ISSN: 2586-6028
JSAS website: http://acoms.accesson.kr/jsas
doi: http://dx.doi.org/10.13106/jsas.2023.vol7.no4.13

The Effects of Weight Training and Complex Training on Youth Soccer Player Performance*

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Received: November 27, 2023. Revised:December 18, 2023. Accepted: December 19, 2023.

Abstract

Purpose: This study aims to determine what changes occur in body composition and performance by subjecting youth soccer players to weight training and combined training, which are known to be effective in improving anaerobic capacity, for 6 weeks. **Research design, data, and methodology**: This study was conducted on 30 high school soccer players from S City who had no current injuries or medical problems and had been registered as players with the Korea Football Association for more than 3 years. Subjects were divided into a weight training group (WTG, n=15) and a combined training group (CTG, n=15). Training lasted 6 weeks, and measurements were taken before and after training. Mean (M) and standard deviation (SD) were calculated to present the descriptive statistics of all dependent variables. Paired t-tests were used to test for within-group differences. Further, Independent t-tests were employed to test for between-group differences. **Results**: In terms of body composition, height significantly increased in WTG and CTG, and body fat percentage significantly decreased in CTG. As for performance, WTG's 20m sprint record decreased significantly. **Conclusion**: As a result, this study confirmed that weight training improved the 20m sprint ability of youth soccer players. Future research could provide more useful information by extending the study period and incorporating the physical characteristics of adolescents.

Keywords: Weight training, Complex training, Performance, Youth soccer players

JEL Classification Code: I10, I12, I18

1. Introduction

South Korean soccer has gained a lot of popularity and attention from the public based on its achievements, including a quarterfinal finish at the 2002 Korea-Japan World Cup, a bronze medal at the 2012 London Olympics, a runner-up finish at the 2019 Under-20 World Cup, and a spot in the round of 16 at the 2022 World Cup in Qatar. The game-related fitness factors required of soccer players include cardiorespiratory endurance, agility, quickness, speed, and equilibrium (Jung, Kim, Kim, Park & Lee, 2019). Soccer, in particular, requires both aerobic and anaerobic fitness traits by intermittently performing high-intensity movements for 90 minutes. Soccer players travel more than 10 kilometers per game, with high-intensity movements accounting for 7-12% of the total, and sprints accounting for 1-4% (Bradley, Sheldon, Wooster, Olsen, Boanas, & Krustrup, 2009).

Modern soccer requires faster transitions between offense and defense compared to the past (Yoon, 2019), which has led to more high-speed runs and sprints than ever before. These high-intensity anaerobic movements are considered to be an important indicator that distinguishes top performers from average players (Bangsbo, 2014).

This is because adolescence is a period of rapid physical growth and high motor learning ability to convert motor

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skills acquired during training or competition into their own abilities (Kang & Jang, 2014). Therefore, scientific training prescriptions for age-specific fitness are needed in soccer.

Good explosive strength is very useful in sports that involve speed and change of direction. Power is also an important factor in sprint speed (Chelly & Denis, 2001). Power is the rate of work done, measured as the product of force multiplied by speed. There are two ways to improve power. The first is to increase strength and speed. Increasing the level of force at a given velocity will be the way to increase power. The second way is to improve the rate of force development (RFD), which is the concept of how much force is generated in a limited amount of time, and the force generated in the early stages of muscle contraction (0-200 ms) can be an important functional outcome that determines power (Aagaard, Simonsen, Andersen, Magnusson & Dyhre-Poulsen, 2002).

Based on these principles, there are many different training methods in the field to improve power, or anaerobic capacity. The first training method that has been shown to be effective in improving anaerobic performance is weight training. Weight training is based on the principle of overload and progression, where you gradually increase the weight. The second is compound training. Complex training is a training method that combines weight training and plyometric training to efficiently increase maximal strength and power at the same time by triggering post-activation potentiation by performing high-intensity training with high weights followed by high-speed training with low weights (Robbins, 2005).

This study aims to determine what changes in body composition and performance occur in youth soccer players after six weeks of weight training and complex training known to improve anaerobic capacity.

2. Methods

2.1. Subjects

This study was conducted with a sample of thirty high school soccer players in the city of S. The participants had no current injuries or medical problems and has been registered with the Korea Football Association for at least three years. Prior to conducting an experiment, authors explained the purpose of the study and asked agreement of experiment participation and received consent form from participants. The experiment participation was voluntarily.

The subjects were randomly divided into two groups: weight training group (WTG) and combined training group (CTG). The physical characteristics of the subjects are shown in Table 1.

Table 1: Physical characteristics of the subjects by groups

Group(n)	Age (years)	Height (cm)	Weight (kg)	Skeletal muscle (kg)	Body fat (cm)
UG(10)	16.76±0.71	178.49±6.73	70.63±8.96	35.52±4.20	11.51±2.48
BG(10)	16.96±0.81	175.63±4.23	68.45±6.70	34.53±3.68	11.90±3.24

Note. Means ± SD

2.2. Research Tools

In this study, the following tools were employed to check the body composition and performance of the subjects. The contents of the research tools are shown in Table 2.

Table 2: Physical characteristics of the subjects by groups

Equipment	Variables & Measure	Company
Inbody 720	Weight(kg) Muscle mass(kg) Body fat(%)	Inbody Co, KOREA
Automated stadiometer	Height(cm)	neogmtec, KOREA
Witty	20m sprint	Microgate, USA

OPTOJUMP	Squat Jump Countermovement Jump	Microgate, USA

2.3. Metrics and Methods

2.3.1. Body Composition

An automatic stadiometer (neogmtec, Korea) was used to measure the height of the subjects. A bioelectrical impedance device (InBody 720, InBody, Korea) was utilized to measure body weight, muscle mass, and body fat percentage. For accuracy, subjects were not allowed to exercise excessively the day before the measurement and were measured in the morning on an empty stomach.

2.3.2. Performance

In this study, performance was measured by squat jump, count movement jump, and 20m sprint. The squat jump and countermovement jump were measured using an automatic measuring device (OPTOJUMP, Microgate, USA) for accurate measurement. The 20-meter sprint was measured using a speed gate (Witty, Microgate, USA) with an automatic sensor. Subjects were trained in advance on how to perform the measurements, and all performance measures were measured twice, using the best record.

2.3.3. Training Program

The training program in this study was conducted for 60 minutes per session, three times a week for six weeks. The training program consisted of 2 weeks of tissue adaptation and 4 weeks of maximal strength, referring to the periodization theory (Song, Park, & Jung, 2008).

The duration of the workout consisted of 10 minutes of warm-up, 45 minutes of main workout, and 5 minutes of cool-down. The training details were adapted from the programs of Arazi, Malakoutinia and Izadi (2018) and Eylen, Daglioglu & Gucenmez(2017). Both WTG and CTG performed the same weight training, but CTG performed 1 set of weight training followed by 1 set of plyometric training. The detailed training program is as follows <Table 3~4>.

Table 3: Adaptation phase 1～2w

Day of the week		1	2
Exercise Type		Lower Limb Exercises Squat / jump 4 times Lunge / lunge jump 4 times Calf raise / snapping 10 times	Lower Limb Exercises Dead lift / Jump 4 times One leg dead lift / One leg jump 4 times Step up / Box one-legged jump 4 times
		Upper limb exercises Lat pull down / medball slam	Upper limb exercises Bench press / medball push
Training Details	Load	60~70%	
	Repetitions	10~12RM, Plyometric 1 week NCM, 2 weeks CMJ	
	Sets	3set	
	Rest	3min	

Note. NCJ: noncounter mevment jump, CMJ: counter movement jump

Table 4: Maximum strength phase 3~6w

Day of the week		1	2
Exercise Type		Lower Limb Exercises Squat / jump 5 times Lunge / lunge jump 6 times Calf raise / snapping 10 times	Lower Limb Exercises Dead lift / Jump 4 times One leg dead lift / One leg jump 4 times Step up / Box one-legged jump 4 times
		Upper limb exercises Lat pull down / medball slam	Upper limb exercises Bench press / medball push
Training Details	Load	85~100%	
	Repetitions	5RM, Plyometric 3 to 4 week CMJ, 5 to 6 weeks DCJ	
	Sets	3set	
	Rest	3min	

Note: CMJ: counter movement jump, DCJ: double contact jump

2.4. Data Processing

Data were analyzed using SPSS 25.0 statistical program. Mean (*M*) and standard deviation (*SD*) were calculated to present the descriptive statistics of all dependent variables. Paired t-tests were used to test for within-group differences. Further, Independent t-tests were employed to test for between-group differences. The statistical significance level was set at .05.

3. Results

3.1. Body Composition

Changes in body composition and differences between groups by time of measurement for WTG and CTG are shown in Table 5. Changes in height were significantly different between pre- and post-training for WTG (p=.01) and CTG (p=.02). There were no significant changes in height between groups for WTG and CTG. There was a significant change in body fat percentage from pre- to post-training in the CTG (p=.009). There were no significant differences between training groups. Otherwise, there were no significant changes in body weight and muscle mass between periods or between groups.

Table 5: Changes of body composition during 6 weeks of exercise training

Variables	Groups	n	Pre M±SD	Post M±SD	t	sig.	
Height (cm)	WTG	15	178.49±6.73	179.21±6.57	-4.36	.01	**
	CTG	15	175.63±4.23	176.06±4.27	-2.68	.02	*
Weight (kg)	WTG	15	70.63±8.96	70.60±8.67	.11	.90	
	CTG	15	68.45±6.70	68.67±6.70	-.71	.49	
Skeletal muscle (kg)	WTG	15	35.52±4.20	35.67±3.91	-.94	.36	
	CTG	15	34.35±3.68	34.80±3.69	-2.07	.58	
Body fat (cm)	WTG	15	11.51±2.48	11.05±2.41	1.89	.08	
	CTG	15	11.90±3.24	11.01±3.17	3.02	.009	**

Note. * p < .05. ** p < .01. *** p < .001

3.2. Performance

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Squat jump and noncounter movement jump did not show significant differences by time period and between groups. There was a significant change in the 20-meter sprint in the WTG by time period (p=.02). There were no significant differences between groups<Table 6>.

Table 6: Changes of performance during 6 weeks of exercise training

Variables	Groups	n	Pre M±SD	Post M±SD	t	sig.	
NCJ	WTG	15	42.60±2.85	41.60±3.42	1.97	.07	
	CTG	15	43.27±3.93	42.84±4.56	.74	.48	
CMJ	WTG	15	40.25±10.87	43.51±5.15	-1.17	.26	
	CTG	15	44.23±4.79	45.14±4.92	-1.37	.20	
20m Sprint	WTG	15	3.107±.093	3.060±.074	2.28	.02	*
	CTG	15	3.094±.102	3.063±.112	1.40	.19	

Note: * p < .05. ** p < .01. *** p < .001., NCJ: non-counter movement jump, CMJ: counter movement jump

4. Discussion

4.1. Body Composition

For adolescents, physique could be an important indicator of an athlete's future, and it is important that growth be guided according to individual characteristics. It has been known that the increase in height, weight, and decrease in body fat are most pronounced during the adolescent period between the ages of 14 and 16 (Lee & Lee, 1999). The age of the subjects in this study was 16.76±0.71 years for WTG and 16.96±0.81 years for CTG, which is a period of active physical change. After 6 weeks of weight training and complex training, height, weight, and muscle mass were maintained or increased, and body fat percentage decreased. In particular, height showed significant changes over time in both groups, and body fat percentage was significantly reduced in CTG. This finding is partially consistent with previous studies that showed no significant changes in body composition after 8 weeks of plyometric training in volleyball players and no significant changes in body composition after 8 weeks of plyometric training in high school inline athletes. The significant changes in height are likely due to the fact that the subjects in this study were in a period of active growth, and the significant decrease in body fat percentage in CTG is likely due to an increase in muscle mass with little change in body weight. In addition, the training period of this study was 6 weeks, which is shorter than other studies, which may have contributed to the lack of significant results.

4.2. Performance

The squat jump and countermovement jump were performed to check the change in agility, and the squat jump showed a slight decrease in height with no significant change. The squat jump does not use a stretch shortening cycle, but both training methods use a stretch shortening cycle, so it is unlikely that SSC had an effect on the improvement of the squat jump that is not using SSC. The countermovement jump, on the other hand, did not show any significant changes, but did improve slightly. This is likely due to the fact that training shortens the time of the amortization phase, which is the intermediate phase between eccentric and concentric contractions, and thus improves the efficiency of the SSC, resulting in improved countermovement jump performance. This is partially consistent with the findings of Ramírez-Campillo, Burgos, Henríquez- Olguín, Andrade, Martínez, Álvarez, Mauricio, Mário, and Izquierdo, (2015) who found an increase in countermovement jump performance after 6 weeks of progressive plyometric training in youth soccer players.

The 20-meter sprint improved in both groups, but significantly in the WTG. This is partially consistent with the findings that a 20-meter sprint test following plyometric training resulted in improved 20-meter sprint times and that 6 weeks of training resulted in improved 10-meter sprint performance (Lockie, Murphy, Schultz, Knight, & de Jonge, 2012). The six-week period was not enough time to determine the difference in training effects between the two groups, and believe that a longer study period would have revealed additional changes.

In conclusion, this study examined the effects of weight training and complex training on body composition and performance of youth soccer players in City S for 6 weeks and found that the height of WTG and CWG improved, and the body fat percentage of CWG decreased. In addition, WTG's 20-meter sprint time decreased. Future research could provide more useful information by extending the study period and incorporating the physical characteristics of adolescents.

References

Aagaard, P., Simonsen, E. B., Andersen, J. L., Magnusson, P., & Dyhre-Poulsen, P. (2002). Neural adaptation to resistance training: changes in evoked V-wave and H-reflex responses. *Journal of Applied Physiology, 92*(6), 2309-2318.

Arazi, H., Malakoutinia, F., & Izadi, M. (2018). Effects of eight weeks of TRX versus traditional resistance training on physical fitness factors and extremities perimeter of non-athlete underweight females. *Physical Activity Review, 6*, 73-80.

Bangsbo, J. (2014). Physiological demands of football. *Sports Science Exchange, 27*(125), 1-6.

Bradley, P. S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P., & Krustrup, P. (2009). High-intensity running in English FA Premier League soccer matches. *Journal of sports sciences, 27*(2), 159-168.

Chelly, S. M., & Denis, C. (2001). Leg power and hopping stiffness: relationship with sprint running performance. *Medicine & Science in Sports & Exercise, 33*(2), 326-333.

Eylen, M. A., Daglioglu, O., & Gucenmez, E. (2017). The Effects of Different Strength Training on Static and Dynamic Balance Ability of Volleyball Players. *Journal of Education and Training Studies, 5*(13), 13-18.

Jung, J-H., Kim, S-E., Kim, H-J., Park, J-J., & Lee, S-H. (2019). A Study on the Compare Analyzed of Body Composition, Physical Strength, and Anaerobic Power of Male Middle, High School, and College Soccer Players. *Korea Sport Society, 17*(3), 1111-1121.

Kang, H., & Jang, S. (2014). The relationship between achievement goal orientation and exercise commitment in adolescent soccer players: A multigroup analysis of background variables. *Journal of the Korean Society of Sport Psychology, 25*(1), 101-113.

Lee, Y-S,, & Lee, Y-J. (1999). Comparison of isokinetic strength in adolescent soccer players: Peak torque, total work, H/Q ratio, and left and right maximal strength. *Korean Journal of Sports Science, 8*(1), 563-572.

Lockie, R. G., Murphy, A. J., Schultz, A. B., Knight, T. J., & de Jonge, X. A. J. (2012). The effects of different speed training protocols on sprint acceleration kinematics and muscle strength and power in field sport athletes. *The Journal of Strength & Conditioning Research, 26(6)*, 1539-1550.

Ramírez-Campillo, R., Burgos, C. H., Henríquez- Olguín, C., Andrade, D. C., Martínez, C., Álvarez, C., Mauricio, C., Mário, M., & Izquierdo, M. (2015). Effect of unilateral, bilateral, and combined plyometric training on explosive and endurance performance of young soccer players. *The Journal of Strength & Conditioning Research, 29*(5), 1317-1328

Robbins, D. W. (2005). Post-activation potentiation and its practical applicability. *The Journal of Strength & Conditioning Research, 19*(2), 453-458.

Song, H-S., Park, D-H., & Jung, D-S. (2008). Natural science: effects of periodized strength training application on performance in swimmers. *Research in Physical Education and Sports Science, 19*(3), 60-72.

Yoon, J-H. (2019). Effects of winter fitness training on cardiorespiratory fitness and muscle function in N-League professional soccer players. *Sports Science, 36*(2), 139-148.