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THE INFLUENCE OF AN 8-WEEK TRAINING PROGRAM WITH SMALL-SIDED GAMES ON THE ANAEROBIC CAPACITY OF JUNIOR FOOTBALL PLAYERS

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ABSTRACT. Introduction. The level of development of anaerobic capacity at footballers requires the achievement of sporting performance. **Objective.** The study analyses whether the anaerobic capacity is developed as a result of the participation of the athletes in a training program with small-sided football games. **Methods**. A group of 40 athletes aged 16-18 years old were grouped in two equal teams, named: experimental group (EG) and control group (CG). During the period of the study, which was between 5.01.2021 – 27.02. 2021, the two groups were exposed to different training programs: the EG in a small-sided football games training program and the CG in a classic way. The following technology was used: Hosand GT.a – to measure HR – and the WittyGateMicrogate2 system for timing of the stress sample. Subjects took the YYIRTL1 sample. SPSS program, variant 23 was used for statistical analysis of the data. **Results.** The results taken in the initial test (IT) between the two groups had no statistical significance in YYIRTL1 field sample was concerned, but there could be noticed significant differences in the final test (FT) for the parameter indicating the hold time in the anaerobic zone>81%HRmax ($U = 67.50$, $N_1 = 20$, $N_2 = 20$, two-tailed $p = .000336$, $d = 1.46$). **Conclusions.** The study shows that the anaerobic capacity of subjects has developed through the implementation of an 8-week period program where small-sided football games have been used.

Keywords: *small-sided games, anaerobic capacity, maximum heart rate, football*

REZUMAT. ***Influența unui program de antrenamente de 8 săptămâni cu jocuri pe teren redus asupra capacității anaerobe a fotbaliștilor juniori .*** **Introducere.** Nivelul de dezvoltare al capacității anaerobe la fotbaliști condiționează obținerea performanțelor sportive. **Obiectiv.** În acest studiu a fost investigat dacă se dezvoltă capacitatea anaerobă a sportivilor în urma participării la un proces de pregătire care include jocuri de fotbal pe teren redus. **Metode.** Un eșantion format din 40 de sportivi cu vârsta de 16-18 ani, divizat în echipe egale: grupa de experiment (GE) și grupa de control (GC). Pe parcursul

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perioadei de desfășurare a acestui studiu 5.01.2021-27 .02.2021, cele două grupe au participat la antrenamente diferite: GE la antrenamente cu jocuri de fotbal pe teren redus, iar GC la antrenamente care au utilizat exerciții tradiționale. Următoarea tehnologie a fost utilizată: Hosand Gt.a – pentru a măsura FC – și sistemul WittyGateMicrogate2 pentru cronometrarea timpului la proba de efort**.** Subiecții au efectuat proba YYIRTL1. A fost utilizat programul SPSS, varianta 23, pentru analiza statistică a datelor. **Rezultate.** Rezultatele înregistrate la testarea inițială (TI) nu prezintă diferențe statistic semnificative între cele două grupe la testul YYIRTL1, dar au fost observate diferențe statistic semnificative la testarea finală (TF) pentru parametrul care indică timpul de menținere în zona anaerobă >81%FCmax (U = 67,50, N_1 = 20, N_2 = 20, two-tailed p = ,000336, d = 1,46). **Concluzii**. Studiul efectuat demonstrează că jocurile de fotbal pe teren redus incluse într-un program de antrenamente pot dezvolta capacitatea anaerobă de efort a sportivilor, după 8 săptămâni de pregătire.

Cuvinte-cheie: *jocuri pe teren redus, capacitate anaerobă, frecvența cardiacă maximă, fotbal*

Introduction

The integrated training method includes small-sided games as a modern concept, successfully applied to football. However, only few studies have shown that training with small-sided games can cause exercise intensities (>90%HRmax) providing a specific incentive to improve effort capacity, values obtained by Hoff, Wisloff, Engen, Kemi, & Helgerud (2002).

Although the aerobic metabolism is the main support of the football efforts (Bangsbo, Norregaard, & Thorso, 1991; Stolen, Chamari, Castagna, & Wisloff, 2005), anaerobic energy is decisive for winning the 1vs1 duels or making your sprints at a superior performance level, which contributes decisively to the final outcome of a football game (Little & Williams, 2003).

The total time of elite footballers' sprints during a match is about 30 seconds (Bangsbo, 2008, p. 62), and the actions of the ball players account for between 0.5 and 3% of the total distance run during a match (Ali & Farrally, 1991; Bangsbo, 2008, p. 63). These actions are often decisive in winning or losing matches, and the need to include anaerobically-type training in training programs (Sporis, Ruzic, & Leko, 2008) is evident. Mohr, Krustrup, & Bangsbo (2003), shows the importance of training anaerobic capacity in achieving sports performances, noting the superior number of sprints, accelerations and decelerations made by elite athletes compared to lower-tier players during a football match.

Training exercises or actions in high-intensity football matches, such as speed runs, sprints, directional changes, bouncing, acceleration, decelerations,

require the generation of anaerobically-powered energy, and the development of these skills is the main objectives in football training (Balsom, Lindholm, Nilsson, & Ekblom, 1999; Reilly, 2007, pp. 83-84; Stolen, Chamari et al., 2005, p. 502).

Anaerobic metabolic processes produce the energy required to perform peak intensity actions, involving the rapid development of muscle force such as sprints, accelerations and decelerations (Bradley et al., 2009; Dellal, Hill-Haas, Lago-Penas, & Chamari, 2011a; Dellal, Lago-Penas, Wong, & Chamari, 2011b; Reilly, 2007, p. 94).

Objective

This research aims to measure the development of the anaerobic capacity in the young football players, as an effect of exposing them to a training program of 8 weeks with small-sided football games.

Materials and methods

Research protocol

a) The period and place of the research

The research was carried out from 5.01.2021 to 27.02.2021 at the multifunctional base of the sports complex at Deva Stadium at the beginning of the preparatory period of the annual training plan.

b) Subjects and lots

The subjects of the study were 40 footballers aged 16-18 years old, divided in groups of 20 individuals – experiment group (EG) and control group (CG). All subjects and their parents have given their written consent to participation in this research, and the medical protocol for outdoor sports activities has been followed. The participation of subjects in the study was voluntary.

c) Applied tests

Subjects took the Yo Yo Intermittent Test Level 1 (Bangsbo, Iaia, & Krustrup, 2008; Bangsbo, 2008, pp. 103-106) at the beginning and end of the experiment, to measure HRmax for delimiting sport-specific effort zones and to assess anaerobic capacity in relation to athletes' ability to maintain, as a time duration, in the anaerobic effort zone > 81%HRmax (Figure 1). YYIRTL1 is a validated, aerobic and anaerobic physical performance evaluation sample specific to footballers (Castagna, Impellizzeri, Chamari, Carlomagno, & Rampinini, 2006; Gumusdag, Unlu, Cicek, Kartal, & Evli, 2013).

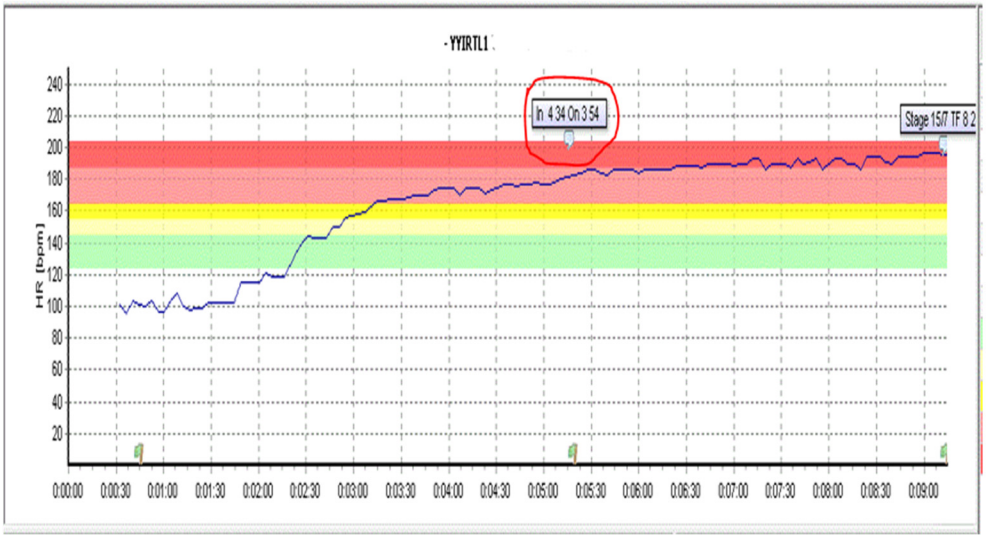

Figure 1. Heart rate monitoring YYIRTL1 sample, with emphasis on hold time in anaerobic zone

d) The intervention program

The intervention program included a total of 24 training with small-sided football games, of which 16 were specific anaerobically defined during the 8 weeks of research. As part of weekly microcycles, small-sided anaerobically football games were planned on Wednesday and Friday. Weekly microcycles also included training with small-sided, but aerobic, games every month and technical-tactical specific training on Tuesday, both forms at 55-60% of HRmax. In the training program, after the maximum intensity, lactate anaerobic training, held every Wednesday, theoretical lessons were planned on Thursday.

Throughout the research, the subjects participated in 5 trainings per week, with an average duration of 90 minutes, with the training program patterned after the training objectives of the preparatory period. For the EG athletes, 3 of the 5 weekly training lessons included small-sided football games and for the CG athletes the training program contained classic training means.

The structure and content of small-sided football games have been adapted to training objectives specific to the training period. For the best effort management, the microcycles training have been structured according to the rest periods necessary to restore the body after effort. The intensity of training means has been monitored by measuring HR (Figure 2).

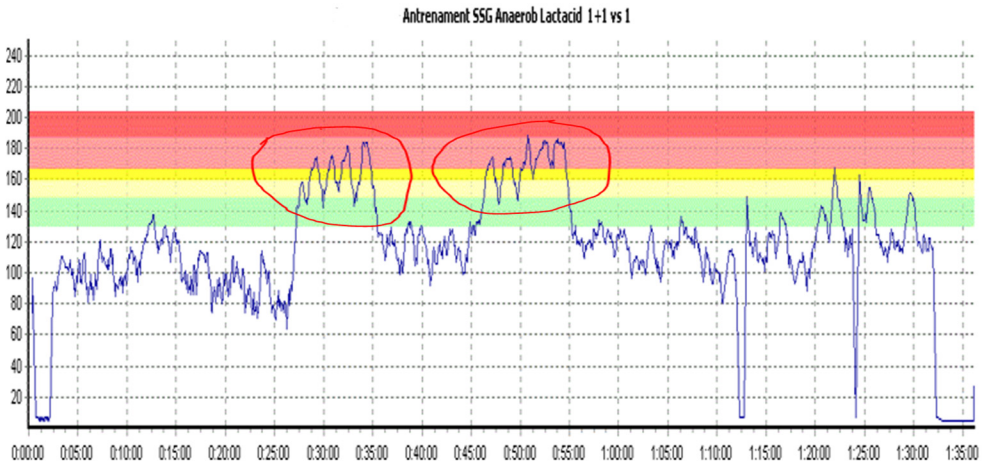

Figure 2. Small-sided football games heart rate monitoring anaerobic effort zones (1+1vs1)

Small-sided football games (Table 1) have been standardized to develop anaerobic capacity, depending on the optimal dynamics of effort/break ratio in lessons and microcycles training. Thus, the maximum intensity anaerobic lactacid exercises were included on Wednesday, theoretical lessons were planned on Thursday and the alactacid anaerobes were scheduled on Friday.

Table 1. The characteristics of small-sided football games used in the intervention program

SSG Format	Sizes	Effort/Break	Variables No.of repetitions	Variables HR effort/break	Effort scale	Effort type
1vsGk	10x15	10``/2`	10	190/120	>90%HRmax	Alactacid anaerob
1vs1	10x15	15``/2`	8	190/120	>90%HRmax	Alactacid anaerob
2vs2	10x15	2`/1	6	185/140	>81%HRmax	Lactacid anaerob
3vs3	10x15	3`/1	6	185/140	>81%HRmax	Lactacid anaerob

Note: HR = Heart rate; SSG – small sided games

To direct training intensity and quantify athletes' physical and physiological capabilities to resist in the anaerobic zone, heart rate was monitored using the Hosand GT.a. In the initial and final tests, the YYIRTL1 sample, the Witty Gate Microgate2 electronic timing system was used.

e) Statistical processing

The analysis and interpretation of the results was carried out using the SPSS program, version 23.0, with the materiality threshold $p < 0.05$ applied. The Shapiro Wilk test was used in the analysis of data distribution normality and parametric or non-parametric tests were used to compare the results obtained by subjects in the two groups depending on the distribution of the data. The size of the effect was also calculated (Cohen, 1988).

Results

The analysis of data distribution and the interpretation of the Shapiro Wilk test for YYIRTL1 sample revealed that in the initial test (IT) the data were distributed normally at the parameter indicating the hold time in the anaerobic zone > 81%HRmax for the experiment group (EG) ($p = .445$), but not normally distributed for the control group (CG) ($p = .009$). Regarding the final test (FT), the distribution was normal for EG at the parameter indicating the hold time in the anaerobic zone >81%HRmax ($p = .325$); the data distribution was not normal for CG ($p = .049$).

The next step was to compare the averages of the distribution of the data using parametric tests (paired samples t-test) in case of normally distributed data and non-parametric tests (Mann-Witney U or Wilcoxon) if the data were not normally distributed. The size of the effect has also been calculated (Cohen, 1988).

The Mann Whitney U test shows that in the initial test the difference between the two groups' averages at the parameter indicating holding time in the anaerobic zone >81%HRmax is not statistically significant ($U = 153.50$, $N_1 = 20$, $N_2 = 20$, two-tailed $p = .208$, $d = .42$), the groups are homogeneous (Table 2). After the completion of the intervention program, the measurements for the sample under investigation were repeated and the results are also statistically analyzed (Table 2). The difference between the scores averages of the two groups was statistically significant for the parameter indicating the holding time in the anaerobic zone >81%HRmax ($U = 67.50$, $N_1 = 20$, $N_2 = 20$, two-tailed $p = .000336$, $d = 1.46$).

Table 2. Comparison of averages and effect size, YYIRTL1 sample, variable OnzonaAn > 81%HRmax, EG and CG, before and at the end of the intervention program (N = 40)

Time	Variable	Group	Mean	AS	ES	Test statistics U*	df.	Sig.	Cohen d
IT	OnZonaAn >81%HRmax	EG (20)	3.68	.68	.15	153.50*	38	.208	.42
		CG (20)	3.42	.54	.12				
FT	OnZonaAn >81%HRmax	EG (20)	5.05	.60	.13	67.50*	38	.000	1.46
		CG (20)	4.15	.63	.14				

Note: IT – initial test; FT – final test; OnzonaAn>81%HRmax – holding time in anaerobic effort zones.

The change in the subjects of the groups produced by the intervention program was also analyzed by comparing the averages recorded by the subjects at the two moments of the study. Thus, the paired samples t-test (Table 3) shows that in the experiment group the differences are significant for the variable indicating the holding time in the anaerobic zone > 81%HRmax (t = -7.337, df = 19, p = .000, d = 2.12). It was used he Wilcoxon test for comparing the control group averages (Table 3) and it appears that there are also significant statistical differences in this group with the holding time variable > 81%HRmax (Z = -3.059, two-tailed p = .002, d = 1.23).

Table 3. Comparison of the averages and effect size of the YYIRTL1 sample, for the variable OnzonaAn >81%HRmax, in the experiment and control groups, before and after the intervention program (N = 40)

Pair	Time	Variable	Paired Samples Statistics		Paired Samples Test[a,b]			
			Mean	Std Deviation	t[a]\Z[b]	df	p	d
Pair 1 EG	**IT**	OnzonaAn >81%HRmax	3.6885	.68558	-7.337[a]	19	.000	2.12
	FT	OnzonaAn >81%HRmax	5.0540	.60945				
Pair 2 CG	**IT**	OnzonaAn >81%HRmax	3.4235	.54950	-3.059[b]	19	.002	1.23
	FT	OnzonaAn >81%HRmax	4.1530	.63911				

Note: a. EG t-test; b. CG Wilcoxon Signed Ranks Test; OnzonaAn >81%HRmax – holding time in anaerobic effort zones.

Discussions

The results obtained show that, after 8 weeks of small-sided football training, the anaerobic performance of athletes, measured by measuring holding time in the anaerobic effort zone > 81% HRmax, is significantly better for

athletes in EG than in CG, who used classic means in the training program. Thus, the EG athletes recorded 5 minutes and 5 seconds of holding in the anaerobic effort zone in the YYIRTL1 sample as compared to the CG athletes who achieved only 4 minutes and 15 seconds.

From the analysis of the results obtained by the two test groups, we can see significant differences in both groups, these data indicating that traditional exercise training also produces effects on the development of the anaerobically available potential of sportsmen after a training program over an 8 week period, as in our case. However, compared to the performance of CG athletes, the results of the EG athletes are higher and the size of the effect is higher (2.12 versus 1.23).

In the analysis carried out by Halouani, Chtourou, Gabbett, Chaouachi, & Chamari (2014), several studies are presented, whose results highlight the effectiveness of the small-sided games method in achieving intensities generally exceeding 80%HRmax, with small-sided games training leading to benefits in both the development of physical qualities, as well as improving the technical-tactical skills specific to football. The results from the studies presented in this analysis show that the differentiated standardization of small-sided games according to the specific requirements of this type of training influences the physiological responses highlighted by the reported HRmax level (Halouani et al., 2014).

Specialists recommend training anaerobic resistance, physical quality specific to football, and to direct physical effort, it is necessary to determine physical performance and physiological characteristics. Research has also been carried out using the monitoring of physiological parameters such as HR (Bangsbo, 2008, pp. 140-142; Ferretti, 140, p. 63; Hoff et al., 2002, p. 219).

Impellizzeri et al. (2006) highlighted the advantages of using small-sided football games in training footballers, by analyzing the effect on fitness while training in this specific program compared to the traditional one. The study was carried out at the level of two groups of 20 athletes, over 12 weeks, 4 in the preparatory period and 8 in the competition period. Data from the two groups show that both methods are effective in developing physical capacity at the level of junior football players. Results from applied training programs showed a significant improvement in retention time in the anaerobic effort zone 90-95%HRmax (Impellizzeri et al. 2006) being similar to those recorded in our study. The studies also show that in junior and senior players the anaerobically threshold is between 76.6%HRmax and 90.3%HRmax (Casajús, 2001; Chamari et al., 2004; Helgerud, Engen, Wisloff, & Hoff , 2001).

Several studies examined the effects of small-sided games training programs in football, handball or rugby compared to the use of other training methods. The results of small-sided games show significant improvements in physical performance in 5 of these studies (Chaouachi et al., 2014; Gabbett, 2006; Iacono,

Eliakim, & Meckel, 2015; Iacono, Ardigò, Meckel, & Padulo, 2016; Seitz, Rivière, de Villarreal, & Haff, 2014; Young & Rogers, 2014). Dellal et al. (2008) have demonstrated that the small-sided games method in football training results in intensities of more than 80%HRmax, comparable to running on an intermittent basis, resulting in positive effects for improving the anaerobic resistance of athletes.

Conclusions

The analysis of the results of the study carried out allows us to draw the following conclusions:

1. The results demonstrate the efficiency of training with small-sided football games over a period of 8 weeks on the development of the anaerobic capacity of the 16-18-year-old juniors.
2. The standardization of small-sided football games for the development of anaerobic capacity, as well as their timing in the training program, has proved effective.
3. Results from the end of the study show that both methods produce improvements in anaerobic effort capacity, but the effects of small-sided games football training are higher than traditional practice training.

Constraints of the research

Even if the study was carried out in two groups, each consisting of numbers in relation to the number of athletes in a football team, the increase in the number of subjects would contribute to the objectivity of the research.

The differences between the two groups after 8 weeks of experiment have shown statistical significance, however we propose that further investigations be carried out over a longer period of time, which would allow for more obvious progress in the development of resistance in the anaerobic effort zone.

Conflicts of interests

The authors declare that there is no conflicts of interests.

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