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ORIGINAL ARTICLE

Investigation of The Effect of Concurrent Training Strength and Endurance Training on Physical, Physiological and Psychological Parameters in Young Football Players

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ABSTRACT

Background: Football is a versatile team sport that requires a range of physical characteristics, including flexibility, power, strength, endurance, speed, repetitive sprinting, quickness-agility and technique-tactics. Developing all these features at the same time, especially in the pre-season, when players are in a deconditioning state, returning to training after a rest period; it is quite difficult for coaches and performance trainers.

Aim: The aim of this study is to examine the effects of strength and endurance training applied simultaneously on some physical, physiological and psychological parameters in young football players.

Methods: U19 age group players were included in the research group, 24 male football players who played amateur or professionally licensed football for at least 5 years and trained for an average of 2 hours a day, 5 days a week; (Endurance+Strength Group n=12, Strength+Endurance Group n=12). In the study, 1 RM strength test, agility, speed, technique, decision-making skills and endurance tests were taken from the participants. In our study, with the pretest-posttest measurement method; Yo-Yo test, Loughborough Soccer Passing Test (LSPT), Illinois Agility Test, 30 meters Speed Test, Maximal (1RM) Strength Test, Jumping Test (CMJ) were applied.

Results: The findings obtained when the performance values of football players within and between groups were evaluated statistically; It has been determined that the positive increase in endurance, strength, sprint, agility/speediness, jump and lspt pass test values as a percentage (%) was seen in the group that applied strength training before endurance training.

Conclusion: The application of strength training before endurance training in 'concurrent' training model applications in young football players; on performance values; It has been determined that endurance training has more effect than applying it before strength training. According to these results, it is thought that designing the programs by taking this situation into consideration in the training program adjustments can contribute more to the coaches and the player group in terms of sportive efficiency.

Keywords: Football, concurrent, strength, endurance, LSPT.

INTRODUCTION

Football is a versatile team sport that requires a range of physical characteristics, including flexibility, power, strength, endurance, speed, repetitive sprinting, quickness-agility and technique-tactics. Developing all these features at the same time, especially in the pre-season, when players are in a deconditioning state, returning to training after a rest period; it is quite difficult for coaches and performance trainers (Bangsbo J., 2003; Mujika I; 2009).

Although the most basic motoric feature that needs to be developed in football players seems to be endurance, it is very important to have a high level of strength, speed, coordination, flexibility, anaerobic power and technical/tactical features. For this reason, it is aimed to develop many features concurrently within short-term training periods in today's football (Aslan, 2012). With the gradual increase in the speed-intensity of the game in modern football and the change in the physiological requirements in training practices, maximum performance in footballers can only be achieved when the stimuli given in the training reach the real match values. In this sense, narrow field games have recently been the most preferred training activities due to their compatibility with the real match format and the intermittent game structure of football. While narrow field games provide the players with motivational power due to the high number of contact with the ball and the struggle with the opponent; Since the number of players and the playing area are limited, it does not allow the players to hide in the game and it is ensured that they reach the expected physical values (Eniseler, 2018).

Concurrent training is a popular training strategy, called strength and endurance training in a training unit, and applied to improve various aspects of physiological abilities in most sports branches (Balabinis et al., 2003; Wong et al., 2010).

Elite athletes often combine maximum muscle strength and endurance training in the same workout. This training arrangement is defined as "concurrent training" (Fyfe et al., 2014).

Athletes need high levels of aerobic and anaerobic capacity and the ability to be strong in match-specific movements (such as jumping, fighting and acceleration) in order to be competitive (Mhor et al., 2003; Wisloff et al., 2004).

The available training time for football players is often limited due to the competitive schedule where players play more than 40 games per season, and these matches are often held 2-3 times a week during busy fixtures (Morgans et al., 2014).

Considering the difficulty of training program arrangement, it is an excellent training method for team sports athletes, especially elite football players, who need various fitness components (aerobic capacity, repeated

sprint ability, maximum muscle strength and (or) explosive power) (Bangsbo, 2006). Therefore, these athletes routinely apply concurrent training models consisting of low-repetition-maximum-intensity strength training that maintains and develops aerobic fitness, maximum muscle strength, and explosive power using high-intensity soccer-specific conditioning games and drills (Little and Williams, 2006). (Wisloff et al. 1998; Hoff et al. 2004).

Apart from the usual training practices in the training plans of Turkish league football players, concurrent training programs can also be included in the training. It may also be important in this context to understand the physical and physiological responses to concurrent training modeling applied in sports branches where many physical performance parameters are used. Thus, it will guide in understanding how to prescribe a concurrent training program that can yield more effective results. With this in mind, the aim of our work is; The aim of this study is to examine the effects of strength and endurance training applied concurrently on some physical, physiological and psychological parameters in young football players.

According to the literature review, no study examining the effects of concurrent training specific to football has been found in Turkish football leagues. This situation reveals the importance of our research subject in terms of the originality of our study.

MATERIAL & METHODS

Participants: U19 age group players were included in the research group, 24 male football players who played amateur or professionally licensed football for at least 5 years and trained for an average of 2 hours a day, 5 days a week; (Endurance+Strength Group n=12, Strength+Endurance Group n=12). The ethics committee approval for the study was received from Marmara University, Institute of Health Sciences, Compliant with the Principles of the Declaration of Helsinki.

Tests Protocols: *Yo-Yo Intermittent Recovery Test (Level 1):* With Yo-Yo Intermittent Recovery tests, it is possible to obtain information about the capacity of the athletes in a short time and has a higher performance validity during competition compared to laboratory tests (Bangsbo et al., 2006). Yo-Yo Intermittent Recovery tests were developed as a field test to measure the performance of players competing in team or individual sports (Sproule et al., 1993). This test; It is a test in which the speed increases regularly. The test consists of a track with 20-meter round trips, at the end of each round-trip there is a 5+5-meter recovery section where the athletes actively rest. If the athlete does not reach the finish line on time twice, the test is considered finished and the distance traveled by the athlete is evaluated as the Yo-Yo Intermittent Recovery Test (YIRT) performance. In the first level of this test, there are a total of 4 arrivals and departures and the speed is 10-13 km/h; At level 2, there are 7 arrivals and departures and the speed is 13.5-14 km/h; the next levels consist of 8 arrivals and departures and 0.5 km / h speed increase, this increase continued until the athlete was exhausted or until two mistakes were made in a row (Krustrup et al., 2006).

Loughborough Soccer Passing Testi (LSPT): An area is drawn as in the picture. There are 3 coaches, one coaching warnings and keeping time, one coach following the athlete, and one coach following the strokes. A random 16 color command is given and they are asked to pass with the center of the rust walls as soon as possible. Various evaluations are made and points are given (BenOunis et al., 2013).

LSPT (Loughborough Soccer Passing Test) Short Pass Test Evaluation Rules: After the test is completed, the test performance time is calculated according to the following data;

- 5s - Completely bypassing the passing wall or passing a pass to the wrong target,
- 3s - Missing the target area (0.6 × 0.3m),
- 3sec – touching the ball by hand,
- 2s - Passing the ball outside the specified area,
- 2s - Ball touches any cone,
- 1sec – For each second taken over 43 seconds allocated to complete the test,
- 1s (bonus) – Deducted from the total time if the 10cm band in the center of the target is hit.

Three performance indexes are then calculated:

- Time required to complete 16 passes (LSPT time: LSPT Time);
- Penalties committed by each player during the execution of the test (LSPT penalties: LSPT Penalty);
- Total performance (LSPT Total performance: LSPT Total Performance), which includes the time required to complete the test after adjustments for penalties and/or bonuses (BenOunis et al., 2013).

In addition, Barbara C. H. Huijgen et al. used the following formula as an evaluation index in a different study they conducted and provided the opportunity to evaluate according to age.

LPST Rust Test Application Time = 86.40 – (5.05 x age) + (0.14 x (age x age))

LPST Pass Test Performance Time = 175.54 – (14.61 x age) + (0.42 x (age x age)) (Huijgen et al., 2013).

If we give an example according to the formula, the expected total application time for the age of 15 is 42.2 seconds, and the expected performance time is 50.9 seconds with the addition and subtraction of the rewards and punishments.

Positive Acceleration (30m Sprint): This test track is 30 meters long. By placing a photocell at every 5 meters, the speed changes made by the player at the speed of 30 meters are recorded. The result made in the first 5 meters is taken as the sprint speed, and the result in the 10 meters is taken as the sprint speed. NewTest PowerTimer 300 photocell device was used for speed measurements.

Maximal (1RM)Strength Test: Aim; The single repetition maximum (1RM) strength test measures the maximum strength of muscle groups engaged during a single specified movement.

Outputs; maximum amount of weight lifted for a single repetition (called absolute strength), maximum force relative to body weight (called relative force).

Jump Test (Countermovement Jump Test / CMJ): The counter motion jump test (CMJ) is a simple, practical, valid and very reliable method used to measure lower extremity strength. It's not surprising, therefore, that it's a core test for many strength/conditioning trainers and sports scientists. The CMJ has been shown to be the most reliable test for measuring lower extremity strength compared to other

jump tests. In addition, CMJ test results; It has been shown to be related to sprint performances, 1RM maximum strength and explosive force tests. This shows that performances in CMJ are associated with maximum speed, maximum power and explosive power (Klavora, 2000).

In the CMJ test, when performed using arm swing, performances may be ≥ 10% higher than without arm swing. Contact mats, force platforms, accelerometers, high-speed cameras, and infrared platforms have all been shown to provide a valid and reliable measure of CMJ performance; however, force platforms are considered the 'gold standard' (Klavora, 2000).

When the testing apparatus is ready (eg strength platform), the athlete then moves onto the platform. When instructed by the test administrator, the athlete must jump as high as possible and try to land on the same platform from which they were taking off. In order for the performance averages to be calculated, the athlete must do at least three jumps (Klavora, 2000).

Illinois Agility Test: This test track; It consists of three cones, 10 m in length, 5 m in width, and 3.3 m in the middle, arranged in a straight line (Image: 10). It is a test consisting of 20 m of slalom between cones and 40 m of straight running, which includes 180º turns every 10 m. After the Illinois Test is set up, a two-door and photocell electronic stopwatch is placed at the start and end, with an accuracy of 0.01 seconds. Before the test, necessary explanations and the course are introduced to the test takers, and then they are allowed to practice at low tempo for 3-4 attempts. Before starting the test phase, the subjects are warmed up and stretched for 5-6 minutes. During the test, at the beginning of the track, the person who will take the test is lying on their face and their hands are in contact with the ground, and they are brought to shoulder level. Test completion times are recorded in seconds. The test is repeated 2 times. Full rest is given between repetitions and the good value is recorded (Hazır, Mahir, & Açıkada, 2010).

Data processing: In this study, pretest-posttest model was used. The pre- and post-tests of the football players participating in our research were carried out with an interval of two months (8 weeks) on the same day and time of the week (10:00-16:00). On the day of the tests, the players were asked not to participate in any activity, to eat at least 2-3 hours before the exercises and to be in a rested state.

Pre-tests of our study were applied in 2 days. Anthropometric measurements, 1 RM strength test, agility and speed tests were taken from all participants on the first test day. On the second day, LSPT rust test (technique/decision making ability), splash test and Yo-Yo test (durability) measurements were taken. For endurance measurements, the players were divided into 2 groups of 12 people. The players divided into groups participated in the test in turn. Before the tests, the players performed 10 minutes of jogging (8 km/h) followed by 5 minutes of dynamic warm-up and stretching exercises.

In this study; *The data obtained as a result of the research were evaluated with the SPSS (IBM corp. version 19.0.0.0) statistical program.

Since the sample size in our study was less than 30 people, «Non-Parametric» tests were used.

- Descriptive statistical methods such as mean and standard deviation were used.
- Wilcoxon Signed Ranks Test was used to evaluate the pre-test and post-test within the group.
- Pre-test and post-test evaluation between groups was made using Mann Whitney U Test.

Spearman correlation analyzes were also performed between parameters. Confidence interval was accepted as 95% and significance value as $p<0.05$. In this study, effect size (EB) analysis was used to provide information about the effect sizes of the applied training and the Cohen d score (Cohen, 1988) was determined. For this purpose, in our research EB; It was determined by the formula recommended for use in pre-test and post-test models in strength and conditioning studies (Rhea, 2004).

- Pretest-Posttest ES= (Posttest average-Pretest average) / (Pretest average SD)*

Power analysis was performed using the G*Power (3.1.9.2) program to determine the number of samples. The power of the study is expressed as 1-β (β = probability of type II error). Based on the total score values obtained from the cmj test in Wong's (2009) research (Control group: 63.5±1.1 points, Experimental group: 66±1.4 points) to obtain 95% power at the α=0.05 level The effect size (d) was found to be 1,785 in the calculation made for Accordingly, it was determined that there should be at least 8 people in each group.

Training Plan: Players are divided into 2 groups on simultaneous training days (Monday-Wednesday-Friday); First group performed soccer-specific endurance (narrow field games; 6v6, 4v2, 3v3, etc…) training and then strength training; The second group first applied strength training and then soccer specific endurance (narrow field games) training. In order not to affect the data to be obtained from the study; The players only did 11v11 tactical training after a 15-minute warm-up as a team on Tuesday and Thursday. During the study period, players were not allowed to do extra-isolated workouts that could affect the research data.

RESULTS

Endurance (Distance Covered (m), MaxVo2): In the in-group and between-group evaluations of the S+E group; distance traveled (m) (K+D 25.95% - E+S 22.58%) and MaxVo2 performance values (S+E 12.58 - E+S 10.12%) statistically significant ($p<0.05$) and showed more improvement in percentage.

Strength (1RM): In the in-group and between-group evaluations of the S+E group; Leg Curl (S+E 23.07% - E+S 14.69%) and Leg Press performance values (S+E 36.3% - E+S 11.4%) were both statistically significant compared to the E+S group. ($p<0.05$) and showed more improvement in percentage.

Jump Test (Countermovement Jump Test / CMJ): In the in-group and between-group evaluations of the S+E group; CMJ jump (S+E 7.5% - E+S 2.15%) performance values were both statistically significant ($p<0.05$) and showed a higher percentage improvement compared to the E+S group.

Illinois Agility Test (sec): In the in-group and between-group evaluations of the S+E group; Illinois agility (with the ball S+E 5.4% - E+S 2.08% and without the ball; S+E

2.31% - E+S 0.19%) performance values were both statistically significant compared to the E+S group. ($p<0.05$) and showed more improvement in percentage.

LSPT (Loughborough Soccer Passing Test) (sec): In the in-group and between-group evaluations of the S+E group; LSPT (S+E 11.48% - E+S 5.02%) test performance values were both statistically significant ($p<0.05$) and showed a higher percentage improvement compared to the E+S group.

30m Sprint Test (sec): In the in-group and between-group evaluations of the S+E group; The performance values of 30 m sprint (S+E 7.12% - E+S 5.9%) were both statistically significant ($p<0.05$) and showed a higher percentage improvement compared to the E+S group.

Table 1: Demographic characteristics of football players

DEMOGRAPHIC FEATURES										
	Strength + Endurance (n=12)				Endurance + Strength (n=12)					
VARIABLES	Min.	Max.	Ort.	SS	Min.	Max.	Ort.	SS	z	ap
Age (year)	17,97	20,06	18,82	0,65	18,16	20,32	19,03	0,6	-0,808	0,419
Height (cm)	1,7	1,91	1,79	0,06	1,66	1,87	1,78	0,06	-0,493	0,622
Weight (kg)	64,5	8282,4	72,49	5,47	62,3	80	72,7	5,73	-0,577	0,564
BMI (kg/m^2)	21	23	22,66	0,65	22	24	23	0,85	-0,891	0,373
Fat(%)	9,4	13,7	11,51	1,38	10,1	13,8	11,88	1,27	-0,752	0,452
Training Age (year)	10	12	10,75	0,86	9	12	10,66	1,07	-0,282	0,778
aMann Whitney U Test									**p<0,01 *p<0,05	

Table 2: Averages and statistics of the pre-post test result for the players.

	Strength + Endurance (n=12				*Endurance + Strength (n=12)*					
YoYo (m)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	1120	2280	1806,66	349,47	1040	2280	1693,33	357,09	-1,245	0,213
Post Test	1560	2640	2250	347,51	1520	2400	2026,66	233,44	-2,031	0,042*
[b]Z	-3,063				-3,063					
[b]p	,002**				,002**					
Difference	240	680	443,33	143,16	80	640	333,33	167,4	-1,39	0,165
Change (%)	11,54	50	25,95	11,37	4	57,14	22,58	16,13		
MaksVO_2	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	40,48	56,7	50,09	4,89	39,36	56,72	48,5	4,99	-1,245	0,213
Post Test	46,64	61,76	56,3	4,86	46,08	58,4	53,17	3,26	-2,031	0,042*
[b]Z	-3,06				-3,06					
[b]p	,002**				,002**					
Difference	3,36	9,52	6,2	2	1,12	8,96	4,66	2,34	-1,39	0,165
Change (%)	6,23	19,4	12,58	4,51	2,12	22,13	10,12	5,96		
Leg Curl (kg)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	65	87	70,91	6,84	60	74	67,91	4,73	-1,105	0,269
Post Test	82	96	86,91	4,29	69	87	77,83	5,98	-3,182	0,001**
[b]Z	-3,063				-3,063					
[b]p	,002**				,002**					
Difference	9	22	15,91	3,52	5	17	10,08	3,89	-2,982	0,003**
Change (%)	10,34	33,85	23,07	6,46	7,81	28,33	14,69	6,16		
Leg Press (kg)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	180	293	233,33	32,74	180	262	209	27,07	-1,765	0,078
Post Test	290	338	312,83	13,76	206	296	232,83	33,43	-4,002	0,001**
[b]Z	-3,059				-3,063					
[b]p	,002**				,002**					
Difference	18	125	79,83	31,81	15	125	48,83	32,32	-2,168	0,030*
Change (%)	5,8	69,4	36,3	18,47	1,48	23,33	11,42	6,41		
30m (sn)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	3,79	4,78	4,25	0,3	3,96	4,77	4,36	0,23	-1,184	0,236
Post Test	3,24	4,71	3,95	0,37	3,9	4,6	4,1	0,23	-1,823	0,068
[b]Z	-3,063				-2,741					
[b]p	,002**				,006**					
Difference	-0,55	0,004	-0,3	0,16	-0,61	0,1	-0,26	0,22	-0,289	0,772
Change (%)	-14,51	-0,84	-7,12	4,13	-13,5	2,53	-5,9	5,07		
LSPT (sn)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	41	62	46,75	7,05	40	58	45,33	6,18	-0,785	0,433
Post Test	36	57	41,41	6,82	38	55	43	5,52	-1,686	0,092
[b]Z	-3,071				-3,081					
[b]p	,002**				,002**					
Difference	-8	-3	-5,33	1,66	-5	-1	-2,33	1,3	-3,533	0,001**
Change (%)	-18,18	-7,14	-11,48	3,6	-10,42	-2,33	-5,02	2,53		

CMJ HF(cm)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	36	55,64	47,38	5,1	35,33	57,65	43,89	7,09	-1,79	0,073
Post Test	43	57,3	50,77	4,2	35,44	58,8	44,83	7,2	-2,367	0,018*
[b]Z	-3,059				-3,061					
[b]p	,002**				,002**					
Difference	1,48	4,52	3,06	0,92	0,11	2,8	0,94	0,73	-3,927	0,001**
Change (%)	2,87	19,44	7,5	4,46	0,31	6,51	2,15	1,69		
CMJ (cm)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Pre Test	31,66	49,19	38,45	5,06	31,48	43,65	34,99	3,86	-2,137	0,033*
Post Test	38,44	53,21	42,34	4,25	34,12	44,56	38,04	3,21	-2,771	0,006*
[b]Z	-3,059				-3,059					
[b]p	,002**				,002**					
Difference	1,34	8,14	3,89	2,22	0,51	6,64	3,05	1,92	-0,722	0,47
Change (%)	3,61	25,71	10,73	7,36	1,51	20,75	9,09	5,98		
Illionis WB(sn)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Ön Test	18,49	25,37	20,25	2,15	18,58	23,79	20,79	1,34	-1,761	0,078
Son Test	17,1	24,55	19,15	1,98	17,89	23,18	20,36	1,49	-2,309	0,021*
[b]Z	-3,059				-1,963					
[b]p	,002**				,050*					
Fark	-2,5	-0,28	-1,13	0,57	-1,11	0,37	-0,34	0,5	-2,829	0,005**
Değişim (%)	-10,51	-0,79	-5,4	2,71	-10,1	1,88	-2,08	3,33		
Illionis (sn)	Min.	Max	Avg.	Sd.	Min.	Max.	Avg.	Sd.	[a]Z	[a]p
Ön Test	14,68	18,2	15,6	1,01	14,84	16,87	15,66	0,54	-1,561	0,119
Son Test	14,2	17,69	15,24	0,99	15	16,49	15,62	0,45	-2,6	0,009*
[b]Z	-3,062				-0,629					
[b]p	,002**				0,529					
Fark	-1,06	-0,13	-0,36	0,24	-0,38	0,25	-0,03	0,17	-3,295	0,001**
Değişim (%)	-6,95	-0,87	-2,31	1,57	-2,25	1,6	-0,19	1,08		

aMann Whitney U Test **p<0,01 *p<0,05

DISCUSSION

In an 8-week study, as a result of concurrently maximal strength and high-intensity endurance training in addition to football training; The results obtained in high-level professional football players (who took part in the UEFA European Cups in their last season) were similar to the results obtained from the player group with a lower performance level (control group). Test results for VO2max and 1RM Squat after training intervention were equivalent to the highest values reported in the literature. Therefore, maximal strength and aerobic endurance training can be successfully applied concurrently in the pre-season training program for top-level football teams (Helgerud et al., 2001).

What is important in concurrent training is that for the workout to be considered high-intensity (HIIT), the intensities must be more than 80% of the maximal heart rate, 100% of the lactate threshold, or 90% of the VO2max, with sprinting exercises as the upper limit. (Wong et al., 2010; Berryman et al., 2019).

The strong effect of concurrent training was mostly seen in adolescent endurance athletes. Preliminary findings from the meta-analysis show that concurrent training improves lower extremity body strength more than strength training performed alone (Gabler, et al., 2018).

World Health Organization; adolescent period between the ages of 10-19, Young people between the ages of 15-24; defined the age of 10-24 as the youth period (WHO). Many factors, such as training method and intensity, muscle groups studied (upper or lower body), and characteristics of the researched groups (elite athletes or sedentary/sedentary, young or old), individual differences can affect the results of concurrent strength and endurance training outcomes (Docherty and Sporer, 2000; Fyfe, Bishop, & Stepto, 2014; Gergley, 2009).

CONCLUSION

As a result, the application of strength training before endurance training in 'concurrent' training model applications in young football players; on performance values; It has been determined that endurance training has more effect than applying it before strength training. According to these results, it is thought that designing the programs by taking this situation into consideration in the training program adjustments can contribute more to the coaches and the player group in terms of sportive efficiency.

REFERENCES

1. Aktaş, S. (2013). The effect of different recovery times on some physiological parameters in 3 by 3 narrow field games in football *(Doctoral dissertation, Selcuk University Health Sciences Institute).*
2. Aslan, C. S. (2012). *Comparison of the Effects of Narrow Field Games and Interval Running Training Methods on Selected Physical Physiological and Technical Capacities of Football Players (Doctoral dissertation, PhD Thesis, Ankara (Advisor: Prof. Dr. G. Ersöz).*
3. Balabinis, C. P., Psarakis, C. H., Moukas, M., Vassiliou, M. P., & Behrakis, P. K. (2003). Early phase changes by concurrent endurance and strength training. *Journal of Strength and Conditioning Research*, *17*(2), 393-401.
4. Balabinis, C. P., Psarakis, C. H., Moukas, M., Vassiliou, M. P., & Behrakis, P. K. (2003). Early phase changes by concurrent endurance and strength training. *Journal of Strength and Conditioning Research*, *17*(2), 393-401.
5. Bangsbo, J. (1994). *Fitness training in football: a scientific approach*. August Krogh Inst., University of Copenhagen.
6. Cometti, G., Maffiuletti, N. A., Pousson, M., Chatard, J. C., & Maffulli, N. (2001). Isokinetic strength and anaerobic power of elite, subelite and amateur French soccer

players. *International journal of sports medicine*, *22*(01), 45-51.
7. Fyfe, J. J., Bishop, D. J., & Stepto, N. K. (2014). Interference between concurrent resistance and endurance exercise: molecular bases and the role of individual training variables. *Sports medicine*, *44*(6), 743-762.
8. Gäbler, M., Prieske, O., Hortobágyi, T., & Granacher, U. (2018). The effects of concurrent strength and endurance training on physical fitness and athletic performance in youth: a systematic review and meta-analysis. *Frontiers in physiology*, *9*, 1057.
9. Helgerud, J., Engen, L. C., Wisløff, U., & Hoff, J. (2001). Aerobic endurance training improves soccer performance. *Medicine & Science in Sports & Exercise*, *33*(11), 1925-1931.
10. Hickson, R. C. (1980). Interference of strength development by concurrent training for strength and endurance. *European journal of applied physiology and occupational physiology*, *45*(2-3), 255-263.
11. Hoff, J., & Helgerud, J. (2004). Endurance and strength training for soccer players. *Sports medicine*, *34*(3), 165-180.
12. Little, T. (2009). Optimizing the use of soccer drills for physiological development. *Strength & Conditioning Journal*, *31*(3), 67-74.
13. Little, T., & Williams, A. G. (2007). Measures of exercise intensity during soccer training drills with professional soccer players. *The Journal of Strength & Conditioning Research*, *21*(2), 367-371.
14. Little, T., & Williams, A. G. (2006). Suitability of soccer training drills for endurance training. *Journal of strength and conditioning research*, *20*(2), 316-319.
15. Little, T., & Williams, A. G. (2007). Measures of exercise intensity during soccer training drills with professional soccer players. *The Journal of Strength & Conditioning Research*, *21*(2), 367-371.
16. Owen, A. L., Wong, D. P., Paul, D., & Dellal, A. (2012). Effects of a periodized small-sided game training intervention on physical performance in elite professional soccer. *The Journal of Strength & Conditioning Research*, *26*(10), 2748-2754.
17. Sousa, A. C., Neiva, H. P., Izquierdo, M., Alves, A. R., Duarte-Mendes, P., Ramalho, A. G., ... & Marinho, D. A. (2020). Concurrent Training Intensities: A Practical Approach for Program Design. *Strength & Conditioning Journal*, *42*(2), 38-44.
18. Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of sports sciences*, *21*(7), 519-528.
19. Wisløff, U., Castagna, C., Helgerud, J., Jones, R., & Hoff, J. (2004). Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. *British journal of sports medicine*, *38*(3), 285-288.
20. Wong, P. L., Chaouachi, A., Chamari, K., Dellal, A., & Wisloff, U. (2010). Effect of preseason concurrent muscular strength and high-intensity interval training in professional soccer players. *The Journal of Strength & Conditioning Research*, *24*(3),653-660.