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Optimizing the aerobic performance of junior football players through small-sided football games training

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Abstract: Training with small-sided games proved to be effective in the training of football players. The purpose of this study was to analyze whether participation in a training programme with small-sided football games resulted in the development of the aerobic capacity. The subjects of this study were 40 16-18-year-old athletes divided into two equal groups: experiment group (GE) and control group (GC). Both groups participated in training programmes from 6.07.2020 to 27.11.2020 – GE in a small-sided football training programme; GC in a classic exercise training programme. The following equipment was used: Hosand GTa – to measure HR – and the WittyGateMicrogate2 system for timing of the samples taken. Subjects took the YIRTL1 sample. The data collected was processed with the SPSS programme, variant 23. In the YIRTL field trial there were no significant differences in the initial testing (IT) between the two groups, but in the final testing (FT) the differences were significant. Thus, at FT the difference between the score means of the two groups was significant both for the covered distance parametre ($U = 4{,}00$, $N_1 = 20$, $N_2 = 20$, two-tailed $p =,000$, $d = 3{,}35$) and for the parametre indicating the hold time in the aerobic zones <81%FCmax ($U = 82{,}50$, $N_1 = 20$, $N_2 = 20$, two-tailed $p =,001$, $d = 1{,}21$). The study revealed that the aerobic capacity developed by implementing a small-sided football games training programme for 21 weeks.

Keywords: aerobic capacity, heart rate, small-sided-games, football

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Introduction

Recent studies, conducted on football teams, show that small-sided games are an effective strategy for developing specific physical qualities and physical skills in football (Chaouachi et al., 2014; Young & Rogers, 2014).

The optimization of sports performance in football involves the development of the technical, tactical as well as the psychological characteristics and the physical ones (Laursen & Buchheit, 2019, p. 547; Stolen, Chamari, Castagna, & Wisloff, 2005; Turner & Stewart, 2014). While in the past small-sided games were used mainly to develop technical-tactical skills, today such exercises are standardized in the training aimed at developing aerobic resistance (Balsom, Lindholm, Nilsson, & Ekblom, 1999; Drust, Reilly, & Cable, 2000; Reilly & Gilbourne, 2003).

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The small-sided games method used in football training produces positive effects both in developing capacity and aerobic power and in developing technical-tactical skills (Gabbett, 2006; Girard, Mendez-Villanueva, & Bishop, 2011; Impellizzeri et al., 2006). According to the authors Castagna, Impellizzeri, Chamari, Carlomagno, & Rampinini (2006), Chamari (2005), Hill-Haas, Dawson, Impellizzeri, & Coutts (2011) and McMillan (2005) achieving sporting performance requires training physical qualities such as aerobic resistance, using appropriate means.

The meta-analysis results of Hammami, Gabbett, Slimani, & Bouhlel (2017) show the higher efficiency of small-sided football training compared to training including classic exercises when it comes to developing the athletes' aerobic capacity. Other studies show that the functional recovery potential of the sportspersons' body, during repeated high intensity efforts, is correlated with their aerobic performance (Castagna, Impellizzeri, Rampinini, D'Ottavio, & Manzi, 2008; Tomlin & Wenger, 2001).

THE PURPOSE OF THIS STUDY

The aim of this study was to investigate the effect of the participation of 16-18-year-old junior football players in a training programme with small-sided football games on their aerobic capacity.

HYPOTHESIS

Subject participation in a training programme with small-sided football games will produce improvements in aerobic capacity compared to subjects who are doing classically trained workouts.

MATERIALS AND METHODS

Research protocol

The period and place of the research

The research was carried out from 06.07.2020 to 27.11.2020 at the multifunctional base of the sports complex at the Stadium in Deva.

Subjects and lots

The sample included in the study consisted of 40 sports pupils aged 16-18, divided into two groups of 20 subjects – experiment group (EG) and control group (CG) – all component subjects of the same sports club. They participated in a programme of 5 workouts per week. For the EG athletes, 3 of the 5 weekly training lessons included small-sided football games, and for the CG athletes the training programme contained classic training means. All subjects and their parents have given their written consent to participation in the study, and the medical protocol for outdoor sports activities has been followed. Participation in research was voluntary.

Equipment used and tests carried out

The subjects performed the initial test, Yo Yo Intermitent Level 1 (Bangsbo et al., 2008; Bangsbo, 2008, pp. 103-106), both for the assessment of aerobic capacity and for the measurement of FCmax in order to delimit the specific effort zones of each sport. The aerobic capacity has been assessed both in terms of the distance sportsmen run in the YYIRTL1 (Bangsbo et al., 2008; Castagna et al., 2009) and their possibilities to maintain themselves, as much as possible, in the aerobic effort zones <81%FCmax.

To drive training intensity, heart rate was monitored using the Hosand GTa system. In the initial and final tests, the YYIRTL1 sample, the WittyGateMicrogate2 electronic timing system was used.

The intervention programme

The microcycles of training included 4 weekly workouts and a bilateral game at the weekend. Due to the situation caused by SARS COV, official competitions being stopped for the competitional season 2020-2021, friendly games were planned at the end of weekly microcycles to model the training programme according to the specific content of each training stage. The training was between 60 and 110 minutes, structured according to the training period specific objectives as follows:

Structure of the weekly microcycle used by EG, specific training for the preparation period:

Monday - 2 small-sided football games for aerobic capacity development (5vs5/6vs6 - 50%/60% FCmax) and 2 games for aerobic power development (3vs3/3vs3+1 - 70%/80% FCmax); Wednesday - 2 small-sided football games for aerobic capacity development (4vs4/5vs5 - 65%FCmax) and 2 small sided football games for developing lactacide anaerobic capacity (2vs2/3vs3 >80%FCmax); Friday - 1 small-sided football game to develop aerobic capacity (6vs6+2Gk - 60%FCmax) and 2 small sided games for developing alactacide anaerobic capacity (1vs1 - 90%FCmax).

Structure of the weekly microcycle used by EG, specific training for the competitive period:

Monday - 3 small-sided football games for aerobic capacity development (5vs5/6vs6 - 50%/60% FCmax) and 1 game for aerobic power development (3vs3/3vs3+1 - 70%/80% FCmax); Wednesday - 1 small-sided football game for aerobic capacity development (4vs4/5vs5 - 65%FCmax) and 2 small-sided football games for developing lactacide anaerobic capacity (2vs2/3vs3 >80%FCmax); Friday - 1 small-sided football game to develop aerobic capacity (6vs6+2Gk - 60%FCmax) and 3 small-sided games for developing alactacide anaerobic capacity (1vsGk - 90%FCmax).

CG subjects attended a training programme with classic exercises during this period. In both groups, the weekly cycle also included technical-tactical training on Tuesday, with an intensity of 50-60% of FCmax. Both groups had theoretical lessons included in the weekly programme on Thursdays.

Small-sided football games were selected, streamlined and standardized to cover all areas of effort, aerobic, anaerobic and mixed. In the standardization of small-sided football games, the same structuring rules were established: the topic approached according to the moments of the game, the size of the field, the number of players, the number of touches, the gates, the size and position of the gates, the half/break ratio, the number of repetitions, the presence or absence of goalkeepers, numerical inferiority and numerical superiority. By monitoring the intensity of the exercises measuring HR, the content was correlated with the area of effort proposed to be achieved: 2vs2, 3vs3, 4vs4 (with/without goalkeepers, support players), time between 1 and 3 minutes with a rate of 2:1 half/break for anaerobic lactacide effort; 4vs4, 5vs5, 6vs6 (with/without goalkeepers or support players) between 3 and 6 minutes with a 1:1 rate for the aerobic effort (Figure 1); 1vs1 (with/without goalkeepers) between 8-10 seconds with a rate of 1:2 for alactacid anaerobic effort.

Statistical processing

The analysis and interpretation of the results were carried out using the SPSS programme, 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).

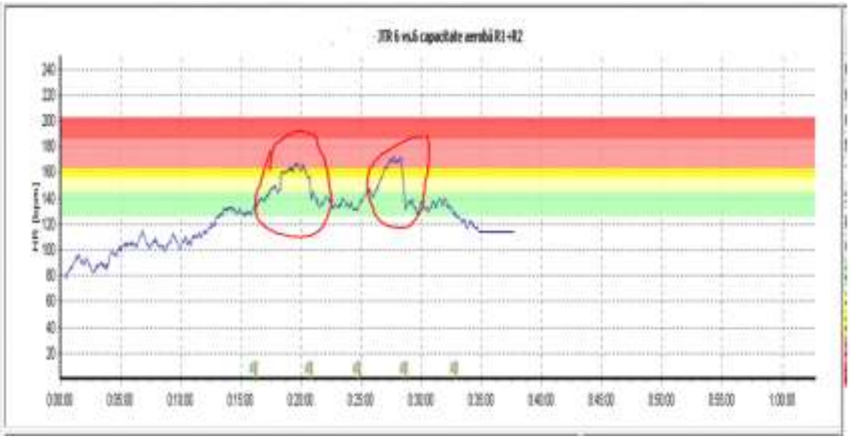

Figure 1. Heart rate monitoring small-sided football game for aerobic capacity development,6vs6

RESULTS

From the analysis of data distribution and interpretation of the Shapiro-Wilk test for YYIRTL1 sample, it was found that in the initial test (IT) the data were not normally distributed at the distance parametre at both EG (p = ,033) and CG (p =,019). At the parametre indicating the hold time in aerobic areas <81%FCmax, the data have been distributed normally for both EG (p = ,218) and CG (p = ,104). Regarding the final test (FT), the distribution was normal for the experimental group (EG) at the distance parametre (p =,179) and the parametre showing the holding time in aerobic areas <81%FCmax (p = ,408); it was not normal for control group on any of the two measured parametre, distance (p =,034), maintaining aerobic range <81%FCmax (p = ,011). Therefore, parametric tests (independent t-test and paired sample t-test) were used for comparison of the media when the data were normally distributed and not parametric (Mann-Witney U or Wilcoxon) when 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' means at the distance parametre is not statistically significant (U = 145,000, N_1 = 20, N_2 = 20, two-tailed p = ,142, d =,26), the groups being homogeneous (Table 1).

To compare the means recorded by the two groups to the parametre indicating the holding time in aerobic areas <81%FCmax, the t-test for independent samples has been used, which shows that the difference between the means of the two groups is not statistically significant, with the groups being also at this parametre of the homogeneous YYIRTL1 sample (t = -450, df = 38, two-tailed p = ,655, d =,13) (Table 1).

Table 1. Comparison of means and effect size, YYIRTL1 sample, distance and OnZonaAe 81%FCmax prior to the intervention programme (N = 40)

Variable	Group	Mean	AS	ES	Test statistics			
					t/U*	df.	Sig.	Cohen d
Distance	EG (20)	992	108,26	24,21	145,00*	38	,131	,26
	CG (20)	1018	83,57	18,68				
OnZonaAe <81%FCmax	EG (20)	5,16	,72	,16	,450	38	,655	,13
	CG (20)	5,06	,79	,17				

Note: EG – experimental group; CG – control group; OnZonaAe – holding time in aerobic effort zones.

After the completion of the intervention programme, the measurements for the sample under investigation were repeated and the results are also analyzed statistically (Table 2). The difference between the scores means of the two groups was significant both for the YYIRTL1 sample distance parametre (U = 4,000, N_1 = 20, N_2 = 20, two-tailed p = ,000, d = 3,35) and for the parametre indicating the hold time in aerobic areas <81%FCmax (U = 82,500, N_1 = 20, N_2 = 20, two-tailed p =,001, d = 1,21).

Table 2. Comparison of means and effect size, YYIRTL1 sample, distance and OnZona Ae <81%FCmax - at the end of the intervention programme (N = 40)

	Dist. TF YYIRTL1	OnZonaAe <81%FCmax
Mann-Whitney U	4,000	82,500
Z	-5,337	-3,179
Asymp. Sig. (2-tailed)	,000	,001
Cohen d	3,35	1,21

Note: FCmax – maximum heart rate; OnzonaAe – holding time in aerobic effort zones.

For the analysis of the effect of intervention programmes on the subjects in the two groups, the means recorded by the subjects at the two points of the study were compared, using tests according to the data distribution. Thus, the Wilcoxon test (Table 3) shows that in the test group the differences between the results obtained are significant for the distance variable (Z = -3,926, two-tailed p = ,000086, d = 4,19). The same test shows that, for the control group, the differences between the mean results obtained by the subjects at the two study points are statistically significant for the distance variable (Z = -3,250, two-tailed p = ,001, d = 1,49).

Table 3. Comparison of the means and effect size of the YYIRTL1 sample, distance variable and OnZone Ae<81%FCmax, in the experiment and control groups, before and after the intervention programme (N = 40)

			Paired Samples Statistics		Paired Samples Test^{a,b}			
Pair	Time	Variable	Mean	Std Deviation	$t^a\backslash Z^b$	df	p	d
Pair 1 EG	TI	distance	992	108,269	-3,926^b	19	,000	4,19
	TF	distance	1418	93,110				
Pair 2 CG	TI	distance	1018	83,578	-3,250^b	19	,001	1,49
	TF	distance	1136	73,870				
Pair 3 EG	TI	OnZonaAe<81%FCmax	5,1685	,72575	-6,222^a	19	,000	2,03
	TF	OnZonaAe<81%FCmax	6,8055	,87143				
Pair 4 CG	TI	OnZonaAe<81%FCmax	5,0605	,79083	-2,221^b	19	,026	,75
	TF	OnZonaAe<81%FCmax	5,7110	,92811				

Note: a. t-test; b. Wilcoxon Signed Ranks Test; IT – initial test; FT – final test; EG- experimental group; CG - control group; OnZonaAe – holding time in aerobic effort zones.

According to the paired samples t-test (Table 3), at the experimental group the differences are significant for the variable indicating the holding time in aerobic areas <81%FCmax (t = -6,222, df = 19, p = ,000006, d = 2,03). The Wilcoxon test was used when comparing the control group means (Table 3) and the differences were also significant in this group (Z = -2,221, two tailed p = ,026, d = ,75).

DISCUSSIONS

As regards our study, the analysis of the data from the YYIRTL1 trial shows that significant progress has been made in the experiment group compared to the control group. Significant progress was also observed between the initial testing and the final one at the level of the experiment group, showing that the training programme with small-sided football games has been effective.

The results obtained by the two groups do not show significant statistical differences in any of the parametres measured by the YYIRTL1 sample at IT moment, which shows that subjects in both groups had a close level of physical preparation as evidenced by the YYIRTL1 field trial.

Unlike IT, the results achieved at the FT for the same sample show significant differences in EG's favour, which shows that small-sided games football training over 21 weeks improves aerobic capacity.

From the analysis of the results obtained by the two groups, we can see significant differences between IT and FT in both groups and these data indicate that traditional exercise training also produces effects on the development of the aerobic potential of athletes. However, compared to the performance of CG athletes, the results of EG athletes are higher. Thus, for the variable that represents the distance run in the aerobic effort zone at YYIRTL, the athletes in EG achieve a higher performance of 426 metres in the FT in comparison with IT, unlike CG where the difference is only 118 metres. Just like in our research, a study by the Hill-Hass, Rowsell, Dawson, & Coutts (2009) shows, through the results obtained, significant improvements of the YYIRTL1 test parametres. The data of this study indicate, after 7 weeks of small-sided games training in the preparatory period, a significant improvement in the YYIRTL1 sample distance. On the other hand, there were no significant statistical differences between the YYIRTL1 distance results, between the group that followed the small-sided games training programme and the group that followed the classical exercise training programme (Hil-Hass et al., 2009).

With regard to the possibility for athletes to maintain the duration in the area of aerobic effort, the difference between the time obtained in the initial test and in the final one was 2 minutes and 4 seconds for EG, unlike CG athletes who have improved their ability to maintain themselves in their aerobic zone by just 1 minute and 5 seconds.

Similar results were also obtained in a study carried out at the level of groups of juniors, girls and boys, in handball (Buchheit et al., 2009). The 10-week study demonstrated that small-sided games used in handball training at intensities of 86,8%FCmax produce significant improvements in both aerobic performance and aerobic maximum power.

Three studies, carried out during the preparatory period in football, have demonstrated significant improvements in the aerobic performance as a result of the implementation of small-sided games in the training programmes (Impellizzeri et al., 2006; Hill-Hass et al., 2009; Radmziminski, Rompa, Barnat, Dargiewicz, & Jastrzebski, 2009). These studies used, in the methodology of the conduct, a comparison of the results of training with small-sided football games and those obtained from traditional practice exercises.

The results obtained in the studies submitted are corroborated with the review carried out by Halouani, Chtourou, Gabbett, Chaouachi, & Chamari, (2014), on small-sided games in sport training. This analysis shows that small-sided games used in football training at higher intensity stimulate cardiovascular functionality, subsequently influencing the body’s adaptation to effort and improving aerobic capabilities.

As far as the evaluation sample selected for this experiment is concerned, Krustrup et al. (2003) have investigated the physiological responses of elite footballers from the YYIRTL1 field sample. Their results highlight the strong correlation between aerobic capacity and sporting performance, especially in relation to distance run during a football game, as shown in the study by Castagna, Impellizzeri, Cecchini, Rampinini, & Alvarez (2009).

According to data from Bangsbo, Iaia, & Krustrup (2008), the distances taken by athletes in the YYIRTL1 test were directly proportional to their aerobic possibilities, as the test is an effective means of determining the specific resistance of footballers, depending on age or football position held (Markovic & Mikulic, 2011).

Another study, conducted in handball during the competitional season, shows that after 10 weeks of small-sided games training, significant improvements in aerobic capacity were achieved, represented by the total distance run in the YYIRTL1 test (Iacono, Eliakim, & Meckel, 2015).

CONCLUSIONS

The analysis of the results of this experiment leads us to the following conclusions: A 21-week training programme, including small-sided football games, significantly improves the aerobic capacity of 16-18-year-old footballers.

By standardizing and by constantly managing the means selected in the intervention programme, as the sport body adapts to the stress stimuli initially planned, the concerned effort zone can be influenced.

The results obtained by the two groups show significant statistical differences between IT and FT times, which shows that both methods improve aerobic capacity after 21 weeks of training.

After the completion of the intervention programme, the difference between the score means of the two groups was statistically significant, and the effect was great, demonstrating that small-sided football games training can be more effective in developing the aerobic performance of athletes compared to the training containing classic exercises.

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