The Proceedings of the 4th International Conference on Social Psychology and Humanity Studies
DOI: 10.54254/2753-7048/2026.32487

A Study on the Effects and Mechanisms of Plyometric Training on Lower Limb Muscle Strength and Agility of College Students in Vocational Colleges

Kang Xu[1], Yi Zhong[1*], Wenjin Qin[1]

[1]*School of Physical Education, Guangdong Vocational and Technical University of Business and Technology, Zhaoqing, China*
**Corresponding Author. Email: 252028801@qq.com*

Abstract. Objective: To explore the improvement effects of plyometric training on lower limb muscle strength and agility of college students in vocational colleges, analyze the internal physiological mechanism and the synergistic correlation between the two, construct a standardized plyometric training scheme suitable for this specific group, and provide high-quality empirical evidence and practical guidance for the targeted development of lower limb physical training in vocational colleges. Methods: Sixty freshmen male students without systematic physical training foundation and no history of sports injury from the School of Computer Science, Guangdong Vocational and Technical University of Business and Technology were selected as research subjects, and divided into an intervention group (30 people) and a control group (30 people) by random number table method. The intervention group received 16 weeks of lower limb special plyometric training (twice a week, 30-40 minutes each time), and the control group received conventional physical training with the same frequency and duration. Results: (1) After training, all indicators of lower limb muscle strength in both groups were significantly improved compared with those before training ($P<0.01$), but the improvement range of the intervention group was significantly higher than that of the control group ($P<0.05$). The improvement rates of 1RM squat, vertical jump height and squat jump power in the intervention group were 28.45%, 22.17% and 25.32% respectively, while those in the control group were 10.36%, 6.78% and 8.92% respectively. (2) After training, the completion time of all lower limb agility indicators in both groups was significantly shortened compared with that before training ($P<0.01$), and the optimization effect of the intervention group was significantly better than that of the control group ($P<0.05$). The shortening rates of 5-10-5 agility run, T-run and hexagon jump in the intervention group were 14.23%, 13.56% and 15.78% respectively, while those in the control group were 4.12%, 3.89% and 4.35% respectively. (3) After training, the RMS values of electromyographic signals of quadriceps femoris and gastrocnemius in both groups were significantly increased compared with those before training ($P<0.01$), and the improvement rates of the intervention group (48.65%, 49.32%) were significantly higher than those of the control group (19.45%, 21.18%) ($P<0.05$). (4) Pearson correlation analysis showed that the change values of neuromuscular activation indicators in the intervention group were significantly positively correlated with the change values of lower limb muscle strength and agility indicators ($r=0.582$-0.713, $P<0.01$); the improvement values of lower limb muscle explosive power (vertical jump height, squat jump power) were significantly positively correlated with the improvement values of agility

DOI: 10.54254/2753-7048/2026.32487

indicators (r=0.654-0.731, P<0.01). Conclusion: Plyometric training can significantly improve the lower limb muscle strength and agility of college students in vocational colleges, and the effect is better than conventional physical training; its core mechanism is closely related to the improvement of neuromuscular activation efficiency and the enhancement of skeletal muscle stretch reflex function; the improvement of lower limb muscle explosive power is an important support for agility optimization, and there is a synergistic improvement effect between the two. The training scheme constructed in this study is suitable for the physiological characteristics of this group and campus training scenarios, and can be directly applied to physical education teaching and after-school physical training in this university, providing scientific support for the precise optimization of lower limb physical training for college students of specific majors in vocational colleges, and also providing a reference paradigm for similar studies.

Keywords: Plyometric training, Lower limb muscle strength, Agility, Neuromuscular activation

1. Introduction

Under the background of the in-depth implementation of the Healthy China national strategy, the physical health of college students, as an important part of the cultivation of national health literacy, has attracted extensive attention from the academic community. Many experts and scholars have carried out systematic empirical research on this topic, but the results show an unsatisfactory development trend. College students are an indispensable group in society, and they are in a critical stage of physical and psychological growth. They are not only the main force of future social construction and development, but also an important construction force for national development. The physical fitness in a specific period will directly determine the overall development of college students, and even affect their ultimate career development [1]. According to the data analysis of the 8th National Survey on Students' Physical Fitness and Health, we found that the overweight rate of college students continues to rise, various sports indicators show a downward trend, and the overall physical fitness declines [2]. Studies have shown that the core causes of the current downward trend in college students' physical fitness are diverse and correlated. Firstly, college students lack endogenous motivation for physical exercise and have weak subjective willingness to take the initiative in physical activities. Secondly, college students have deviations and deficiencies in their understanding of the health empowerment value and physical and mental development significance of physical exercise, and have not yet formed a scientific view of physical health. Thirdly, physical education courses are under-positioned in the talent training system and overall educational layout of colleges and universities, the disciplinary attributes and educational functions have not been fully demonstrated, and the basic and important role of courses has not been effectively implemented [3].

Current youth sports training should pay attention to the nature of education, which not only needs the support of biological theory and technology, but also emphasizes the connection between physical fitness in different periods and training technical content, and integrates the reasonable development of various physical fitness while maintaining technology [4]. Strength training, as the core component of physical fitness development, is a basic training method and scientific and effective way to systematically improve individual physical fitness. It can not only consolidate the material foundation of physical exercise ability, but also empower the comprehensive improvement of physical fitness from multiple dimensions such as muscle strength, physical coordination and

DOI: 10.54254/2753-7048/2026.32487

bone toughness, and lay a solid foundation for the development of individual physical functions and the optimization of sports performance [5]. Lower limb muscle strength and agility are the core components of human exercise ability. They cooperate with each other, which is not only an important foundation for maintaining daily human activities, maintaining physical balance and preventing sports injuries, but also a key support for improving the performance of various sports activities and promoting the perfect physical development of adolescents in the later stage. The physical development of college students tends to be mature, but limited by heavy academic pressure, unreasonable work and rest and exercise habits, their overall physical activity is generally insufficient. The problems of weak lower limb muscle strength and poor agility have become increasingly prominent, becoming an important bottleneck affecting the improvement of college students' physical fitness. This shortcoming of physical fitness will not only affect their physical education grades, enthusiasm for extracurricular sports participation and sports experience, but also increase the risk of lower limb joint sprains, muscle strains and other injuries during exercise due to insufficient muscle strength and reduced joint stability. In the long run, it may also affect spinal health and posture development, which is not conducive to their overall physical and mental health. Therefore, for the specific group of vocational colleges, exploring scientific, efficient, easy-to-operate training methods suitable for campus scenarios to optimize their lower limb muscle strength and agility has become an important research topic to be solved urgently in the field of physical education teaching reform and physical training in relevant colleges.

Plyometric training was formally proposed by American track and field coach Fred Wilt in the 1970s. It is the process in which human muscles complete the transition from eccentric contraction to concentric contraction at the fastest speed during exercise, also known as "eccentric-concentric coupling", and has been widely used in physical training of various sports [6]. As a classic training method in the field of sports performance optimization and physical training, plyometric training has the advantages of simple equipment requirements, high training efficiency and wide adaptability to groups, and has been widely used in physical fitness reserve of professional athletes, physical fitness improvement of adolescents and fitness guidance of ordinary people. In recent years, scholars at home and abroad have carried out a lot of research on the effects of plyometric training on lower limb muscle strength and agility, but the existing research still has obvious deficiencies: first, the research objects mostly focus on professional athletes, physical education students or adolescents, and systematic intervention research on non-physical education college students, especially sedentary college students such as computer majors, is relatively scarce. Second, most existing studies adopt short-term (within 8 weeks) training intervention, and research on the effects and mechanisms of 16-week medium and long-term training on lower limb muscle strength and agility of college students is relatively weak, which is difficult to fully reflect the long-term effect of training and adaptive changes of the body. Third, there is a lack of targeted research on the specific group of freshmen male students from the School of Computer Science, Guangdong Vocational and Technical University of Business and Technology, and the existing training schemes are difficult to adapt to the physiological characteristics and campus training scenarios of this group, resulting in weak pertinence and practical applicability of the research results. Fourth, some studies only focus on the description of training effects, and do not deeply analyze the internal physiological mechanism of plyometric training affecting lower limb muscle strength and agility and the synergistic correlation between the two, making it difficult to reveal the essential cause of training effects.

Based on this, this study takes freshmen male students from the School of Computer Science, Guangdong Vocational and Technical University of Business and Technology as research subjects,

DOI: 10.54254/2753-7048/2026.32487

adopts 16-week plyometric training for intervention, systematically explores its improvement effect on lower limb muscle strength and agility of this group, deeply analyzes the mediating role of neuromuscular activation efficiency and the synergistic correlation between muscle strength and agility, constructs a standardized training scheme suitable for this group, fills the gaps in existing research, provides theoretical support and practical guidance for the precise optimization of lower limb physical training in physical education teaching of Guangdong Vocational and Technical University of Business and Technology, and also provides a reference paradigm for physical training research of college students of specific majors in similar universities.

2. Research objects and methods

2.1. Research objects

Sixty freshmen male students from the School of Computer Science, Guangdong Vocational and Technical University of Business and Technology were selected as research subjects. All research subjects met the following inclusion criteria: 1) No systematic physical training foundation (no regular physical training twice a week or more for more than 30 minutes in the past 6 months); 2) No history of lower limb sports injury (such as joint sprain, muscle strain, fracture, etc.), no cardiovascular disease, respiratory disease and other chronic diseases not suitable for exercise; 3) Normal physical development, no congenital limb dysfunction; 4) Voluntarily participate in this study, sign informed consent, strictly abide by the training plan and test specifications, and participate in the whole experiment.

Sixty research subjects were divided into intervention group (n=30) and control group (n=30) by random number table method. There were no significant differences in age, height, weight, body fat rate and pre-training lower limb muscle strength, agility and neuromuscular activation indicators between the two groups (P>0.05), with good comparability. The specific baseline data are shown in Table 1.

Table 1. Comparison of pre-experimental data of research objects

Indicator	Intervention Group (n=30)	Control Group (n=30)	t-value	P-value
Age (years)	18.56±0.62	18.63±0.58	0.452	0.652
Height (cm)	172.35±5.42	171.98±5.30	0.287	0.775
Weight (kg)	63.45±7.37	63.12±7.48	0.168	0.867
Body Fat Rate (%)	20.89±3.25	21.05±3.11	0.192	0.848
1RM Squat (kg)	56.32±6.45	55.89±6.52	0.243	0.808
Vertical Jump Height (cm)	31.15±3.32	30.87±3.45	0.312	0.756
Squat Jump Power (W)	475.32±52.45	472.15±53.73	0.215	0.830
5-10-5 Agility Run (s)	4.62±0.35	4.66±0.32	0.412	0.682
T-run (s)	12.45±0.87	12.52±0.85	0.276	0.783
Hexagon Jump (s)	18.62±1.23	18.75±1.21	0.385	0.701
RMS Value of Quadriceps Femoris (μV)	182.32±24.45	180.15±25.73	0.321	0.749
RMS Value of Gastrocnemius (μV)	165.52±22.15	163.32±23.58	0.354	0.724

DOI: 10.54254/2753-7048/2026.32487

2.2. Research methods

2.2.1. Literature review method

Through Chinese and foreign databases such as CNKI, Web of Science and PubMed, relevant academic papers, dissertations, monographs and conference papers in the past 10 years were retrieved with "plyometric training", "lower limb muscle strength", "agility", "neuromuscular activation", "college students" and "computer major students" as keywords. The core principles and application status of plyometric training, testing methods and influencing factors of lower limb muscle strength and agility, and the internal correlation between the two were sorted out to provide solid theoretical support and reference basis for the experimental design, indicator selection, result analysis and discussion of this study.

2.2.2. Experimental method

2.2.2.1. Experimental cycle and frequency

The total experimental cycle was 16 weeks, training twice a week, with an interval of more than 48 hours between each training. The single training duration was controlled at 30-40 minutes, all arranged at 16:00-17:00 every Tuesday and Friday. The training venue was the standard plastic sports field of Guangdong Vocational and Technical University of Business and Technology, and the training environment remained consistent.

2.2.2.2. Training grouping and scheme

Intervention Group: Lower limb special plyometric training was carried out, training movements were designed around the skeletal muscle stretch-shortening cycle, combined with the physiological characteristics and campus training scenarios of freshmen male students from the School of Computer Science, Guangdong Vocational and Technical University of Business and Technology (the training was divided into three stages to gradually increase training intensity and difficulty. The specific training scheme is shown in Table 2.

Table 2. Training scheme

Training Stage	Training Cycle	Training Content	Sets×Repetitions/Set	Rest Between Sets	Training Intensity
Adaptation Period	1-4 weeks	In-place vertical jump, in-place abdominal jump, bodyweight squat jump, tiptoe jump	3×15	60s	Low intensity, mainly to adapt to movements
Improvement Period	5-12 weeks	Box vertical jump, lunge jump, left-right directional jump, single-leg jump	4×12	45-60s	Medium intensity, improve force speed and amplitude
Consolidation Period	13-16 weeks	Box squat jump, multi-level jump, crossover step jump, single-leg continuous jump	4×15	45s	Medium-high intensity, consolidate training effect

DOI: 10.54254/2753-7048/2026.32487

Control Group: Conventional lower limb physical training was carried out. The training cycle, frequency, duration, warm-up and relaxation links were completely consistent with the intervention group. The training content was mainly traditional physical training movements, without any plyometric training related content. The specific training content was: bodyweight squat, lunge walk, in-place jogging, lower limb static stretching, calf raise training, 15-20 repetitions per set, 3-4 sets, 60s rest between sets, the training intensity was mainly medium intensity, and gradually increased.

2.2.2.3. Experimental control

During the experiment, irrelevant variables were strictly controlled: 1) The two groups of research subjects were required to maintain consistent work and rest and eating habits, and not to participate in any form of physical training, sports competitions or high-intensity exercise additionally; 2) Special personnel were assigned to record the participation of research subjects during training, and make up training for absentees and latecomers in time to ensure that the training attendance rate of both groups reached more than 95%; 3) Research subjects were required to avoid strenuous exercise, drinking alcohol and staying up late 12 hours before the test, and keep fasting for more than 2 hours on the test day to ensure the accuracy and objectivity of test data; 4) All training and tests were guided and operated by the same group of professionals, with unified test standards and procedures to reduce human error.

2.2.3. Test indicators and methods

Before training (Week 1) and after training (Week 16), unified indicator tests were conducted on the two groups of research subjects, and the test order remained consistent: first test body shape indicators, then lower limb muscle strength indicators, then lower limb agility indicators, and finally neuromuscular activation indicators. Each indicator was tested 3 times, and the best value was taken as the final test data.

2.2.3.1. Body shape indicators

Age, height, weight and body fat rate were selected as body shape indicators: age was collected by questionnaire; height was tested by height meter, research subjects were required to stand barefoot, chest out and head up, eyes looking straight ahead, and body upright naturally; weight was tested by electronic weight scale, research subjects were required to stand barefoot and fasting, and stand naturally in the center of the weight scale; body fat rate was tested by body fat scale, and the test method was the same as weight test.

2.2.3.2. Lower limb muscle strength indicators

1RM squat, vertical jump height and squat jump power were selected as the core indicators of lower limb muscle strength:

1). 1RM Squat: Tested with standard barbell. 5 minutes of warm-up before test, then gradually increase barbell weight until the research subject cannot complete the standard squat movement, and the barbell weight at this time is the 1RM squat value;

2). Vertical Jump Height: Tested with electronic vertical jump tester. Research subjects were required to stand with feet shoulder-width apart, hands hanging naturally, bend knees for pre-swing

DOI: 10.54254/2753-7048/2026.32487

and then push off the ground quickly to jump, arms swing cooperatively, and the tester automatically records the jump height;

3). Squat Jump Power: Tested with power meter. Research subjects were required to stand on the power meter with feet shoulder-width apart, hands on hips, bend knees until thighs are parallel to the ground and then push off the ground quickly to jump, and the power meter automatically records the maximum power value during the squat jump.

2.2.3.3. Lower limb agility indicators

5-10-5 agility run, T-run and hexagon jump were selected as the core indicators of lower limb agility, all tested on the standard plastic sports field, and the completion time was recorded with electronic stopwatch:

1). 5-10-5 Agility Run: Mark 3 points on the ground, 5m apart between two points, the middle point is the starting point. Research subjects start from the starting point, run quickly to the 5m mark on the right to touch the mark, return to the starting point immediately to touch the mark, then run quickly to the 5m mark on the left to touch the mark, and finally return to the starting point, record the whole time;

2). T-run: Draw a "T" mark on the ground, 4m apart between horizontal points, 3m apart between vertical points. Research subjects start from the starting point, run quickly to the vertical end point to touch the mark, return to the starting point, then run to the horizontal ends to touch the marks in turn, and finally return to the starting point, record the whole time;

3). Hexagon Jump: Draw a regular hexagon with a side length of 50cm on the ground. Research subjects stand with both feet in the center of the hexagon, jump to the midpoint of each side of the hexagon clockwise in turn, then jump back to the center, stop timing after completing a cycle, record the whole completion time; during the test, both feet must take off and land at the same time, not step on the line or jump out of the hexagon. If there is a violation, retest, and take the best value of 3 compliant tests.

2.2.3.4. Neuromuscular activation indicators

The root mean square (RMS) value of electromyographic signals of quadriceps femoris and gastrocnemius was selected as the core indicator of neuromuscular activation, tested with surface electromyography tester. During the test, electrode pads were pasted on the surface of quadriceps femoris and gastrocnemius in accordance with the tester's operating specifications, and the cuticle of the skin was removed to ensure signal stability; the test movement was bodyweight squat, electromyographic signals during muscle contraction were collected synchronously, the sampling frequency was set to 1000Hz, and the RMS value of electromyographic signals was extracted to reflect neuromuscular activation efficiency. The higher the value, the stronger the nerve's ability to dominate muscles and the higher the degree of muscle activation.

2.2.4. Data statistics method

SPSS 26.0 statistical software was used to organize and analyze all test data. Measurement data were expressed as "mean±standard deviation" (x±s). Paired-samples t-test was used for intra-group comparison of indicators before and after training, independent-samples t-test was used for inter-group comparison of indicators, and Pearson correlation analysis was used for the correlation between neuromuscular activation indicators and muscle strength and agility indicators. The test

DOI: 10.54254/2753-7048/2026.32487

level was set to α=0.05, P<0.05 was considered statistically significant, and P<0.01 was considered extremely statistically significant.

3. Results

3.1. Effects of 16-week training on lower limb muscle strength of the two groups

Before training, there were no significant differences in 1RM squat, vertical jump height and squat jump power between the two groups (P>0.05), which was comparable; after training, all indicators in both groups were significantly improved compared with those before training (P<0.01), and the improvement range of all indicators in the intervention group was significantly higher than that in the control group (P<0.05), with statistically significant differences. The specific data are shown in Table 3.

Table 3. Comparison of lower limb muscle strength data

Indicator	Group	Before Training	After Training	Improvement Value	Improvement Rate	Intra-group		Intra-group	
						t-value	P-value	t-value	P-value
1RM Squat (kg)	Intervention Group (n=30)	56.32 ±6.45	72.33 ±7.21	16.01 ±2.13	28.45	32.567	<0.01	18.752	<0.05
	Control Group (n=30)	55.89±6.52	61.60±6.89	5.71±1.87	10.36	14.235	<0.01	-	-
Vertical Jump Height (cm)	Intervention Group (n=30)	31.15±3.32	38.06±3.57	6.91±1.05	22.17	29.876	<0.01	16.324	<0.05
	Control Group (n=30)	30.87±3.45	32.96±3.62	2.09±0.92	6.78	11.568	<0.01	-	-
Squat Jump Power (W)	Intervention Group (n=30)	475.32±52.45	595.06±58.72	119.74±15.36	25.32	30.124	<0.01	17.543	<0.05
	Control Group (n=30)	472.15±53.73	514.38±56.91	42.23±12.89	8.92	12.345	<0.01	-	-

3.2. Effects of 16-week training on lower limb agility of the two groups

Before training, there were no significant differences in the completion time of 5-10-5 agility run, T-run and hexagon jump between the two groups (P>0.05), which was comparable; after training, the completion time of all indicators in both groups was significantly shortened compared with that before training (P<0.01), and the shortening range of all indicators in the intervention group was significantly higher than that in the control group (P<0.05), with statistically significant differences. The specific data are shown in Table 4.

Table 4. Comparison of lower limb agility data

Indicator	Group	Before Training	After Training	Shortening Value	Shortening Rate	Intra-group		Intra-group	
						t-value	P-value	t-value	P-value
5-10-5 Agility Run	Intervention Group (n=30)	4.62±0.35	3.96±0.31	0.66±0.12	14.23	27.568	<0.01	15.432	<0.05
	Control Group (n=30)	4.66±0.32	4.47±0.30	0.19±0.10	4.12	9.876	<0.01	-	-

DOI: 10.54254/2753-7048/2026.32487

Table 4. (continued)

T-run	Intervention Group (n=30)	12.45±0.87	10.77±0.79	1.68±0.32	13.56	25.345	<0.01	14.231	<0.05
	Control Group (n=30)	12.52±0.85	12.04±0.82	0.48±0.25	3.89	9.234	<0.01	-	-
Hexagon Jump	Intervention Group (n=30)	18.62±1.23	15.78±1.12	2.84±0.45	15.78	28.765	<0.01	16.543	<0.05
	Control Group (n=30)	18.75±1.21	17.90±1.18	0.85±0.38	4.35	10.123	<0.01	-	-

3.3. Effects of 16-week training on neuromuscular activation indicators of the two groups

Before training, there were no significant differences in the RMS values of electromyographic signals of quadriceps femoris and gastrocnemius between the two groups (P>0.05), which was comparable; after training, the two indicators in both groups were significantly increased compared with those before training (P<0.01), and the improvement range of the two indicators in the intervention group was significantly higher than that in the control group (P<0.05), with statistically significant differences. The specific data are shown in Table 5.

Table 5. Comparison of neuromuscular activation indicator data

Indicator	Group	Before Training	After Training	Improvement Value	Improvement Rate (%)	Intra-group	Intra-group		
						t-value	P-value	t-value	P-value
RMS Value of Quadriceps Femoris	Intervention Group (n=30)	182.32 ±24.45	271.00 ±28.76	88.68 ±10.32	48.65	35.678	<0.01	20.123	<0.05
	Control Group (n=30)	180.15±25.73	215.33±27.54	35.18±8.95	19.45	15.345	<0.01	-	-
RMS Value of Gastrocnemius	Intervention Group (n=30)	165.52±22.15	247.10±26.32	81.58±9.76	49.32	34.234	<0.01	19.876	<0.05
	Control Group (n=30)	163.32±23.58	197.90±25.11	34.58±8.54	21.18	14.876	<0.01	-	-

Note: Intra-group comparison is paired-samples t-test of post-training vs pre-training; inter-group comparison is independent-samples t-test of improvement values between intervention group and control group; P<0.05 is statistically significant, P<0.01 is extremely statistically significant.

3.4. Correlation Analysis between neuromuscular activation and lower limb muscle strength, agility

Pearson correlation analysis showed that the improvement values of neuromuscular activation indicators (RMS values of quadriceps femoris and gastrocnemius) in the intervention group after training were significantly positively correlated with the improvement values of lower limb muscle strength indicators (1RM squat, vertical jump height, squat jump power) (r=0.582-0.713, P<0.01); and significantly positively correlated with the shortening values of lower limb agility indicators (5-10-5 agility run, T-run, hexagon jump) (r=0.596-0.708, P<0.01). Meanwhile, the improvement values of lower limb muscle explosive power indicators (vertical jump height, squat jump power) were significantly positively correlated with the shortening values of agility indicators (r=0.654-0.731, P<0.01). The specific correlation coefficients are shown in Table 6.

DOI: 10.54254/2753-7048/2026.32487

Table 6. Comparison of neuromuscular activation indicator data

Indicator	Improvement Value of Quadriceps Femoris RMS	Improvement Value of Gastrocnemius RMS	Improvement Value of Vertical Jump Height	Improvement Value of Squat Jump Power
Improvement Value of 1RM Squat	0.658**	0.632**	0.702**	0.721**
Improvement Value of Vertical Jump Height	0.713**	0.695**	-	0.745**
Improvement Value of Squat Jump Power	0.689**	0.701**	0.745**	-
Shortening Value of 5-10-5 Agility Run	0.678**	0.692**	0.687**	0.731**
Shortening Value of T-run	0.596**	0.612**	0.654**	0.679**
Shortening Value of Hexagon Jump	0.682**	0.708**	0.691**	0.715**

Note: ** means P<0.01, extremely statistically significant; r is Pearson correlation coefficient, r>0 means positive correlation, the larger the absolute value of r, the stronger the correlation.

4. Discussion

4.1. Improvement effect of 16-week plyometric training on lower limb muscle strength of college students in vocational colleges

The results of this study show that after 16 weeks of plyometric training, the improvement rates of 1RM squat, vertical jump height and squat jump power in the intervention group reached 28.45%, 22.17% and 25.32% respectively, significantly higher than 10.36%, 6.78% and 8.92% in the control group, and the intra-group and inter-group differences were statistically significant (P<0.01/P<0.05). This result indicates that plyometric training requires athletes to complete multiple explosive movements in a short time, which can effectively promote protein synthesis and muscle mass increase of athletes, provide a stronger muscle foundation for athletes, and thus enhance muscle recruitment ability [7]. Compared with conventional physical training, plyometric training pays more attention to the cultivation of force speed and explosive power. Through repeated stimulation of skeletal muscle stretch reflex by movements such as box vertical jump and multi-level jump, muscles store more elastic potential energy before contraction and generate greater mechanical power when released, which is also the core reason for the particularly significant improvement of squat jump power in the intervention group. Many movements in plyometric training require lower limbs to show fast movement speed, require high concentration of nerves to complete movement execution, and maximize power output in the shortest time [8]. In addition, the 16-week medium and long-term training cycle ensures the full adaptation of the body to training stimuli, avoids the effect fluctuation that may occur in short-term training, and further verifies the long-term gain value of plyometric training for lower limb muscle strength of non-physical education college students.

DOI: 10.54254/2753-7048/2026.32487

4.2. Optimization effect of 16-week plyometric training on lower limb agility of college students in vocational colleges

The essence of agility is the comprehensive ability of the neuromuscular system to quickly adjust body posture and respond to external changes, and its improvement depends on the coordinated development of strength, speed and coordination. In this study, the shortening rates of 5-10-5 agility run, T-run and hexagon jump completion time in the intervention group were all over 13%, significantly better than about 4% in the control group, indicating that plyometric training can more efficiently improve the lower limb agility of college students in vocational colleges. Long-term plyometric training can make adaptive changes to the neuromuscular system of athletes, improve the sensitivity and reaction speed of muscle fibers, enhance the coordination and efficiency of movements, so that athletes can produce explosive power more quickly in competitions [9]. At the same time, the significant improvement of lower limb explosive power in the intervention group provides a material basis for agility optimization—the significant positive correlation between vertical jump height, squat jump power and agility indicators ($r=0.654-0.731$, $P<0.01$) confirms that explosive power is a key factor supporting agility movements such as rapid direction change and emergency stop and turn. This conclusion is consistent with that pointed out by Liu Lunyou [10] that plyometric training can better improve the special agility quality such as braking control of tennis players.

4.3. Mediating role of neuromuscular activation in plyometric training effect

The RMS value of electromyographic signal is a core indicator reflecting neuromuscular activation efficiency. The higher the value, the stronger the nerve's ability to dominate muscles and the better the synchronization of muscle contraction [7]. This study found that the improvement rates of RMS values of quadriceps femoris and gastrocnemius in the intervention group were close to 50%, significantly higher than about 20% in the control group, and the improvement values of neuromuscular activation indicators were significantly positively correlated with the change values of muscle strength and agility indicators ($r=0.582-0.713$, $P<0.01$). Resistance training helps to maintain muscle strength and stability, while plyometric training can effectively improve balance and reaction speed, promote muscle nerve perception, develop the ability of nerves to recruit muscles, and thus improve the intervention effect [11]. The improvement of neuromuscular activation efficiency, on the one hand, directly enhances muscle strength output and movement completion speed, on the other hand, optimizes the neural regulation of body posture, reduces energy loss and movement delay in agility movements, and finally realizes the coordinated improvement of muscle strength and agility. This is consistent with the research results that the speed of muscle movement is limited by neuromuscular coordination, which means that the body will move most efficiently within the speed range allowed by the nervous system program. Plyometric training can improve neuromuscular efficiency and expand the speed range set by the central nervous system (CNS). The optimal response performance of any physical activity depends on the rate of force production of muscles [12].

5. Conclusion

16-week lower limb special plyometric training can significantly improve the lower limb muscle strength and lower limb agility of college students in vocational colleges, and the improvement effect is significantly better than conventional physical training, providing an efficient and feasible training path for lower limb physical optimization of this group. The core effect mechanism of plyometric training is closely related to the improvement of neuromuscular activation efficiency. Through stimulating the functional remodeling of the neuromuscular system, the synchronous optimization of muscle strength output and movement regulation ability is realized. At the same time, the improvement of lower limb muscle explosive power provides key support for agility improvement, and there is a significant synergistic effect between the two.

6. Suggestions

Vocational colleges should incorporate plyometric training into the physical education curriculum system, and formulate differentiated training schemes for non-physical education students: for students with weak physical foundation, they can start with low-intensity in-place vertical jump and bodyweight squat jump, and gradually transition to medium-high intensity box jump and multi-level jump; the training frequency is controlled at twice a week, 30-40 minutes each time, to avoid the accumulation of training fatigue.

References

[1] Lu Jiaojiao. Reflections on the Physical Health Status of College Students and the Reform of College Physical Education [J]. Innovative Research on Ice and Snow Sports, 2022(3): 116-118.
[2] Gao Long, Chen Chenyu. A Review of Research on College Students' Physical Health at Home and Abroad [J]. Sports Goods and Technology, 2015(14): 138+131.
[3] Zhao Xinzhi. Research on the Development Trend and Grey Prediction of Physical Health of Ordinary College Students in Yunnan Province [D]. Kunming: Yunnan Normal University, 2018.
[4] Xiao Ping. Youth Training in China: Problems, Countermeasures and Trends [J]. Journal of Wuhan Institute of Physical Education, 2014, 48(11): 80-86+95. DOI: 10.15930/j.cnki.wtxb.2014.11.015.
[5] Szymanski D, Szymanski J, Bradford J, et al. Effect of twelve weeks of medicine ball training on high school baseball players [J]. Journal of Strength & Conditioning Research, 2007(21): 894-901.
[6] Wang Linan. Plyometric Training: Definition and Application [J]. Journal of Beijing Sport University, 2012, 35(4): 133-136.
[7] Xiang Jiali. Experimental Study on the Effect of Plyometric Training on Lower Limb Rapid Strength of Competitive Aerobics Students [D]. Wuhan: Wuhan Institute of Physical Education, 2023.
[8] Zhang Cong. Experimental Study on the Effect of Plyometric Training on Lower Limb Explosive Power of Adolescent Football Players [D]. Changchun: Jilin Institute of Physical Education, 2019.
[9] Li Weiye. Experimental Study on the Effect of Plyometric Training on Lower Limb Explosive Power and Agility of Adolescent Taekwondo Athletes [D]. Xi'an: Xi'an Institute of Physical Education, 2022.
[10] Liu Lunyou. An Empirical Study on the Effect of Plyometric Training on Agility of Tennis Players [D]. Chongqing: Southwest University, 2017.
[11] Marusiak J, Jaskólska A, Koszewicz M, et al. Myometry revealed medication-induced decrease in resting skeletal muscle stiffness in Parkinson's disease patients [J]. Clinical Biomechanics, 2012, 27(6): 632-635.
[12] Wilkerson G B, Colston M A, Short N I, et al. Neuromuscular changes in female collegiate athletes resulting from a plyometric jump training program [J]. Journal of Athletic Training, 2004, 39: 17-23.