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EFFECTS OF SIX-WEEK CONCURRENT FITNESS TRAINING FOR SPEED AND EXPLOSIVE POWER IN FOOTBALL PLAYERS

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(Original scientific paper)

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Abstract

The study included total of 15 participants (average age of 17 [± 0.5] [SD +/-] years), within 3 groups ((G1) N=5, (G2) N=5, and (G3) N=5). G1 performed power exercises (traditional set – with break between sets) (~75-80% 1RM). G2 performed exercises for acceleration/speed and plyometrics (traditional set – with break between sets). G3 performed exercises for speed / plyometrics / strength with contrast method (supersets- no break between sets). The trainings for all 3 groups were concurrent trainings, followed by regular football training, on the same day. To follow the effect of the program, the participants were tested in 2 tests, maximal speed at 30 meters -[30m] and maximal standing long jump –[Jump]. Friedman Anova (and Post Hoc Frieadman-Nemenyi -Q test) was performed for each group between 3 test points, as well as Kruskal-Wallis Anova for the comparison of differences between groups. The effect size with 90 % CL was evaluated according Field, A. (2017). The G1 group, had no effect on improving the speed (30 m sprint test) in football players (p = 0.07). For G2 group (speed + plyometrics) and G3 (strength + speed + plyometrics), 9 trainings were sufficient to significantly improve the speed (p = 0.01) Only 6 trainings made significant (p = 0.03) transformation of participants explosive strength, in the G2 group. The training of strength (G1) and strength + speed + plyometrics (G3) had a significant transformation (p = 0.01) on explosive strength after 9 supplemental trainings.

Key words: *muscle power, contrast method, traditional set.*

Introduction

The football game demands specific motor abilities from the players, as well as quick decision-making, competitiveness in duels, and covering a big area on the pitch. Football training (technique + tactic) is insufficient on its own as a stimulus for the purposes of modern football. The concurrent fitness training is needed in the periodization of the football training plan and program-making.

During a football game, the most decisive skills (the ability to jump high, kick, turn and sprint fast in duels against opponents) are crucial in modern football. They are directly related with the power production capacity of the neuromuscular system (Requena et al, 2009). Similar stimulus, such as high-intensity strength training (speed, strength, plyometrics), has to be incorporated as concurrent training (on micro + macro level of periodization), to enhance the player's overall performance capacity (Christou, et al., 2006; Silva et al., 2015; Sáez de Villarreal, et al., 2015; Tasevski et al., 2019).

Choosing the correct load intensity (dosing/prescription), type of exercises, duration, types of muscle contraction etc., is the key point in designing the strength/ speed model (Vuksanovikj et al.,2021). According to Baker & Newton (2005), when choosing the strength exercises, we should have in mind the selection of the intensity zones as stimulus: speed power (0-20 % 1 PM), ballistic power (20-40% 1PM), maximal power (40-60% 1PM), explosive power (60-80% 1PM), maximal strength (80-100% 1PM). In addition, a combined (not block periodization) program can be used for training with weights and plyometrics for transformation of strength, jump and sprint performance in football players of different ages (Rodríguez-Rosell et al., 2017). High-intensity training improves intramuscular coordination of the nervous system and muscle fibers, whereas low-intensity exercises, when performed quickly, improve the rate of force development (Bompa & Buzzichelli, 2015).

Variety of exercises can be used for the purposes of transformation of strength/speed abilities (Olympic lifting, maximum speed weightlifting, ballistic throwing, plyometrics, sprints). The variety of strength

methods (forced repetitions, drop sets, supersets, heavy negatives-eccentric contraction etc.,) is used as fitness training in football (Schoenfeld, 2011). Superset method is often used (Kraemer et al, 2002), especially because it produces greater metabolic load (kJ·min−1, blood lactate, and EPOC) compared to traditional sets (Kelleher et al, 2010).

For power/speed transformation, a period of about 6 weeks of pre-season resistance training + plyometrics with low volume and low load is usually recommended (Vuksanovikj et al, 2014; Rodríguez-Rosell et al, 2015;). The combination of field football training and strength training is also used in the competition period.

SAQ (speed, agility, quickness) trainings effectively improve power performance (Pearson, 2001; Polman et al, 2004; Sporiš et al., 2011;), especially in young football players during in-season and the competition season (Gissis et al 2006; Jovanovic et al., 2011).

Football depends on such fast movements, and in order to maintain the high level of this ability, speed training is also a crucial part of football training. In addition, the speed, as human motor ability, is correlated to heredity (Vuksanovikj et al, 2021), which put in question the size effect of speed training. On the other hand, the improvement of the horizontal force production capability (Buchheit et al, 2014) can be stimulated, with speed training.

Because of the similar CNS activation processes (as well as fast muscle fibers type activations-(Vuksanovikj et al, 2021), speed training could even be an equivalent substitute to strength training (Wenzel & Perfetto, 1992). On the other side, strength training induces greater performance improvements in jump actions than in running-based activities (Silva et al, 2015). While performing a combination of traditional and semi-specific resistance training exercises, there is a lack of velocity-specific performance, as in speed movements (Blazevich & Jenkins, 2002). This is probably because of the biomechanical structure of movements (strength vs. speed-fast running).

Because of the similar energy mechanisms of speed and strength/power training, the question that arises is whether those 2 types of exercises should be mixed in the same training. Or they should be trained on different days, or even as block periodization.

Such information regarding types of strength and speed training, choosing the correct intensity, duration, rest between the sets, especially included in the regular football training, from the micro/macro cycle periodization point of view, is crucial while designing strength/ speed supplemental training. It is also the leading missing piece in football fitness practice regarding how effectively a concept of strength/speed training is to be prepared, because the football game is constantly changing and becomes more dependent on speed and strength.

The idea of this research, which distinguishes it from the previous researches, is to discover [1] whether the football players will benefit more if they train with contrast method of training mixing strength + speed (performed as supersets - mix of 2 different exercises, no break between the superset), compared with two other groups exercising with a traditional strength set and a traditional set of speed + traditional set of strength. Moreover, the idea [2] is to check whether the 6 weeks period of speed + explosive strength supplemental training will result in positive transformation of explosive strength and speed, in addition to the different methods of exercising speed and strength.

Materials and Methods

Participants

Total of 15 participants (average age of 17 [± 0.5] [SD +/-] years), within 3 groups ((G1) N=5, (G2) N=5, and (G3) N=5), were included in this study. While the experimental program was being realized, the participants (football players) were in the middle of a competitive period. The research was approved by the Ethics Committee of the Faculty of Physical Education, Sport and Health at the University of Ss. Cyril and Methodius, verifying that it is in accordance with the Declaration of Helsinki.

Design and Procedures

The participants were tested in 2 tests, (running time 30 m) with maximal speed at 30 meters -[30m] and after that maximal standing long jump –[Jump]. Regarding the estimation of the power performances, tests for acceleration/speed and tests for explosive strength (jump) were used (Jovanovic et al., 2011; Vuksanovikj et al., 2016; Vuksanovikj et al., 2018); The groups were homogenized by results of the jump test, performed at initial testing. The participants were divided in the three experimental groups (G1/G2/G3).

The first group, G1, performed the (traditional set – with break between sets) power exercises (~75-80% 1RM). The second group (G2) performed the (traditional set – with break between sets) exercises for acceleration/speed and plyometrics. The third group (G3) performed exercises of the contrast method (supersets- no break between sets) of exercises for speed / plyometrics / strength training. The training sessions for all 3 groups were concurrent, followed by regular football training, on the same day. Tests and training were performed on artificial grass, on the same place where the football training was performed. Tests were preceded by 20-minutes warm-up which included slow running, static and dynamic stretch/mobility exercises. All participants were undergoing a continuous training process without any history of injuries for a period of at least one year. During the tests, the participants were continuously encouraged to do their best. Tests (firstly-[30m] and after that–[Jump]) were realized by the same tester. Two test trials for each test were done. The best result from each trial was used in the study. Test [30m] was tested with a stopwatch. Beside the high relative reliability of speed tests done by stopwatch and speed gun (Mann, J. B., et al.,, 2015), the final result (for a test done by stopwatch) depends on the timer's experience (Baechle, T. R., & Earle, R. W. (Eds.)., 2008). Because of this, in this experimental program, the timer was an experienced PE teacher as well as coach (and football goalkeeper).

In the first week, in addition to the testing, two training sessions were performed. There was a 24h break between training 1 and training 2, i.e. these training sessions were performed with a one-day break. The same principle (24-hours break) was applied for the second week. During the third week, the players had only football training, no other training. During the fourth week, the players had two training sessions, as during the second week. In the fifth week, the players had a control test and two training sessions, as in the first week. In the sixth week, the players had one training session because there were two matches during the same week. The final test was performed during the seventh week. Control test was performed after 6 supplemental training sessions. The final test was performed after 9 training sessions (3 training sessions after the initial test). The periodization is provided in Table No. 1. Detailed program for each training is provided in Table No. 2 Regarding weights exercises, weights 75-80% of 1RM are used.

Table No. 1. Microcycle (plan) for the experimental program of 6 weeks trainings

week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
# 1	***initial test***	***training option # 1***	football training	***training option # 2***	football training	match day	day off
# 2	day off	***training option # 1***	football training	***training option # 2***	football training	match day	day off
# 3	day off	football training	football training	foddball training	day off	football training	match day
# 4	day off	***training option # 1***	football training	***training option # 2***	football training	match day	day off
# 5	***control test***	***training option # 1***	day off	***training option # 2***	football training	match day	day off
# 6	day off	***training option # 1***	football training	match day	day off	football training	match day
# 7	***finall test***						

Table No. 2. Exercise set

group	exercise #	**trening option # 1**	reps	sets	**trening option # 2**	reps	sets
G1	1	Trap bar squat	5	3	Barbell Lunges	5	3
	2	1 Leg Rdls	5	3	Hip Thrust	5	3
	3	Push-ups	10	3	Barbell Back row	5	3
	4	Pull-ups	5	3	Barbell Military press	5	3
G2	1	Sprint 15m	5	1	Sprint 10m (starting position: reverse lunge)	5	1
	2	Hurdle Jumps	5	3	KB Swing (10кг)	5	3
	3	Clap Push-ups	5	3	Board Jump	5	3
	4	Medball Slam (10кг)	5	3	Medball throw from chest	5	3
G3	1	Trap bar squat + Hurdle Jumps	3+3	3	Barbell Lunges + Sprint 10m (starting position: reverse lunge)	6 (total) +1	3
	2	1 Leg Rdls + Sprint 15m	6 (total) +1	3	Hip Thrust + KB Swing (10кг)	3+3	3
	3	Push-ups + Clap Push-ups	3+3	3	Barbell Back row + Board Jump	3+3	3
	4	Pull-ups + Medball Slam (10кг)	3+3	3	Barbell Military press + Medball throw from chest	3+3	3

Statistical Analysis

In order to test the planned program, Friedman Anova (and Post Hoc Frieadman-Nemenyi -Q test) was performed for each group (XX, RR, XR) between 3 test points, as well as Kruskal-Wallis Anova for the comparison of differences between groups. The effect size (Q-stat) with 90 % CL was evaluated as trivial (0–0.19), small (0.20–0.49), medium (0.50–0.79) and large (0.80 and greater) (Field, A. (2017)). Data processing was performed with the statistical program SPSS (V22, SPSS Inc, Chicago, USA), and Excel Real Statistics (for Mac) and the level of significance was set at $p<0.05$.

Results and Discussion

Table No.3. presents descriptive statistics, normality and confidence level of the data collected

Table No. 3. Descriptive statistics

Shapiro-Wilks, alpha = 0,05

	test	G 1	N	Min	Max	Mean	SD	SE	Kurt.	Skew	CL (95,0%)	W-stat	p-value	normal
G 1	30m	initial	5	4.18	4.70	4.49	0.20	0.09	-0.02	-0.87	0.25	0.94	0.66	yes
		control	5	4.20	4.55	4.42	0.14	0.06	1.69	-1.25	0.17	0.87	0.26	yes
		final	5	4.15	4.52	4.39	0.14	0.06	2.49	-1.43	0.18	0.88	0.30	yes
	Jump	initial	5	196.00	249.00	223.00	19.30	8.63	0.94	-0.11	23.96	0.99	0.97	yes
		control	5	206.00	250.00	225.60	16.59	7.42	0.40	0.60	20.60	0.98	0.94	yes
		final	5	214.00	253.00	230.50	14.84	6.64	0.73	0.78	18.43	0.96	0.80	yes
G 2	30m	initial	5	4.22	4.66	4.43	0.20	0.09	-2.58	0.22	0.24	0.95	0.70	yes
		control	5	4.11	4.60	4.37	0.17	0.08	2.00	-0.42	0.22	0.72	0.02	no
		final	5	4.02	4.42	4.21	0.14	0.06	1.62	0.33	0.18	0.83	0.16	yes
	Jump	initial	5	206.00	251.00	223.20	18.57	8.30	-0.05	0.81	23.05	0.88	0.32	yes
		control	5	221.00	255.00	238.33	12.03	5.38	2.00	-0.14	14.93	0.66	0.00	no
		final	5	210.00	261.00	231.25	18.86	8.43	1.83	0.99	23.42	0.88	0.33	yes
G 3	30m	initial	5	4.17	4.63	4.36	0.17	0.08	2.34	1.11	0.21	0.89	0.40	yes
		control	5	3.97	4.55	4.26	0.22	0.10	0.34	-0.10	0.27	1.00	0.99	yes
		final	5	3.93	4.43	4.19	0.18	0.08	1.74	-0.16	0.22	0.97	0.83	yes
	Jump	initial	5	197.00	255.00	223.20	21.45	9.59	0.91	0.54	26.64	0.91	0.48	yes
		control	5	209.00	266.00	230.52	21.45	9.59	2.70	1.42	26.63	0.81	0.11	yes
		final	5	209.00	271.00	233.60	22.79	10.19	2.78	1.30	28.30	0.74	0.03	no

The Friedman test (Table No. 4) has showed that strength training (G1 group: 5 reps Max, ~ 75-80% 1RM), had no effect ($p = 0.07$) on improving the speed (30 m sprint test) in football players during the experimental procedure (similar to Silva et al., 2015).

Table No. 4 Friedman test (Non-parametric Anova- repeated measures) for speed test (30 m)

	Friedman's Test				
	30м	Alpha	Q-stat	df	p-value
30м	G 1	0.05	5.2	2	0.07
	G 2	0.05	8.4	2	***0.01***
	G 3	0.05	9.00	2	***0.01***
Jump	G 1	0.05	9.33	2	***0.01***
	G 2	0.05	7.60	2	***0.02***
	G 3	0.05	9.58	2	***0.01***

Table no. 5 Post hoc test for a 30 m and Jump test (Control test performed after 6 trainings. Final test performed after a total of 9 exercises)

FRIEDMAN-NEMENYI / Q TEST		*G 2 [30м]*			*G 3 [30м]*			*G 1 [jump]*			*G 2 [jump]*			*G 3 [jump]*		
		R sum	*q-stat*	*p*	*R sum*	*q-stat*	*p*	*R sum*	*q-stat*	*p*	*R sum*	*q-stat*	*p*	*R sum*	*q-stat*	*p*
initial	control	3	1.34	0.61	5.5	2.46	0.19	3	1.34	0.61	***8***	***3.58***	***0.03***	5.5	2.46	0.19
initial	final	***9***	***4.02***	***0.01***	***9.5***	***4.25***	***0.01***	***9***	***4.02***	***0.01***	7	3.13	0.07	***9.5***	***4.25***	***0.01***
control	final	6	2.68	0.14	4	1.79	0.42	6	2.68	0.14	1	0.45	0.95	4	1.79	0.42

While in both groups, G2 group (speed + plyometrics) and G3 (strength + speed + plyometrics), 9 training sessions were sufficient to significantly improve the speed (Post Hoc, p = 0.01, Table no. 5). The lack of effect of strength exercises (G1) on speed scores could be due to the insufficient stimulus. However, it is also probably necessary to train similar structure exercises cyclic movements = running to improve the sprint (Morin at all, 2015).

Implemented concurrent training sessions did a positive transformation of explosive strength within the 3 groups.

After only 6 training sessions for speed + plyometrics significant transformation of explosive strength, in the G2 group, was observed (Post Hoc, p = 0.03). Therefore, training with a combination of speed and plyometric exercises can be recommended, which in a short period of 3-4 weeks and a total of 6 supplemental training sessions, will have an effect on the speed of football players.

The training of strength (G1) and strength + speed + plyometrics (G3) had a significant transformation on explosive strength after 9 supplemental training sessions (for both groups, the Post hoc test is p = 0.01), similar to the findings of Marques et all (2013).

Regarding the energy supplied for fast/power movements, (CP) and CNS-dependent mechanisms (Wenzel & Perfetto, 1992) one of the ideas in this research was if the power trainings (for maximal strength) will provoke significant change in manifestation of fast movements (speed).

However, the question is whether the biomechanical structure of the movements in the exercises and the test should be similar. Probably the specificity or similar structure of movements and bioenergetics during training and testing (Knudson, 2007; Bompa & Buzschelli, 2019; Zatsiorsky et al., 2020) have a significant role in setting training sessions and the selection of representative tests. If there is similarity in movements, human adaptability as a dynamic system (Hristovski et al., 2011; Balague et al., 2013; Araújo et al., 2019) will be more efficient, most likely as an effect of CNS neuroplasticity (Fields, 2015), in particular in such abilities that are dependent on the organizational structure of motor abilities.

Graph No. 1 whisker box plot 30m + Jump test

The general picture of the effect of this type of training sessions in the experimental program of 6 weeks, between the three groups, showed that the transformation of strength and speed of football players, in both tests (after 6 and 9 training sessions) has the same effect. There is no statistically significant difference between the groups, in the testing (initial / control), in both tests Table No. 6.

Table no. 6 Kruskal-Wallis Anova (between groups) - Jump test

test	*G1 vs G2 vs G3*	H-stat	H-ties	df	p-value	alpha	sig
30m	initial	1.14	1.14	2	0.57	0.05	no
	control	2.44	2.45	2	0.29	0.05	no
	final	2.58	2.58	2	0.28	0.05	no
Jump	initial	0.01	0.02	2	0.99	0.05	no
	control	2.24	2.24	2	0.33	0.05	no
	final	0.00	0.01	2	1.00	0.05	no

Conclusion

Positive transformation of explosive strength (in competitive season) was observed after 5 weeks of 9 supplemental traditional strength trainings (G1) and 9 supplemental contrast methods trainings (supersets of strength/ or plyometrics + strength/ or plyometrics and strength + speed exercises-G3).

Traditional (training) sets, where a combination of speed and plyometric exercises were performed (G2) within a similar group of participants, had an effect on the positive transformation of explosive strength after 6 training sessions (3 weeks). The amount of only 3 additional speeds + plyometric training (performed in 2 weeks, for that combination of speed and plyometric exercises) was insufficient to make a positive transformation on explosive strength.

Regarding the speed improvement, the traditional strength training (G1), had no significant effect at all on the speed ability, according to this research. On the other hand, 9 trainings of the traditional training of speed + plyometric exercises (G2) and contrast methods (supersets of strength/ or plyometrics + strength/ or plyometrics and strength + speed exercises-G3) had a positive effect on speed in football players.

When selecting exercises, such strength/power training programs should incorporate a significant number of exercises targeting the efficiency of stretch-shortening-cycle activities and soccer-specific strength-based actions (Silva et al., 2015). The training for plyometrics, as well as the contrast method (superset of different speed + plyometrics combination) should meet this stretch-shortening-cycle principle. Therefore, combined resistance and running-speed supplemental training is recommended for improved performance of soccer players, rather than only the conventional resistance training (Kotzamanidis et al., 2005). Accordingly, similar to the recommendations of Christos et al., 2005, a training combination of both abilities is recommended (speed + strength), which is more efficient and aims to create good adaptation in football players.

Furthermore, the important point is that, regarding choosing the correct exercises, the training dosage should be individual and in correlation with age and fitness of football players (Rodríguez-Rosell et al., 2017).

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