ISSN 2618-1584 Vol. 7, Issue 2: 1-5, DOI: 10.25236/FMSR.2025.070201

The Effect of Pressure Training Combined with Resistance Training on the Physical Function of Adolescent Football Players

Nazakaiti Keyimu, Abula Yusufu*

Institute of Physical Education, Xinjiang Normal University, Urumqi, Xinjiang, 830054, China
2574989209@qq.com
**Corresponding author*

Abstract: *This study investigated the effects of 12-week blood flow restriction training (BFRT) combined with moderate-intensity resistance training on muscle function and cardiovascular health in elite male football players. Twenty-two athletes (aged 14.67 ± 1.46 years) were evaluated for lower limb muscle strength, vertical jump performance, rapid sprint capacity, isokinetic muscle strength, and serum nitric oxide (NO) levels before and after the intervention. Key findings included: 1) Both groups demonstrated significant increases in bilateral knee joint extension and flexion peak torque ($p < 0.01$), with the experimental group (BFRT + moderate training) showing superior improvements compared to the control group (traditional high-intensity training) ($p < 0.05$); 2) Countermovement jump (CMJ) and squat jump (SJ) performance improved significantly more in the experimental group ($p < 0.01$); 3). The experimental group exhibited substantially greater elevations in serum nitric oxide levels versus controls ($p = 0.001$ and $p = 0.039$ at different measurement points), with post-intervention NO levels remaining significantly higher in the experimental group ($P = 0.019$). These results indicate that combining BFRT with moderate-intensity resistance training for 12 weeks enhances lower limb muscle function in elite football players more effectively than conventional high-intensity training while concurrently improving cardiovascular health markers.*

Keywords: *Blood flow restriction training, Resistance training, Football player, Muscle function*

1. Preface

Blood flow restriction training (BFRT), also known as pressure training (KAATSU training)[1] uses special pressure devices to restrict local muscle arterial blood supply, inhibit venous blood outflow, and keep muscles in a state of blood accumulation and hypoxia[2]. Scholars at home and abroad have found that BFRT has significant effects on muscle maximum strength, explosive power, muscle circumference, etc. of rugby, road cycling, and gymnasts, and has not caused adverse reactions such as arteriosclerosis, coagulation, and thrombosis. At present, there is relatively little research on the effects of pressure training on the muscle function of football players.

Therefore, this study compared the effects of traditional high-intensity resistance training and BFRT combined with moderate intensity resistance training to explore the impact of BFRT combined training on the lower limb muscle function of football players. In order to provide new ideas and methods for improving the muscle function of football players.

2. Research Object and Method

2.1 Research object

This study was conducted at a certain club in May 2024. According to G Power 3.1 software, for a repeated measures analysis of variance (RM-ANOVA) with a significance level of $\alpha=0.05$ and moderate effects ($f=0.25$), a sample size of at least 20 participants is required to achieve a statistical power of 0.9. Meanwhile, considering a dropout rate of 10%, this study requires at least 22 participants.The experimental subject information is shown in Table 1

The inclusion criteria are as follows:

ISSN 2618-1584 Vol. 7, Issue 2: 1-5, DOI: 10.25236/FMSR.2025.070201

All participants have received no less than 3 years of professional football training.

The subject has not had any serious sports injuries in the past 6 months.

The subject has no other health problems or long-term medication history in the past 6 months.

The subject has never been exposed to BFRT training method.

Table 1: Basic information of experimental subjects

group	Age	Training years
Pressure group	14.35±0.83	5.46±0.93
control group	15.19±1.77	6.00±1.24
P	0.48	0.35

2.2 Research Design

Strength training twice a week. The training content of the two experimental groups is consistent. The experimental group uses the KAATSU master compression training device for compression training during the training process. The compression band is tied with a pressure of 40 mmHg and an inflation pressure of 180 mmHg. The compression band is tied in the upper third of the thigh. Test various test indicators before and after the experiment.The intervention plan is shown in Table 2

Table 2 Exercise Intervention Plan

Training phase	Training content	Training intensity (1RM)	
		experimental group	control group
Adaptation stage (1-3 weeks)	Single leg Romanian hard pull Bulgaria Single Leg Squat Flat Street Mat Half Squat BOSU Ball on the Horse Step System Load bearing swallow style flat torn high top leg	30-40%	60%-70%
Stable phase (weeks 4-6)	Bouncy squat Front and back leg squat Neck front half squat Bulgaria Single Leg Squat Single leg Romanian hard pull BOSU ball jumps horizontally BOSU carries weight on the ball, Yan Shi Ping Street connects high and lifts legs	40-50%	70%-75%
Enhancement phase (weeks 7-12)	Bouncy squat Single leg Romanian hard pull Bulgaria Single Leg Squat Balance pad half squat BOSU on the ball, swallow style balance, raised legs, and raised legs Sports pedal, barbell plate, single leg squat	40-50%	75%-80%

2.3 Research Methods

2.3.1 Vertical jump test

Two testing methods, counter motion jump (CMJ) and squat jump (SJ), were used to measure the longitudinal jumping ability of the experimental subjects. Perform 3 jumps for each of the two testing methods and record the best score.

2.3.2 Isokinetic muscle strength test

The multi joint isokinetic testing training system (HUMAC NORM, USA) was used to test the isokinetic muscle strength of the experimental subjects' knee joints, with peak torque testing conducted at an angular velocity of 60 °/s.

ISSN 2618-1584 Vol. 7, Issue 2: 1-5, DOI: 10.25236/FMSR.2025.070201

2.3.3 Biochemical index testing

On the day before intervention and the morning after intervention, 5ml of venous whole blood was collected from the experimental subjects on an empty stomach. The blood was centrifuged at 3000 r/min for 15 minutes, and the serum was collected and stored in a -80 ℃ freezer. The ELISA method was used to measure the levels of endothelin and vascular endothelial growth factor in the experimental subjects, while the nitrate reductase method was used to detect nitric oxide and endothelial nitric oxide synthase.

2.3.4 Data analysis method

Statistical analysis was conducted on the experimental data using SPSS22.0 software, and homogeneity of variance test was used to screen the data. The data in this study conforms to a normal distribution. General linear analysis was used to analyze the differences between groups. After the experiment, t-test was used to compare within group data, and general linear analysis was used to compare between group differences. Continuous variables are represented in the form of mean ± standard deviation. $P<0.05$ indicates statistical significance.

3. Research results

3.1 Changes in isokinetic muscle strength of athletes before and after the experiment

As shown in Table 3.The peak torque changes of knee joint flexion and extension are shown in the table below. The peak torque of knee joint extension and flexion on both sides of the experimental subjects significantly increased ($p<0.01$). After 12 weeks of experimental intervention, the peak torque of knee joint flexion and extension in both sides of the experimental group was significantly better than that in the control group ($p<0.05$).

Table 3 Changes in isokinetic muscle strength of experimental subjects before and after the experiment

index	group	Before the experiment	After the experiment	P value
Right knee extensor muscle	experimental group	130.35±16.23	170.24±11.27	<0.01
	control group	124.27±15.17	158.17±18.20	<0.01
	P value	0.75	<0.01	
Right knee flexor muscle	experimental group	78.17±14.71	99.64±9.05	<0.01
	control group	74.15±16.70	91.62±7.12	<0.01
	P value	0.52	<0.01	
Left knee extensor muscle	experimental group	123.20±16.06	144.38±15.92	<0.01
	control group	126.39±19.42	135.45±14.57	<0.01
	P value	0.64	<0.01	
Left knee flexor muscle	experimental group	71.21±19.51	89.74±12.26	<0.01
	control group	73.49±16.05	76.56±11.12	<0.01
	P value	0.82	<0.01	

3.2 Changes in deep squat and vertical jump of athletes before and after the experiment

As shown in Table 4, after 12 weeks of intervention, the CMJ and SJ of the experimental group showed significant improvement compared to before the experiment (P=0.03,<0.01,<0.01), while the CMJ of the control group showed significant improvement compared to before the experiment (P=0.049, 0.046), and SJ did not show significant changes (P=0.08). After the experiment, the data comparison between the two experimental groups showed that the CMJ and SJ test scores of the experimental group were better than those of the control group (P=0.036, 0.049, 0.016).

ISSN 2618-1584 Vol. 7, Issue 2: 1-5, DOI: 10.25236/FMSR.2025.070201

Table 4 Changes in squat and vertical jump of experimental subjects before and after the experiment

index	group	Before the experiment	After the experiment	P value
CMJ	experimental group	34.8750±6.53	38.79±4.48516	<0.01
	control group	33.54±5.17	36.22±6.08	0.014
	P value	0.147	0.037	
SJ	experimental group	30.17±9.35	37.68±5.73	<0.01
	control group	32.64±7.56	34.66±4.12	0.054
	P value	0.357	0.025	

3.3 Changes in blood cytokine levels of athletes before and after the experiment

As shown in Table 5, the serum nitric oxide levels in the experimental group significantly increased before and after the experiment (P=0.001, 0.000), while those in the control group significantly increased (P=0.027, 0.000),; After the experiment, the experimental group showed a significant increase in nitric oxide levels compared to the control group (P=0.032, 0.001).

Table 5: Changes in Blood Cytokines Levels of Experimental Subjects Before and After the Experiment

index	group	Before the experiment	After the experiment	P value
nitric oxide	experimental group	34.24±9.42	39.64±9.16	0.001
	control group	33.18±7.83	36.40±6.45	0.039
	P value	0.85	0.019	

4. Discussion

This study shows that a combination of 12 weeks of blood flow restriction training, moderate intensity resistance training, and high-intensity resistance training can significantly improve the isokinetic muscle strength, squat, vertical jump, directional change ability, and thirty meter sprint ability of football players. At the same time, the experimental results showed that the combination of blood flow restriction training and moderate intensity resistance training had a better effect on improving the isokinetic muscle strength, squat, vertical jump, directional change ability, and thirty meter sprint ability of football players. The results[3] of this experiment are basically consistent with previous[4] research. After conducting a 4-week pressure training on 20 professional freestyle wrestlers, Ji[5] Xiaolei et al. found that the peak torque of left knee flexion and right knee extension, as well as the maximum static increase of bench press in the pressure group, were significantly higher than those in the control group. The study by Che Tongtong et al[6]. also found that the combination of low-intensity resistance exercise and pressure training for 6 weeks significantly improved the lower limb strength of female wrestlers compared to high-intensity resistance training. Yamanaka et al. and Luebbers et al. found that the combination of pressure and resistance training had a better effect on muscle strength improvement of rugby and weightlifters.

This study speculates that the main source of the effect of pressure training on muscle strength improvement is the regulation of muscle growth factor secretion levels by pressure training. Biological studies have shown that pressure training can cause the accumulation of metabolic products such as lactate at the pressure site, and put muscles in a local hypoxic state, thereby increasing the secretion of nitric oxide synthase (NOS) and upregulating serum nitric oxide (NO) secretion. NO can also promote the activity, proliferation, and differentiation of myoblasts[7]; Increasing blood supply to muscle tissue, upregulating glucose carrier GLUT4 levels in muscle cells, enhancing glucose uptake, and improving muscle energy metabolism to accelerate muscle tissue growth. In addition, studies have shown that short-term low-intensity pressure resistance training can stimulate the secretion of hepatocyte growth factor (HGF). Molecular studies have shown that HGF can directly activate muscle satellite cells and promote their division and differentiation, thereby accelerating muscle tissue growth.

5. Conclusion

The results of this study suggest that the combination of 12 week pressure training and moderate intensity resistance training has a significantly better effect on improving the isokinetic muscle strength,

ISSN 2618-1584 Vol. 7, Issue 2: 1-5, DOI: 10.25236/FMSR.2025.070201

vertical jump, sprint running, and turning ability of football players than traditional high-intensity resistance training. In addition, pressure training can effectively regulate the serum nitric oxide level of football players and improve their blood circulation function.

References

[1] Lei Forest, Zhang Minghui, Ma Chunlian, etc Muscle effects, dose-response relationship, and physiological mechanisms of pressure resistance training [J]. Chinese Journal of Tissue Engineering Research, 2023, 27 (26): 4254-4264

[2] Chen Keyi, Wang Dingxuan, Zhao Sike, etc Research hotspots of pressure training in rehabilitation field and visualization analysis of 10-year literature data [J]. Chinese Journal of Tissue Engineering Research, 2022, 26 (15): 2406-2411

[3] Yamanaka T, Farley RS, Caputo JL. Occlusion training increases muscular strength in division IA football players[J]. J Strength Cond Res,2012,26(9):2523-2529.

[4] Che Tongtong, Li Zhiyuan, Yang Tieli, et al. The effect of 6-week low-intensity compression combined with high-intensity resistance training on the core area and lower limb muscle strength of adolescent female wrestlers [J]. Journal of Capital Institute of Sport, 2022, 34 (03): 333-341. DOI: 10.14036/j.cnki. cn11-4513.2022.03.012

[5] Yamanaka T, Farley RS, Caputo JL. Occlusion training increases muscular strength in division IA football players[J]. J Strength Cond Res,2012,26(9):2523-2529.

[6] Ji Xiaolei, Wu Xinyi, Sun Ke, etc. The effect of blood flow restriction on muscle strength and morphology during specialized training for freestyle wrestlers [J]. Chinese Journal of Sports Medicine, 2024, 43 (05): 348-355. DOI: 10.16038/j. 1000-6710.2024.05.005

[7] Li Zhuoqian, Wei Wenzhe, Zhao Zhiguang, etc The effect of different degrees of blood flow restriction on serum growth hormone and testosterone secretion during low-intensity resistance exercise [J]. China Sports Science and Technology, 2020, 56 (04): 38-43. DOI: 10.16470/j.csst.209078