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THE EFFECTS OF DOUBLE-PYRAMID RESISTANCE AND PYRAMID SPEED TRAINING ON SOME PHYSIOLOGICAL ADAPTATIONS OF YOUNG ELITE FOOTBALL PLAYERS

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ABSTRACT

This study aimed to investigate the effects of the double-pyramid resistance training (DPRT) and the pyramid speed training (PST) on some physiological adaptations of Young elite football players. 30 football players (age 18.31 ± 2.5 years; height 177.2±4.6 cm; weight 74.25 Kg and BF% 14.60±5.03) were randomly divided into three groups of DPRT (n=10), PST (n=10) and control (n=10). The subjects trained for 40 minutes, 3 sessions a week, 8 weeks using two exercise patterns. After assurance the normal data distribution (Kolmogorov-Smirnov test), MANCOVA test and sidak post-hoc test showed significant improvement in body weight, BMI, body fat mass, muscular strength of the lower body, peak power and, average power for DPRT compare to PST and control groups ($p \le 0.05$). On the other hand, the PST group was found to have significantly better results in 30 meters running record, 400 meters running time and, sprint drop compared to the DPRT and control groups ($p \le 0.05$). Muscular endurance and flexibility make more improvements by DPRT and PST compare to control group ($p \le 0.05$). In conclusion, it seems that both training models were suitable for increasing Physiological variables, although the DPRT probably improves the muscular strength and hypertrophy, while PST can be more effective in improvement of the sprint variables of Young elite football players

Key words: Resistance training. Hypertrophy. Sprint variables. Young elite football players.

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RESUMO

Os efeitos da resistência da pirâmide dupla e do treinamento de velocidade da pirâmide em algumas adaptações fisiológicas de jovens jogadores de futebol de elite

Este estudo teve como objetivo investigar os efeitos do treinamento resistido em pirâmide dupla (DPRT) e do treinamento de velocidade em pirâmide (PST) sobre algumas adaptações fisiológicas de jovens jogadores de futebol de elite. 30 jogadores de futebol (idade 18,31 ±2,5 anos; estatura 177,2 ±4,6 cm; peso 74,25 kg e% GC 14,60 ±5,03) foram divididos aleatoriamente em três grupos de DPRT (n=10), PST (n=10) e controle (n=10). Os sujeitos treinaram por 40 minutos, 3 sessões por semana, 8 semanas usando dois padrões de exercício. Após a garantia da distribuição normal dos dados (teste de Kolmogorov-Smirnov), o teste MANCOVA e o teste sidak post-hoc mostraram melhora significativa no peso corporal, IMC, massa de gordura corporal, força muscular da parte inferior do corpo, potência de pico e potência média para DPRT comparar para PST e grupos de controle ($p \le 0,05$). Por outro lado, o grupo PST apresentou resultados significativamente melhores no recorde de corrida de 30 metros, tempo de corrida de 400 metros e queda do sprint em comparação aos grupos DPRT e controle ($p \le 0,05$). A resistência muscular e flexibilidade fazem mais melhorias por DPRT e PST em comparação com o grupo de controle ($p \le 0,05$). Em conclusão, parece que ambos os modelos de treinamento foram adequados para aumentar as variáveis fisiológicas, embora o DPRT provavelmente melhore a força muscular e a hipertrofia, enquanto o PST pode ser mais eficaz na melhoria das variáveis de sprint de jovens jogadores de futebol de elite.

Palavras-chave: Treinamento de resistência. Hipertrofia. Variáveis de sprint. Jovens jogadores de futebol de elite.

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INTRODUCTION

Today all available evidences show that football is the most popular sport in the international arena (Silva et al., 2008). Development in the level of physical fitness for the competition is the main aim of any conditioning programs for elite football player(Mohammadi et al., 2013).

Additionally, the programming of these competitions do not always match the best periodization plan and may need a modified training program to reach a high level of competitive fitness in a short-time structure (Bompa, Buzzichelli, 2015, McCarthy, 1991).

In these cases, double-pyramid resistance training (DPRT) and pyramid speed training (PST) can be considered. Pyramid training systems are widely known and are often utilized in resistance training programs (Blanchard, 2006).

DPRT combines the ascending and descending approaches, starting light the client builds up to a heavy set, then reverses this to finish with a lighter set (Rahro et al., 2016).

The potential of DPRT and PST to induce quick improvement in performance capacity and skeletal muscle adaptation has been extensively examined. About the DPRT, Nezami et al., (2016) showed that both of simple-pyramid and, flat-pyramid resistance training result in increases the muscle strength and hypertrophy (Nezami et al, 2016).

Hoseini et al., (2012) suggested that double pyramidal resistance training and reverse step had similar results in maximizing muscle strength and hypertrophy. Among young wrestlers, the inverse stepping pattern was more appropriate while the double pyramidal pattern induces more increase in leg strength.

Sprint-interval training has been engaged with several forms of cycling (Rodas et al., 2000) or repeated sprints on a treadmill (Nevill et al., 1989, Sokmen et al., 2018) to examine the effects on physiological adaptations.

Showed that a Sprint-interval training program with short recovery can improve both aerobic and anaerobic performances in trained wrestlers during the preseason phase (Cometti et al., 2001).

The effects of sprint training based on the pyramid method, to our knowledge, have not been examined. A wide range of adaptations have been shown after sprint training, including increased resting glycogen content (barnett et al., 2004), increased activity of various glycolytic and oxidative enzymes (Koral et al., 2018), H^+ buffering capacity (Fashi, 2011), time to exhaustion (Koral et al., 2018, MacInnis et al., 2019) and VO_2max (Han et al., 2017).

Besides, muscle adaptations from resistance training are also important to elite football players.

The extent of these adaptations by pyramid methods can lead to elite football players success. Therefore, this study examined physiological adaptations to double-pyramid resistance and pyramid speed training in young elite football players.

MATERIALS AND METHODS

Subjects

Young elite football players (age 18.31 ±2.5 years; height 177.2±4.6 cm; weight 74.25 Kg and BF% 14.60 ±5.03) with 3-5 years of football-training experience were randomly divided into three groups of DPRT (n=10), PST (n=10) and control (n=10). The participants trained for 40 minutes, 3 sessions a week, 8 weeks using two exercise patterns: DPRT and PST.

Subjects were not involved in any other exercise training and were asked to maintain their routine diet patterns during the study.

After familiarization with the study procedures and protocols, all participants signed informed written consent prior to the evaluation. The study was approved by the University's Research and Ethics Committees.

Procedures

Before and after 8 weeks of DPRT and PST, Body mass was measured and recorded, using a SECA calibrated scale and stadiometer (Seca GmbH & Co. KG, Hamburg).

For evaluation of body fat Percentage, the measurer determined the subcutaneous fat thickness at seven sites (Jackson and Pollock) using skinfold caliper.

The seven sites included the abdominal, chest, thigh, and triceps, subscapular, supra-iliac and midaxillary.

Land-marking was carried out in accordance with the guidelines by the ISAK. A Harpenden SC (Baty International, West Sussex) was used to measure the sites. Each skinfold was measured twice, and the average

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of the two measurements was used in subsequent calculations (mm). Body fat percent was computed through the fórmula developed by (Brozek et al., 1963).

Then the body mass fat was calculated based on the following fórmula:

Body Fat Mass (kg) = Total Body Weight (kg) × Body Fat Percentage
Lean body mass (kg) = Total Body Weight (kg) - Body Fat Mass (kg)

Flexibility by sit and reach test: This test involves sitting on the floor with legs stretched out straight ahead. The soles of the feet are placed flat against the box.

With the palms facing downwards, and the hands on top of each other or side by side, the subject reaches forward along the measuring line as far as possible. After some practice reaches,

the subject reaches out and holds that position for one-two seconds while the distance is recorded.

Strength assessment

Strength calculated in kilograms and the maximum strength was measured using the 1RM test by method. In the case of the back squat, multiple warm-up trials were given prior to actual 1RM testing as modified from (Wilson et al.,1993).

These consisted of 5 repetitions at 30% followed by 2 min rest, 4 repetitions at 50% followed by 2 min rest, 3 repetitions at 70% followed by 3 min rest, 1 repetition at 90% followed by 3 min rest (% are given of subject Estimated 1RM obtained through use of an Epley chart and previous data from the subjects training logs).

From the last warm-up set, loading was increased through subject feedback on the level of repetition intensity so that 1RM was achieved within 3 trials. Four minutes of rest was given between each 1RM effort.

Vertical jump

The subjects performed the Sergeant Jump as a vertical jumping test (Canavan vescovi, 2004). 5 min jogging and 5 min dynamic stretching were applied for warm- up before the test.

By standing by the side of the wall, standing height was marked initially using contrast marking powder with hand vertically extended. 3 trials of Sergeant Jump were performed from a semi-squatting position with the knees flexed to approximately 90° with arm swing allowed and marked again on the wall.

The average difference between standing height and maximum jump height was recorded as verticais jump performance. In addition, peak and average power calculated by the following fórmula:

Peak power (W) = 61.9 (jump height (cm) + 36.0 (body mass (kg) + 1822
Average power (W) = 21.2 (jump height (cm) + 23.0 (body mass (kg) - 1393

30-m running speed test: The speed of the subjects was measured using a 30 m sprint. After the initial warm-up, each subject ran 3 × 30 meters and the best time was considered as 30 m time record (Drozd et al., 2017).

Anaerobic endurance (seconds)

Anaerobic endurance was assessed using the 400-meter drop test .After the initial warm-up the subject ran a distance of 100 meters with maximum power and speed. After a 5-minute rest, the subjects ran a distance of 400 meters. Anaerobic endurance was calculated by the following fórmula:

Anaerobic endurance (seconds) = (400 m (s) ÷4) – 100m (s).

Resistance training program

The resistance training program included 10 minutes of warming-up. The resistance training program consisted of the performance of resistance training (leg press, squat, Leg extension and Leg curl) in a pyramidal pattern. DPRT performed exercises using the double-pyramid program (4×80% ‹ 3×85% ‹2×90% ‹1×95% ‹1×95% ‹2×90% ‹ 3×85% ‹4×80%) (Figure1).

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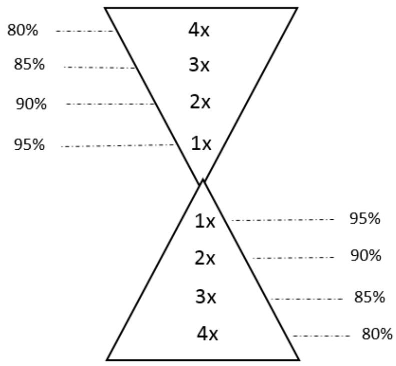

Figure - Schematic representation of Experimental Protocol: Double-pyramid resistance training

Sprint training program

This protocol included 10 minutes of warming up using stretching exercise and afterwards, 6 sets of speed running with all out.

In this regard, first, there were more repetitions with less distance as the process gradually reversed.

The rest time between each set was the walk-back to the starting point (figure2).

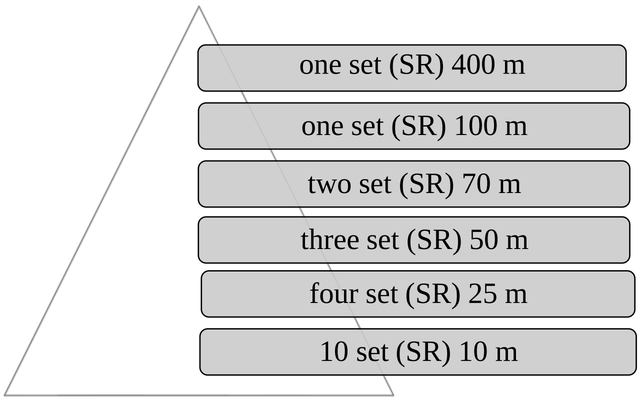

Figure 2 - Schematic representation of Experimental Protocol: pyramid speed training. SR= sprint running.

Statistical analysis

A Kolmogorov-Smirnov test was conducted to confirm a normal distribution of variables. Data were analyzed using The MANCOVA test and the Sidak post-hoc test. Results are expressed as mean ± SD with the α-level for significance set at 5%.

RESULTS

The finding of this study showed significant improvement in body weight, BMI, body fat mass, muscular strength of the lower body, peak power and, average power for DPRT compare to PST and control groups ($p \leq 0.05$).

On the other hand, the PST group was found to have significantly better results in 30 meters running record, 400 meters running time and, sprint drop compared to the DPRT and control groups ($p \leq 0.05$).

Muscular endurance and flexibility make more improvements by DPRT and PST compare to control group ($p \leq 0.05$) (table1).

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Table 1 - Mean ± SD, study variables before and after 8 weeks of double-pyramid resistance training (DPRT) and the pyramid speed training (PST). *Significantly different among groups (p≤0.05).

variables	Pre-test	Post-test	Changes%	groups			Effect Size
				con	DPRT	PST	
Body weight (kg)							
con	74,76±4/22	75.25±4.44	0.06±1.49	-	0.001*	0.130	0.704
DPRT	81.47±6.57	83.94±5.84	3.05±1.40	0.001*	-	0.001*	
PST	76.23±6.27	75.49±6.11	-1.22±0.84	0.130	0.001*	-	
Body Mass Index (BMI)							
con	26.37±1.44	26.36±1.51	-0.06±1.44	-	0.001*	0.166	0.593
DPRT	27.12±1.95	28.58±2.15	3.05±1.40	0.001*	-	0.001*	
PST	26.50±2.66	26.18±2.65	-1.22±0.84	0.166	0.001*	-	
lower body Muscular strength (kg)							
con	83.00±6.32	86.50±6.69	4.73±10.93	-	0.001*	0.702	0.451
DPRT	89.50±7.25	101.00±6.15	13.04±3.52	0.001*	-	0.004*	
PST	83.50±6.26	89.00±5.68	6.71±3.52	0.702	0.004*	-	
lower body Muscular endurance (kg)							
con	20.70±3.62	23.20±3.82	12.30±4.33	-	0.001*	0.008*	0.470
DPRT	19.30±2.26	26.30±2.11	37.49±16.27	0.001*	-	0.452	
PST	20.80±3.91	26.20±3.33	27.86±15.89	0.008*	0.452	-	
Flexibility (%)							
con	35.50±1.15	36.90±1.07	3.97±2.22	-	0.001*	0.001*	0.538
DPRT	35.90±1.07	39.25±1.30	9.38±3.75	0.001*	-	0.560	
PST	36.00±1.08	38.85±1.03	7.94±1.54	0.001*	0.560	-	
Body fat (%)							
con	9.72±0.86	9.69±0.68	-0.21±3.00	-	0.001*	0.012*	0.824
DPRT	10.92±1.29	11.63±1.24	6.71±3.34	0.001*	-	0.001*	
PST	10.65±1.20	10.07±1.01	-5.28±2.80	0.012*	0.001*	-	
Fat mass (kg)							
con	7.39±1.03	7.35±0.81	-0.13±4.02	-	0.001*	0.130	0.867
DPRT	8.96±1.78	9.82±1.77	9.96±3.55	0.001*	-	0.001*	
PST	8.17±1.61	7.63±1.41	-6.43±3.15	0.003*	0.001*	-	
Lean Body Mass (kg)							
con	68.36±4.31	68.40±3.92	0.10±1.32	-	0.002*	0.628	0.493
DPRT	72.50±4.93	74.12±5.27	2.23±1.53	0.002*	-	0.001*	
PST	68.06±4.77	67.66±4.76	-0.58±0.81	0.628	0.001*	-	
Sergeant Jump Test (cm)							
con	37.90±3.00	39.05±2.80	3.10±1.65	-	0.001	0.030	0.678
DPRT	37.45±2.78	44.30±2.52	18.60±6.85	0.001	-	0.001	
PST	39.35±3.69	42.55±4.46	8.12±4.17	0.030	0.001	-	
Peak power (W)							
con	6895.01±267.19	6966.20±237.37	1.05±0.88	-	0.001*	0.201	0.763
DPRT	7072.72±381.91	7586.01±365.66	7.31±2.17	0.001*	-	0.001*	
PST	7002.04±354.60	7166.29±419.52	2.32±1.40	0.201	0.001*	-	
Average power (kg)							
con	1152.73±136.75	1177.11±120.07	2.31±2.76	-	0.001*	0.584	0.786
DPRT	1274.52±199.04	1476.78±195.61	16.35±5.17	0.001*	-	0.001*	
PST	1194.51±178.54	1240.73±199.84	3.78±2.61	0.584	0.001*	-	
30meters speed running (S)							
con	5.17±0.54	4.78±0.59	-7.40±8.86	-	0.701	0.001*	0.413
DPRT	5.33±0.49	4.75±0.39	-10.61±5.73	0.701	-	0.014*	
PST	5.25±0.40	4.26±0.36	-18.88±2.30	0.001*	0.014*	-	
400meters speed running (S)							
con	70.75±4.52	69.43±4.02	-1.79±3.20	-	0.519	0.015*	0.476

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DPRT	74.30±3.20	73.24±3.24	-1.38±3.21	0.519	-	0.001*	
PST	75.14±3.45	68.45±2.99	-8.80±4.40	0.015	0.001*	-	
100meters speed running (S)							
con	12.85±0.49	12.62±0.40	-1.66±3.92	-	0.764	0.761	0.037
DPRT	13.90±0.74	13.22±0.62	-4.75±5.12	0.764	-	0.998	
PST	13.33±0.58	12.99±0.47	-2.44±4.51	0.761	0.998	-	
Anaerobic endurance (S)							
con	4.84±0.98	4.73±0.82	-0.87±13.35	-	0.323	0.010*	0.455
DPRT	4.68±0.33	5.09±0.75	8.79±12.83	0.323	-	0.001*	
PST	5.46±0.77	4.13±0.74	-23.7±12.85	0.010*	0.001*	-	

DISCUSSION

The present study showed that DPRT led to an increase in body weight, BMI, lower body muscle strength, peak power and average power. While PST training is associated with improved in 30 meters running record, 400 meters running time and, anaerobic endurance. This results in agreement with Gettman et al., (1978),Hoseini et al., (2012).

It is due to the special characteristics of the double-pyramid resistance training protocol that induce higher lower body muscle strength that results in better outcomes in the Sergeant Jump test. This improvement can be attributed to the increases in both peak and average power.

The finding of the present study indicated increases in body weight and lean body mass, which can be associated with improved strength and muscle hypertrophy.

It seems that DPRT induces maximal stimulation of all muscle fibers and more muscle damage which is accompanied by the secretion of more growth factors. This ultimately leads to the development of muscle and lean body mass (Schoenfeld, 2010).

Other results of the study showed that the performance times are affected by PST. Several authors have studied the relationship between speed exercises and time performance adaptation. They suggested an important correlation between pyramid speed training and time running performance among athletes (Cometti et al., 2001, Bosquet et al., 2013, Fernandez et al., 2012).

Many adaptations have been shown after sprint training, including increased resting glycogen store (Barnett et al., 2004), increased activity of glycolytic and oxidative enzymes (Koral et al., 2018), buffering capacity (Fashi, 2011).

These changes are in part associated with improved running times. However, the role of neuromuscular adaptation is also important in improving adjustments from speed training (Cometti et al., 2001).

We also found that improvement in flexibility by DPRT. Flexibility is an important component of physical aptitude.

According to the American College of Sports Medicine (Pollock et al., 1998, Behm, 2018), it is one of the essential qualities for acquiring and developing human physical conditioning. Improved flexibility brings certain benefits, e.g. reduced risk of injuries and enhanced athletic performance (Nelson, Bandy, 2005).

It is generally believed that strength training has minimal effects on flexibility (Maclnnis et al., 2019) due to muscle hypertrophy.

However, Muscles are an essential component of flexibility owing to their elastic properties. Performing only resistance training can result in increases in flexibility.

Indicated that hat while a heavy back squat training program is effective in improving strength, it harms the flexibility of the hamstring muscle groups. It seems that there is an interaction between strength and flexibility and athletes should select the appropriate training protocols for maximizing performance.

We also found that improvement in the anaerobic endurance after participation in PST. Speed training is very intensive and should be monitored and increased with caution; otherwise, the performance may be reduced.

One of the most effective methods in this regard seems to be the use of the pyramid method. The present study showed that pyramid-based speed training can be effective in improving running performance time, anaerobic endurance and sprint downfall.

In this study, peak and average power with DPRT showed a greater increase than PST.

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Given the impact of speed and strength on power, as well as an increase in back Squat strength by DPRT, Increase in power can be attributed to an increase in strength (Slater and Mitchell., 2019). Although, more lean body mass with DPRT is also important in this regard.

Contrary to our hypothesis, the fat percentage by DPRT was higher than PST and control groups. This can in part be due to less fat metabolism.

It seems that DPRT induces more lean body mass associated with increased muscle strength and hypertrophy. PST increase buffering capacity (Fashi, 2011) and oxygen consumption (Han et al., 2017). They also increase fat metabolism.

CONCLUSION

In summary, it can be concluded that both of the double-pyramid resistance and pyramid speed training protocols are appropriated methods for improvement in physiological changes in young elite football players.

Also, it can be excluded that double-pyramid resistance training can have better results in terms of improved muscular adaptation while pyramid speed training can be more effective in the development of speed performance.

However, the combination of pyramid resistance and speed training seems to improve young elite football players performance more than strength and speed training alone.

Future studies examining the effects of strength and speed concurrent training on young elite football players performance are warranted.

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