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The impact of strength training on the improvement of jumping ability and selected power parameters of the lower limbs in soccer players

Patricia Fischerova
Department of Sport Theory, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland,
p.fischerova@awf.katowice.pl

Magdalena Nitychoruk
Department of Sport Theory, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland,
magda.aneta.krawczyk@gmail.com

Wojciech Smolka
Clinical Department of Laryngology, School of Medicine in Katowice, Medical University of Silesia, Katowice, Poland,
wojciech.smolka@op.p

Marcin Zak
Department of Sport Theory, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland,
m.zak@awf.katowice.pl

Artur Golas
Institute of Sport Sciences, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland,
a.galas@awf.katowice.pl

See next page for additional authors

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Abstract

Introduction: The aim of the study was to compare the impact of a 6-week program combined with football training and strength training on strength and power parameters in highly trained soccer players. It was hypothesized that 6 weeks would be enough for the experimental group to improve their jumping ability and pushing power.Material and methods: The study involved 34 female footballers playing in Ekstraliga (age: 22 ± 5 years; body height: 167 ± 5 cm; body weight: 60 ± 8 kg). The contestants were divided into an experimental group and a control group of 17 people in each group. The control group performed football trainings combined with 2 additional strength units (50% 1RM load) 3 times a week. The experimental group, apart from football trainings, additionally performed 2 strength trainings per week (50–85% 1RM load).Results: The results of the experiment show a significant improvement in the height of the vertical jump and bench press while sitting in the experimental group CMJ ($p < 0.05$; $p = 0.000029$; ES: 1.00; 11%), CMJA ($p < 0.05$; $p = 0\ 00003$; ES = 1.09; 13%), and LP ($p < 0.05$; $p = 0.027681$; ES = 0.48; 6%), while in the control group the changes in the results after the training program were statistically insignificant CMJ ($p > 0.05$; $p = 0.274000$; ES: 0.07, 1%), CMJA ($p > 0.05$; $p = 0.350958$ ES = 0.27, 3%), and LP ($p > 0.05$; $p = 0.130153$; ES = 0.27; 4%).Conclusion: The presented research results suggest that a short, six-week training program including general football training and strength training performed twice a week with loads gradually increasing during the preparatory period may significantly improve the strength and jumping parameters of the lower limbs in soccer players. Such information can be valuable at the stage of training in the field of special skills training in football.

Keywords

strength training, jumping ability, power, lower limbs

Authors

Patricia Fischerova, Magdalena Nitychoruk, Wojciech Smolka, Marcin Zak, Artur Golas, and Adam Maszczyk

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Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Patricia Fischerova[1 ABCDEF], Magdalena Nitychoruk[1 ABCDEF], Wojciech Smółka[2 CDEF], Marcin Żak[1 ADEF], Artur Gołaś[3 DEF], Adam Maszczyk[3, 1 CDEF]

[1] Department of Sport Theory,
The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

[2] Clinical Department of Laryngology, School of Medicine in Katowice,
Medical University of Silesia, Katowice, Poland;

[3] Institute of Sport Sciences,
The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

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Conclusions: The presented research results suggest that a short, six-week training program including general football training and strength training performed twice a week with loads gradually increasing during the preparatory period may significantly improve the strength and jumping parameters of the lower limbs in soccer players. Such information can be valuable at the stage of training in the field of special skills training in footbal.

Key words: strength training, jumping ability, power, lower limbs, soccer players.

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Corresponding author: Magdalena Nitychoruk - Department of Sport Theory, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland, e-mail: magda.aneta.krawczyk@gmail.com; phone number: +48-518-443-073

INTRODUCTION

The most important factors influencing the result during the game are soccer/football[1] skills, tactical and mental preparation and high motor skills: endurance, speed, strength and coordination [1, 2]. When analyzing football players' motor activities, we noticed a recurring profile of work with short-term intense efforts, dynamic movements (e.g. jump, slide, change of direction, contact situation with an opponent) [3, 4], which occurs alternately with low-intensity efforts [3].

To prepare players well for league games, the preparatory period should be conducted well and precisely. During this period, coaches have more time to introduce new tactical elements, to improve the technique and cooperation in a team, and, most importantly, to prepare for motor skills.

During the season, there is no time to improve the efficiency, it can only be maintained at a high level with various additional exercises, which during the preparatory period the athlete will gain through training. Therefore, so much attention is paid to motor preparation in the preparatory period [1].

The motor preparation of women in football is of particular importance as women are more prone to lower limb injuries, overloads and injuries of the musculoskeletal system than men (e.g. damage to the anterior cruciate ligament ACL) [5–8]. This is mainly due to anatomical, hormonal, biomechanical and neuromuscular factors [5,7]. Balanced motor development, which is a combination of stability, endurance, mobility and muscle strength, determines the effectiveness of movement and prevents contusion [9,10].

Developing a high level of muscular strength is a decisive goal in preparing a football player for competition [11] as stronger athletes perform better [12]. Properly performed strength training improves the maximum running speed, increases acceleration, improves endurance, increases the jump height, improves the efficiency of changes in the direction of running and the power of kicking the ball [13,14]. These aspects are very important during the game when the player acyclically performs motor activities such as sprinting with the ball, off the ball, lunges, accelerations, rapid changes of direction, jumps and many others [3,4].

This study aims to compare muscle strength and power parameters before and after the preparatory period using a 6-week program based on soccer training and soccer strength training in highly skilled female soccer players. We hypothesized that a 6-week training program was sufficient to correct neuromuscular factors (i.e., explosive power of the lower limbs). Strength training was based on bilateral exercises strengthening the neuromuscular factors, on exercises shaping muscle strength using movement patterns, muscle power and body stability.

MATERIAL AND METHODS

Characteristics of the studied group

The study was carried out at the Laboratory of Muscular Strength and Power at the Jerzy Kukuczka Academy of Physical Education in Katowice. The study involved 34 female footballers playing in the Polish Ekstraliga (age: 22 ±5 years; body height: 167 ±5 cm; body weight 60 ±8 kg). The contestants were divided into two groups, the experimental and the control group, with 17 contestants in each group. Eleven competitors from each group were randomly selected for the final tests.

[1] In this text, the authors use the terms soccer and football interchangeably - football in the sense of "association football".

Description of the experiment

The study of jumping parameters and power of the lower limbs was carried out at two time intervals, before the beginning of the preparatory period and before the starting period, both groups conducted a 6-week training plan between the tests. The test included the leg press power test and the vertical jump power test.

Test on Keizer Air300 Leg Press, both [LP]

The test consisted of pressing the load while sitting. The adjustable sitting position protected the lower back, keeping it stabilized, which allowed the gluteal muscles to stretch better and allowed them to be more active during the exercise. First, 1 RM was established and 5 minutes later, a test was conducted where the competitor pressed both times with a weight of 60% 1RM. This test examined the maximum concentric force of the lower extremities divided by the athlete's body weight (W/kg).

Test on a force plate

The test is performed on the AMTI force plate. The aim of the study is to assess the height and power of the lower limbs during counter movement jump with arm swing (CMJA) and without (CMJ) based on the measured ground reaction force.

6-week training plan for the control group and experimental game

The surveyed team took part in a 6-week preparation for the main games in women's football. One week consisted of 3 soccer training units, including one friendly match and two strength training units. All players playing in different positions together with the goalkeepers participated in the same strength training. In the first training session, the maximum strength level of each competitor was determined in each exercise using the CM (maximum weight) test. Football training sessions were held on an artificial pitch 3 times a week, and consisted of small and large games of high intensity (mixed zone). Strength training took place twice a week, one of which was used as the base training for strength. The second training, on the other hand, included prophylaxis, correction and equalization of pathological muscle imbalance. The last training unit of the week was a control game, i.e. the friendly match.

Strength training

The 6-week training plan prepared by a coach of motor preparation was aimed at regaining the correct muscle balance, improving central stabilization and preventing the most common injuries in women. The training was based on energy systems: a 4-week plan to build the maximum muscle strength (glycolytic system), a 1-week plan with a predominance of fast glycolysis and a 1-week advantage of the phosphagen system.

The players in the experimental group performed a 60-minute circuit training at 8 stations twice a week. In the first and second training sessions, the stations included 3 different bilateral exercises for the lower limbs, 3 stabilization exercises and 2 exercises for the upper limbs. 10 repetitions at a 2-0-1-0 rate and at 70% 1RM (week 1), 75% 1RM (week 2), 80% 1RM (week 3), and 85% 1RM (week 4). In the following week the weight was changed to maintain the dynamics of the movement (50% 1RM, 8 repetitions in week 5, and 6 repetitions in week 6, at the pace of movement 4-0-1-0) [Tab.1,2]. The rest period between series was 30–60 seconds. The stations in the first and second training consisted of 3 different exercises for the lower limbs (back squat with the barbell, front squat, deadlift, forward drop of the torso while kneeling, lifting the hips with the barbell, rolling the fitness ball while lying back), 3 exercises stabilizing (front and side platform) and 2 exercises for the upper limbs (pull-ups, push-ups, moving the dumbbell behind the head while lying on the back, Spiderman push-ups). The control group followed the same training program, but the load ranged from 50–60% 1 RM and with 6–8 repetitions for each limb in the series.

Table 1. Summary of the strength training program of the experimental group on Monday

	MONDAY	1st W (70% 1RM)	2nd W (75% 1RM)	3rd W (80% 1RM)	4th W (85% 1RM)	5th W (50% 1RM)	6th W (50% 1RM)	
1	Back squat	6	6	6	6	8	8	3
2	Basic plank	UT	UT+15 sec	UT+20 sec	UT+30 sec	UT	UT	3
3	Hip trust	-	10	8	6	-	-	3
	Swiss Ball Leg Curl	12				30 sec	30 sec	3
4	Side plank LS	UT	UT+15 sec	UT+20 sec	UT+30 sec	UT	UT	3
5	Lying Dumbbell Pullover to Extension	12	12	12	12	10	8	3
6	Romanian deadlift	8	8	8	8	10	8	3
7	Spider-man push- ups	6	8	10	12	8	6	3
8	Side plank RS	UT	UT+15 sec	UT+20 sec	UT+30 sec	UT	UT	3

note: UT - until tearing; LS - left size; RS - right size; W - week; RM - repetition maximum

Table 2. Summary of the strength training program of the experimental group on Wednesday

	WEDNESDAY	1st W (70% 1RM)	2nd W (75% 1RM)	3rd W (80% 1RM)	4th W (85% 1RM)	5th W (50% 1RM)	6th W (50% 1RM)	
1	Back squat	6	6	6	6	8	6	3
2	Basic plank	UT	UT+15 sec	UT+20 sec	UT+30 sec	UT	UT	3
3	Hip trust	12	12	14	16	12	10	3
4	Side plank LS	UT	UT+15 sec	UT+20 sec	UT+30 sec	UT	UT	3
5	Lying Dumbbell Pullover to Extension	6	6	8	10	8	6	5
6	Romanian deadlift	6	6	8	10	8	6	5
7	Spider-man push- ups	12 (2)	12(2)	14(2)	16(2)	10 (2)	8 (2)	3
8	Side plank RS	UT	UT+15 sec	UT+20 sec	UT+30 sec	UT	UT	3

note: UT - until tearing; LS - left size; RS - right size; W - week; RM - repetition maximum

Statistical analysis

The test results were initially processed in MS Excel and then analyzed in STATISTICA. Student's T-test for dependent samples was used to assess the significance of changes in the power strength of the players before and after the training protocol. The statistical significance level for the t-test was set at $p < 0.05$. The size of the difference or effect size (ES) was calculated according to Cohen's d and interpreted as small (> 0.2 and < 0.5), medium (≥ 0.5 and < 0 , 8) or large (≥ 0.8) [15].

RESULTS

Leg press

The results of the test in the experimental group on the Kaiser leg press (LP) device testing the power of the lower limbs before the beginning of the preparatory period (mean 22.88 ±3.12 W/kg) changed, and the competitors improved the result obtained after the preparatory period (mean 24.23 ±2.46 W/kg). The differences were statistically significant ($p < 0.05$; $p = 0.027681$; ES = 0.48; 6%). There was no significant improvement in the results of peak power in the control group ($p > 0.05$; $p = 0.130153$; ES = 0.27; 4%).

CMJA AND CMJ

In the experimental group, the counter movement jump without arm swing (CMJ) before (mean 31.24 ±3.7 cm) and after (mean 34.71 ±3.2 cm) the preparatory period changed and was statistically significant ($p < 0, 05$; $p = 0.000029$; ES: 1.00) (Fig. 1, Table 2) compared to the control group, where the results were statistically insignificant ($p > 0.05$; $p = 0.274000$; ES: 0.07; 1%) (Table 3).

Table 3. The results of the student's t-test for dependent samples for CMJ, CMJA and LP in the experimental group

	Mean PRE	SD PRE	Mean POST	SD POST	difference [%]	t	p < 0.05	Cohen's d	ES
CMJ	31.25	3.73	34.72	3.20	11%	-6.5111	0.000029	0.998	large
CMJA	34.55	4.20	39.20	4.29	13%	-6.48912	0.00003	1.094	large
Leg Press	22.88	3.12	24.23	2.47	6%	-2.5046	0.027681	0.48	small

CMJ (cm) - counter movement jump, CMJA (cm) - counter movement jump with arm swing, LP (W / kg) - leg press, SD - standard deviation, t - test result, df - number of degrees of freedom, p - probability level, ES - effect size

The explosive power of the lower limbs in the CMJA jump test before the preparatory period was lower (mean 34.55 ± 4.2) than in the results after the preparatory period (mean 39.2 ± 4.29) in the experimental group (Fig. 1). This means that the female players improved their swing jump by an average of 13%, and the differences were statistically significant ($p <0.05$; $p = 0.000030$; ES: 1.09). In the control group, the improvement was not statistically significant ($p > 0.05$; $p = 0.350958$ ES = 0.27; 3%) (Table 4).

Table 4. The results of the student's t-test for dependent samples for CMJ, CMJA and LP in the control group

	Mean PRE	SD PRE	Mean POST	SD POST	difference [%]	t	p < 0.05	Cohen's d	ES
CMJ	30.99	3.85	31.28	4.09	1%	-1.15742	0.274000	0.07	small
CMJA	34.16	3.54	35.23	4.29	3%	-0.978387	0.350958	0.27	small
Leg Press	20.97	2.82	21.81	3.31	4%	-1.64905	0.130153	0.27	small

CMJ (cm) - counter movement jump, CMJA (cm) - counter movement jump with arm swing, LP (W / kg) - leg press, SD - standard deviation, t - test result, df - number of degrees of freedom, p - probability level, ES - effect size

Comparing CMJ and CMJA in the experimental group, it can be seen that the mean CMJA jump before the 6-week period (34.55 cm) is similar to the mean CMJ jump after the preparatory period (34.71 cm). This means that the players jumped up without a swing almost the same as 6 weeks before with the swing (Fig. 1).

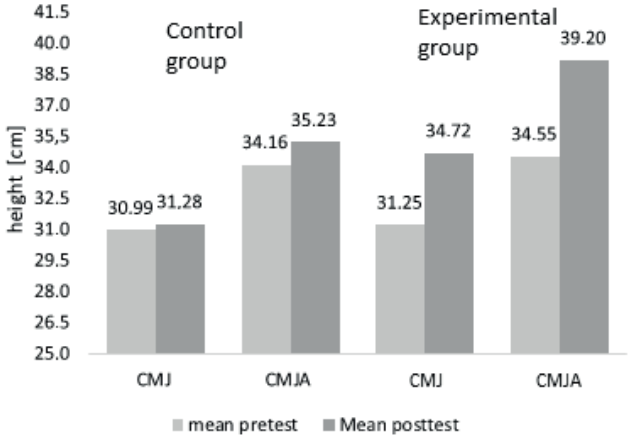

Fig. 1. Arithmetic means of vertical jumps CMJ and CMJA before and after the preparation period

Note: CMJ - counter movement jump; CMJA - counter movement jump with arms

The results of the est in the experimental group on the Kaiser leg press (LP) device, testing the power of the lower limbs before the beginning of the preparatory period (mean 22.88 3.12 W/kg) changed, and the competitors improved the result obtained after the preapratory period (mean 24.23 2.46 W/kg) (Fig. 2).

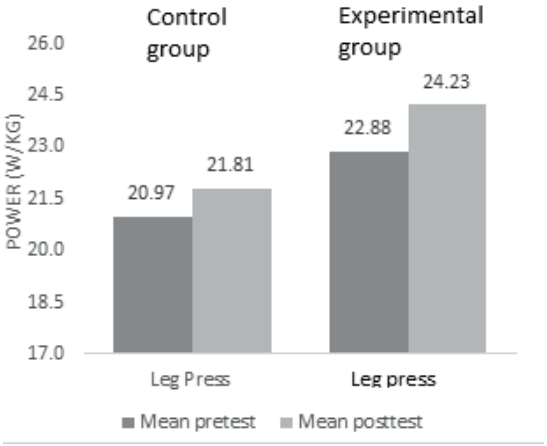

Fig. 2. Arithmetic means of peak bench press power while sitting on the leg press machine before and after the preparation period

DISCUSSION

The purpose of this study was to evaluate parameters related to explosive power during a six-week strength and soccer program in soccer players. In line with our initial hypothesis, this program improved vertical jump performance and peak leg power in professional soccer players.

In the current study, the test of the maximum power parameters on a leg press device in the experimental group changed significantly ($p < 005$; ES = 0.48). Soccer players improved their pre-season performance by 6%. The CMJ stroke height increased by 11% and the CMJA by 13%.

Others have also documented improvement after 6 weeks of additional strength training. Marques et al. [16] noted that in young footballers 6 weeks' of strength training combined with plyometric exercises and football training resulted in an increase in jump efficiency by 7.7% in comparison to football training alone. Styles et al. [17] determined that a 6-week strength training program increased the squat strength of professional soccer players, which could result in improvements in sprinting and jumping.

In our research, in the experimental group, the female athletes performed strength training based on multi-joint complex exercises, which resulted in an increase in jumping parameters and explosive power.

Similar changes were also noticed by de Hoyo et al. [18] who, after 10 weeks of strength training based on the maximum concentric and eccentric load with a combination of exercises — leg-curl exercise and half squat (squat with a barbell) — observed an improvement in CMJ tests (ES: 0.58). A year later, the same authors, de Hoyo et al. [19], found that a half-squat exercise improved jumping and sprint skills more than running or plyometric training. Hammami et al. [20] observed that performing an 8-week program of additional strength training (back half-squat – 70–90% 1RM / 3–5 sets / 3–8 reps) performed twice a week before standard training sessions improved jumping performance (CMJ) in young footballers. The same author, Hammami [21], stated one year later that 8 weeks of strength training improved key performance components (maximum power) in younger players compared to standard seasonal training. Chelly et al. [22] proved that 2 sessions of squat exercises per week improved sprint running, jumping and peak power in 17-year-old footballers.

Earlier studies by other authors were conducted only on male subjects (amateurs, elite footballers, young footballers) [11, 18, 17, 19, 21]. In other authors' studies on the effect of strength training in women practicing other team games also improved power parameters. Hammami [23] proved that 10 weeks of combined strength training influenced explosive muscle performance in young handball players.

Differences between men and women may be important when comparing physical fitness, for example. Lopes [24] found that in physical fitness tests men showed higher values of power and strength of the lower limbs, as well as endurance than women. Morawetz [25] found that eccentric training could have the same effect on women and men. In practice, the possible greater loss of strength in women immediately after eccentric exercise would be one potential gender difference.

Askow [26] noticed that, when strength was normalized, no significant differences between the sexes were observed and concluded that differences between males and females may appear sooner from strength than from biological sex. Walts [27] proved that strength training does not alter subcutaneous or intermuscular fat, regardless of gender. Kossow [17] found no significant interaction between the type of plyometric exercise and gender. Thanks to these studies, it can be concluded that the increase in muscle power after training is independent of gender.

However, there are also studies in which strength training did not bring the effect of increasing maximum power. Bouteraa [28] noticed that additional 8-week balance and plyometric training in young basketball players showed no significant differences in jump height (CMJ). It could be caused by many factors, e.g. selection of exercises, load, number of repetitions or already high threshold of achieving maximum explosive power in individual players.

CONCLUSIONS

Based on the results of this study, the following conclusions can be drawn about the power parameters of female soccer players:

1. Female competitors in the experimental group significantly improved their power parameters in all three tests compared to the control group
2. A 6-week program of football training sessions combined with 2 strength training sessions a week with a changing load every week was enough to improve these parameters.
3. The contestants improved the explosive power of the lower limbs by not performing plyometric exercises.
4. Strength training was also used to prevent injury during the competition period. Additional tests are recommended at the end of the competition period to check whether the strength training performed during the preparatory period and the competition period prevented injury.

REFERENCES

[1] Chmura J, Chmura P, Ciastoń J. Przygotowanie motoryczne piłkarzy do wysiłku startowego [Motor preparation of footballers for the starting effort]. Sport Wyczynowy. 2018;46(10-12):526-528.

[2] Soroka A. Identyfikowanie różnic w sytuacyjnie uwarunkowanych zmianach sprawności działania w grze w piłkę nożną graczy i zespołów reprezentujących mistrzowski poziom umiejętności [Identifying differences in situational changes in the performance of players and teams representing the championship level of skills in football]. Siedlce; 2018, 7-153.

[3] Chmura J. Charakterystyka zespołowych gier. Piłka nożna [Characteristics of team games. Football]. In: Zając A, Chmura J, eds. Współczesny system szkolenia w zespołowych grach sportowych [Contemporary training system in team sports games]. Katowice: Akademia Wychowania Fizycznego; 2016, 25–26.

[4] Sghair Z, Ben-Moussa Z, Kebsi W, et al. Strength training reduces injury rate in elite young soccer players during one season. J Strength Cond Res. 2016;30(5):1295–1307. doi: 10.1519/JSC.0000000000000920

[5] Casao M, Seijas R, Pérez-Bellmunt A, Navarro R, Ragazzi P, Alvarez P. Epidemiology of primary anterior cruciate ligament ruptures in men and women. Int J Sports Exerc Med. 2019;5:114. doi: 10.23937/2469-5718/1510114

[6] Giza E, Mithöfer K, Farrell L, Zarins B, Gill T. Urazy w zawodowej piłce nożnej kobiet [Injuries in women's professional football)]. Br J Sports Med. 2015;39:212–216. doi: 10.1136/bjsm.2004.011973

[7] Grygorowicz M, Piontek T, Dudzinski W. Evaluation of functional limitations in female soccer players and their relationship with sports level - A cross sectional study. Plos One. 2013;8(6):1-7. doi: 10.1371/journal.pone.0066871.

[8] Kuszewski M. Kontuzje i urazy sportowe - geneza i profilaktyka. In: Zając A, Chmura J, eds. Współczesny system szkolenia w zespołowych grach sportowych [Contemporary training system in team sports games]. Katowice: Akademia Wychowania Fizycznego; 2016, 550.

[9] Andrychowicz Ż, Domżalski M, Drobniewski M, Synderek M, Osmulska M, Borowski A. Assessment of motor fitness in soccer players by means of functional movement screening. Polish J Sport Med. 2018;34(4):257-268.

[10] Blasco E, Paredes A, Monleon C, Martin M, Margueta M, Elvira L. Injury in elite women soccer and national women soccer in the lower extremity. J Hum Sport Exerc. 2018;13(3):566-576. doi: 10.14198/jhse.2018.133.08

[11] Haff GG, Stone MH. Methods of developing power with special reference to football players. Strength Con J. 2018; 37(6):1-13. doi: 10.1519/SSC.0000000000000153

[12] Kossow AJ, DeChiara TG, Neahous SM, Ebben WP. Kinetic analysis of horizontal plyometric exercise intensity. J Strength Cond Res 2018; 32(5): 1222–1229. doi: 10.1519/JSC.0000000000002096.

[13] Comfort P, Stewart A, Bloom L, Clarkson B. Relationships between strength, sprint, and jump performance in well-trained youth soccer players. J Strength Cond Res. 2014;28(1):173–177. doi: 10.1519/JSC.0b013e318291b8c7

[14] Sporiš G, Jovanović M, Krakan I, Fiorentini F. Effects of strength training on aerobic and anaerobic power in female soccer players. Sport Sci. 2011;4(2):32-37.

[15] Cohen, J. Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates; 1998.

[16] Marques MC, Pereira A, Reis IG, Van den Tillaar R. Does an in-season 6-week combined sprint and jump training program improve strength-speed abilities and kicking performance in young soccer players? J Hum Kinetics. 2013; 39:157-166. doi: 10.2478/hukin-2013-0078.

[17] Styles WJ, Matthew MJ, Comfort P. Effects of strength training on squat and sprint performance in soccer players. J Strength Cond Res. 2016;30(6):1534-9. doi: 10.1519/JSC.0000000000001243.

[18] de Hoyo M, Pozzo M, Sañudo B, et al. Effects of a 10-week in-season eccentric-overload training program on muscle-injury prevention and performance in junior elite soccer players. Int J Sports Phys Perf. 2015;10:46-52. doi: 10.1123/ijspp.2013-0547

[19] de Hoyo M, Gonzalo-Skok O, Sañudo B, Carrascal C, Plaza-Armas J, Camacho-Candil F, Otero-Esquina C. Effects of in-season full-back squat, resisted sprint training, and plyometric training on explosive performance in U-19 elite soccer players. J Strength Cond Res 2016; 30(2): 368–377. doi: 10.1519/JSC.0000000000001094

[20] Hammami M, Negra Y, Shephard R, Chelly M. The effect of standard strength vs. contrast strength training on the development of sprint, agility, repeated change of direction, and jump in junior male soccer players. J Strength Cond Res. 2017;31(4):901-912. doi: 10.1519/JSC.0000000000001815

[21] Hammami M, Negra Y, Billaut F, Shephard R, Chelly M. Effects of lower-limb strength training on agility, repeated sprinting with changes of direction, leg peak power, and neuromuscular adaptations of soccer players. J Strength Cond Res. 2018;32(1):37-47. doi: 10.1519/JSC.0000000000001813

[22] Chelly M, Fathloun M, Cherif N, Amar M, Tabka Z, Praagh E. Effects of a back squat training program on leg power, jump, and sprint performances in junior soccer players. J Strength Cond Res. 23(8):2241-2249. doi: 10.1519/JSC.0b013e3181b86c40

[23] Hammami M, Gaamouri N, Aloui G, Shephard R, Chelly M. Effects of complex strength training program on athletic performance of junior female handball players. Int J Sports Physiol Perform. 2018;14(2):1-22. doi: 10.1123/ijspp.2018-0160

[24] Lopes T, Simic M, Alves D, Bunn P, Rodrigues A, Terra B. Physical performance measures of flexibility, hip strength, lower limb power and trunk endurance in healthy navy cadets. J Strength Cond Res. 2021 Feb 1;35(2):458-464. doi: 10.1519/JSC.0000000000002365

[25] Morawetz D, Blank C, Koller A, Arvandi M, Siebert U, Schobersberger W. Sex-related differences after a single bout of maximal eccentric exercise in response to acute effects: a systematic review and meta-analysis. J Strength Cond Res. 2020;34(9):2697-2707. doi: 10.1519/JSC.0000000000002867.

[26] Askow A, Merrigan JJ, Neddo JM, White JB, Oliver JM, Jones MT. Effect of strength on velocity and power during back squat exercise in resistance-trained men and women. J Strength Cond Res. 2019;33(1):1–7. doi: 10.1519/JSC.0000000000002968

[27] Walts C, Hanson E, Delmonico M, Yao L, Wang M, Hurley B. Do sex or race differences influence strength training effects on muscle or fat? Med Sci Sports Exerc. 2018;40(4):669-76. doi: 10.1249/MSS.0b013e318161aa82.

[28] Bouteraa I, Negra Y, Shephard R, Chelly M. Effects of combined balance and plyometric training on athletic performance in female basketball players. J Strength Cond Res. 2018;34(7):1967–1973. doi: 10.1519/JSC.0000000000002546

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