. The above data reflect that after the training period, the special physical fitness for hurdling of students in the experimental group was significantly better than that in the experimental group, and the difference in special physical fitness for hurdling between the two groups of experimental students was relatively obvious, a phenomenon that was significantly reflected through statistical analysis. This indicates that functional training methods have a more obvious impact on improving students' special physical fitness for hurdling.

3.2.2. Comparison of Hurdle Specialized Performance of the Two Groups of Students after the Experiment

Table 9. Comparison of Hurdling Special Achievements of Two Groups of Students after the Experiment (N = 20)

Indicator	Experimental group (X±SD)	Control group (X±SD)	t	p
110m hurdles results (s)	17.82±0.09	18.12±0.11	4.099	0.001

As shown in Table 9, the average performance of the experimental group was 17.82±0.09s, and that of the control group was 18.12±0.11s, with a significant gap. The significance test showed $p < 0.01$, indicating a significant difference in special hurdling performance between the two groups after the experiment.

3.2.3. Comparison of Hurdling Technique Performance between the Two Groups of Students after the Experiment

Table 10. Comparison of Hurdling Technique Performance between the Two Groups of Students after the Experiment (N = 20)

Indicator	Experimental Group (X±SD)	Control group (X±SD)	t	p
Swinging leg attacking the hurdle on the side of the hur- dle (points)	81.23±1.26	77.36±1.47	2.301	0.008
Crossing the hurdle on the side of the lead leg (points)	82.45±1.51	79.52±1.38	1.896	0.005

Running over hurdles (points)	80.12±1.53	76.44±1.64	2.869	0.003
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After a series of functional training sessions, the hurdling technical evaluation of high school male athletes was conducted again, focusing on three technical movements: attacking hurdle on the side of the swinging leg, clearing hurdle on the side of the lead leg, and clearing hurdle during running. The results showed significant differences in the test scores of these three movements between the two groups after the experiment, verifying the effectiveness and significance of functional training in improving the hurdling technical performance of high school male athletes.

4. Discussion

4.1. The Relationship between Functional Training and Hurdling-specific Physical Fitness

Functional training has significantly improved the physical fitness of high school male athletes through multi-dimensional neuromuscular regulation mechanisms, indicating that Hypothesis 1 is valid. The reasons are as follows: the relationship between functional training and special physical fitness for hurdling reflects the systematic optimization of the neuromuscular system. By using diverse training methods, athletes' neural conduction efficiency is improved, muscle recruitment patterns become more reasonable, and movement execution becomes more coordinated and precise[4]. Through multi-joint linkage and three-dimensional movement patterns, it is more consistent with the biomechanical characteristics of human movement, effectively improving the transmission efficiency of the kinetic chain, optimizing energy transfer, reducing local joint load, minimizing energy consumption, and promoting the improvement of students' physical qualities such as coordination, speed, strength, endurance, and the level of movement automation.

4.2. The Relationship Between Functional Training and Hurdling Techniques

4.2.1. The Relationship Between Functional Training and Hurdling Technical Compliance

Functional training directly promotes the achievement of special hurdling performance standards by improving technical scores, indicating that Hypothesis 2 is valid. The relationship between functional training and hurdling technical compliance shows that technical improvements have a direct role in enhancing special performance. By optimizing technical details, athletes can shorten flight time, reduce speed loss rate, and form a more stable inter-hurdle rhythm when clearing hurdles^[5]. These technical innovations are transformed into improved exercise efficiency through biomechanical mechanisms, ultimately leading to a significant improvement in special hurdling performance, confirming the causal relationship between technical compliance and exercise performance.

4.2.2. The Relationship Between Functional Training and Hurdling Technical Evaluation

Functional training significantly improved hurdling technical evaluation scores by optimizing movement details, verifying that Hypothesis 3 is valid. The correlation between functional training and hurdling technical evaluation is reflected in the precise optimization of technical details. Through targeted training, athletes can achieve precise control of movement phase differences, optimization of joint movement trajectories, and reconstruction of muscle coordination patterns in key

technical processes such as swinging leg attacking, lead leg clearing, and clearing during running. These improvements directly enhance movement stability, rhythm control, and body balance ability, meeting the requirements for movement quality in technical evaluation standards.

5. Conclusions and Suggestions

5.1. Conclusions

After 3 months of functional training, the special physical fitness indicators for hurdling of the experimental group significantly improved and were better than those of the control group, indicating that functional training can comprehensively promote the development of special physical fitness for hurdling and verifying the effectiveness of the training plan.

After the experiment, there was a significant difference in the 110m hurdling performance between the experimental group and the control group, which benefited from the enhancement of special physical fitness for hurdling and the improvement of hurdling techniques, reflecting the role of functional training in improving special hurdling performance.

The hurdling technical evaluation scores of the experimental group significantly increased, with obvious differences from the control group, indicating that functional training helps students master hurdling techniques, improve movement accuracy and stability, and is conducive to competition performance.

5.2. Suggestions

Strengthen functional training to comprehensively improve physical fitness. Carry out comprehensive training in speed, strength, endurance, and flexibility, regularly evaluate and adjust the plan, and comprehensively improve students' physical fitness to lay a foundation for special sports.

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