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Research article

SMALL-SIDED GAMES VERSUS INTERVAL TRAINING IN ADOLESCENT SOCCER PLAYERS: EFFECTS ON BODY COMPOSITION

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Abstract. *The aim of this research was to determine the effects of small-sided games (SSGs) and high-intensity interval training (HIIT) on body composition in adolescent soccer players. A total of 60 young male soccer players (Age: 15.6±0.6 years) were recruited. We registered the following body composition variables: body fat, percentage of fat mass (BF%), muscle mass, body mass, total body water (TBW), and BMI. Players were randomly assigned to the SSG or HIIT group during the last eight weeks of the season. The HIIT group showed significantly improved body fat and body fat % ($p \leq 0.05$), whereas no change was observed for body mass, BMI, body water and muscle mass in both groups. In conclusion, HIIT training improved or maintained body composition status in adolescent soccer players. On the contrary, SSG training seems to increase body fat and consequently affect players' performance at the end of the season.*

Key words: *Soccer, Conditioning, In-Season, Body Composition, Effects*

INTRODUCTION

Nowadays, body composition assessment is considered a usual and elementary component of elite level soccer (Milsom et al., 2015). It was shown (Gravina et al., 2008) that better players are leaner than lower-level players, even in the younger age categories. Moreover, it was stated recently that elite senior players show grater increases in lean mass compared to junior player (Bilsborough et al., 2010). Similarly, Milsom et al. (2015) found

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that professional soccer players from the English Premier League differ in whole body and regional aspects of body composition according to different age and training history.

During one soccer match, elite adolescent soccer players often cover distances greater than six kilometers during which an intermittent activity has the most important roll for performance and success (Bucheit, Mendez-Villanueva, Simspon & Bourdon, 2010). High-intensity interval training (HIIT) and Small-sided games (SSG) are a very popular and effective form of exercise with small time requirement.

One paper found similar results for HIIT and traditional aerobic conditioning for improving (VO2max) in female collegiate soccer players (Rowan, Kueffiner & Stavrianeas, 2012). More recently, Howard and Stavrianeas (2017) found in high school soccer players that both the endurance training group and the high-intensity interval training group showed significant improvements in aerobic fitness. In one study, conducted on 14-year-old soccer players peak VO2 increased significantly following 5 weeks of HIIT compared to high-volume training (Sperlich et al., 2011). Concerning body composition in soccer, Carling and Orhant (2010) found significant changes in body fat after a six-month training program.

In contrast, small-sided games (SSGs) have been used for years in soccer. However, SSGs have only recently been the focus of scientific research because of their effects on physical capacity, while the technical and tactical parameters remain on the same level (Dellal, Varliette, Owen, Chirico & Pialoux, 2012). Moreover, coaches and players generally prefer the use of SSGs (Dellal, Lago-Penas, Wong & Chamari, 2011).

However, SSGs might not be an ideal solution for all playing standards and levels because Dellal et al. (2012) revealed that the physiological responses to SSG were skill and level dependent.

Although the effects of SSGs versus HIIT have been already compared in elite soccer players (Impellizzeri et al., 2006), to the authors' knowledge no studies have yet attempted to compare the effects of SSGs and HIIT on body composition in adolescent soccer players. Therefore, the aim of this research was to determine the effects of SSG and HIIT on body composition in adolescent soccer players.

METHODS

Participants

A total of 60 young male soccer players (15.6±0.6 years old) were recruited (Table 1). Written informed consent was obtained from the players and their parents. All participants were from a professional soccer club and completed on average 10 hours of combined soccer training and competitive play per week. The experimental protocol received approval from the institutional ethics committee from the Faculty of Sport and Physical Education, University of Novi Sad.

Table 1 Basic descriptive statistics of adolescent soccer players

Descriptive variables	Mean±SD
Age	15.6 ± 0.6
Height	177.64 ± 6.5
VO_{2max}	52.1 ± 2.04
Experience (years)	6.4 ± 2.5
Training (min·week-1)	401 ± 122

Testing procedures

Body height was measured under standard conditions. The InBody 230 (Biospace Co. Inc., Seoul, South Korea) Bioelectrical Impedance Analyzer (BIA) was used. This foot-to-foot, hand-to-hand and hand-to-foot contact device uses two stainless-steel foot pad electrodes mounted on a platform scale and two stainless steel handles to allow for a Tetrapolar eight-point tactile electrode system. The platform scale uses a single load cell to measure body mass (with a measure of stature) and calculate the body mass index (BMI). Body fat percentage was determined using a summation of a segmental lean analysis to determine total lean body mass, fat mass, and ultimately the proportion of fat to total weight mass fraction. An estimate of muscular percentage was derived by Body weight (0.1 kg) – measured using InBody 230, evaluating water content in the segmental regions using proprietor equations. The participants entered the testing area and removed their shoes and socks and wore only light clothing. Once positioned on the In-Body 230, their age, sex, and stature were entered. The InBody 230 displays a visual cue (photo) how and when to hold the handles during the impedance measure. We registered the following body composition variables: body fat (BF), percentage of fat mass (BF%), muscle mass, body fat mass, total body water (TBW), and BMI.

Training program

The players were randomly assigned to the SSG (28 players) or HIIT group (32 players) during the last eight weeks of the season. In addition to the SSG and HIIT programs, all players continued to participate in their usual training (technical and tactical) sessions and official games. It was ensured that all the players received the same training routines, except for the HIIT and SSG parts.

HIIT training

High-intensity interval training was performed over 40-m shuttles, with 15s-15s, intermittent runs (Table 2). The individual intensity of the runs was selected according to the players' V30-15IFT as previously shown (Bucheit, 2008).

Table 2 HIIT training program

Week	Protocol	VIFT-Based Intensity
1	3 sets (5 reps of 15"-15" HIIT)	90% VIFT
2	3 sets (5 reps of 15"-15" HIIT)	90% VIFT
3	3 sets (8 reps of 15"-15" HIIT)	90% VIFT
4	3 sets (8 reps of 15"-15" HIIT)	90% VIFT
5	4 sets (6 reps of 15"-15" HIIT)	95% VIFT
6	4 sets (8 reps of 15"-15" HIIT)	95% VIFT
7	4 sets (6 reps of 15"-15" HIIT)	95% VIFT
8	4 sets (6 reps of 15"-15" HIIT)	95% VIFT

VIFT - speed of the final phase completed in full

Small-sided games

The content of the SSG programme was inspired and modified from several protocols. We used a team size of 3 or 4 players on each team because it elicits the best responses,

both physiologically and in terms of skill development (Jeffreys, 2004). Mean HR during the SSG training sessions was 154±18 bpm (85-89% of HRpeak). The exercise program was performed over eight weeks. The sessions were performed in the 4x4 and 3x3 method on a 20x15m, 25x18 field. The protocol included several rule changes in order to increase the intensity of play. No goalkeepers were allowed. Maximum of two touches were allowed during the first ten minutes. Moreover, each time the ball went out of play, the coach immediately fed in another ball, resulting in a constant flow of the play and thus avoiding any notable decrease on the physical demands of the player. These exercises were done twice a week.

Statistical analysis

Data were tested for normality with a Shapiro-Wilk normality test. To test within-group changes, differences were analysed using a paired *t* test. An analysis of covariance (ANCOVA) with baseline data as a covariate and groups as a between-subject comparator was used to evaluate the main and intervention effects. If the data were not normally distributed, a Kruskall-Wallis test by ranks with Dunn's *post hoc* test was used. Statistical analyses were processed using SPSS Statistics (SPSS Inc., Chicago, IL, USA, version. 16.0). The data are expressed as mean ±SD and the alpha value of significance was $p \leq 0.05$.

RESULTS

The HIIT group showed significantly changed body composition after eight weeks (Table 3). The HIIT group showed significantly improved BF and BF%, compared to the SSG group ($p \leq 0.05$), whereas no significant changes were observed for body mass, BMI, TBW and muscle mass in both groups.

Table 3 Mean ± SD results of different body composition parameters before and after 8 weeks of SSG and HIIT training

	SSG group N=28		HIIT group N=32	
	Baseline	Final	Baseline	Final
Body Height	176.29 ± 6.1	176.49 ± 6.2	180.57 ± 6.6	180.77 ± 6.5
Body mass	63.41 ± 9.71	64.45 ± 8.61	71.89 ± 9.12	72.72 ± 8.73
Body water	41.49 ± 4.98	41.73 ± 5.01	46.75 ± 6.04	47.41 ± 6.00
Body fat	6.75 ± 4.85	7.49 ± 3.55	8.02 ± 1.82	7.44 ± 1.22*
Body fat %	10.25 ± 4.97	11.44 ± 3.99	11.20 ± 2.02	10.96 ± 2.92*
BMI	20.35 ± 2.52	20.72 ± 2.11	21.98 ± 1.89	22.23 ± 1.79
Muscle mass	31.93 ± 4.11	32.08 ± 4.16	36.42 ± 5.02	37.01 ± 4.99

* Significantly different from the SSG group, $p<0.05$

DISCUSSION

The main aim of this study was to examine the effects of SSGs and HIIT on body composition in adolescent soccer players. The main finding of our study was that HIIT training was more effective than SSGs in maintaining body composition status in adolescent

soccer players during the last weeks of the season. Moreover, the results of this study revealed that eight weeks of soccer training including HIIT significantly improved body composition in adolescent soccer players.

As far as the difference between groups is concerned, our results suggest that both groups demonstrated changes in body mass, but without statistical significance. However, BF and BF% changed significantly in the HIIT group ($p<0.05$) compared to the SSG group.

The game of soccer has an intermittent nature, and consequently, HIIT was used to simulate the demands of a match-play (Iaia, Eemanno & Bangsbo, 2009; Orendurff et al., 2010). It was stated that HIIT training improves not only maximal aerobic performance and VO_{2max} (Wong, Chaouachi, Chamari, Dellal & Wisloff, 2010) but also solicits anaerobic metabolism (Dellal et al., 2010). Dellal et al. (2011) found similar results for both the SSG and HIIT training for improving aerobic performance.

Body composition is not only considered a prerequisite for health, but also firmly fits in the structure of sport performance and together with other factors determines the quality of human motion and the final level of performance (Williams, Drust, Williams, & Ford, 2013). Regarding the findings of body composition values, the present results indicated that after an eight-week training program, BF and BF% levels of the HIIT group decreased compared to the increase obtained by the SSG group. Based on these results, the increase in body mass of both groups, from baseline to final measurement, was logical and could be explained by a gain in lean tissue. Increases in lean tissue result from gains in muscle tissue, suggesting that the players' strength also improved. Moreover, the young soccer players' reports of high percent body fat could be due to low absolute levels of lean mass and not high levels of fat mass, which is not the case with senior player (Milsom et al., 2015).

BF is a standard measurement in soccer because better players tend to be leaner than lower-level players, even in the younger age groups (Gravina, Gil, Ruiz, Zubero, Gil & Irazusta, 2008; Janssens, Van Renterghem, & Vrijens, 2001). Contrary to our results, Campo et al. (2009) revealed no significant effects on BF following plyometric training in female soccer players, and that may be because of the absence of organized training during the transition period appears to increase BF in soccer players (Sotiropoulos, Travos, Gissis, Souglis & Grezios, 2009). The aforementioned authors also found that soccer players that were involved in a training program during the transition period achieved significantly lower BF% compared to the control group.

As far as the BF% results are concerned, the value of ~11% was similar with those of some other studies (Casajus, 2001; Rakhila & Luhtanen, 1991; Rhodes et al., 1986; Rico-Sanz, 1998; Rico-Sanz et al., 1998), but lower compared to the results of Matkovic et al. (2003) recorded among Croatian elite players (14.9%). These differences in results could be due to different methods of body fat assessment, but also differences in training programs (Silvestre, West, Maresh & Kreamer, 2006). There is a decreasing trend in BF and body mass across the season in soccer (Mercer, Gleeson & Mitchell, 1997; Ostojic, 2003; Reilly, Bangsbo & Franks, 2000), which is mainly due to body composition status during the off-season.

CONCLUSION

In the off-season, players became deconditioned, with low fitness levels. During pre-season they are often involved in a rigorous training programme (usually twice a day), which results in large decreases in BF. Moreover, the possible reason for discrepancy in the results could be the differences in the length and content of pre-season training. During the last weeks of the season, HIIT training in addition to the technical and tactical training improved or maintained body composition status in adolescent soccer players. On the contrary, compared to HIIT training, SSG training seems to increase BF and BF%, consequently affecting players' performance at the end of the season.

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REFERENCES

Bilsborough, J.C.; Greenway, K.G.; Opar, D.A.; Livingstone, S.G.; Cordy, J.T.; Bird, S.R.; Coutts, A.J. Comparison of anthropometry, upper-body strength, and lower-body power characteristics in different levels of Australian football players. *The Journal of Strength & Conditioning Research* 2015, *29*, 826-834.

Buchheit, M. The 30-15 intermittent fitness test: accuracy for individualizing interval training of young intermittent sport players. *The Journal of Strength & Conditioning Research* 2008, *22*, 365-374.

Buchheit, M.; Mendez-Villanueva, A.; Simpson, B.; Bourdon, P. Match running performance and fitness in youth soccer. *International journal of sports medicine* 2010, *31*, 818-825.

Campo, S.S.; Vaeyens, R.; Philippaerts, R.M.; Redondo, J.C.; de Benito, A.M.; Cuadrado, G. Effects of lower-limb plyometric training on body composition, explosive strength, and kicking speed in female soccer players. *The Journal of Strength & Conditioning Research* 2009, *23*, 1714-1722.

Carling, C.; Orhant, E. Variation in body composition in professional soccer players: interseasonal and intraseasonal changes and the effects of exposure time and player position. *The Journal of Strength & Conditioning Research* 2010, *24*, 1332-1339.

Casajus, J.A. Seasonal variation in fitness variables in professional soccer players. *Journal of sports medicine and physical fitness* 2001, *41*, 463.

Dellal, A., Ougulshi, M., & Al Ghari, M. A. The field use of the ball to improve the cardiovascular aspect in rehabilitation and re-training–Application for high level soccer players of national Saudi Arabia team. In *Congress of Sciences in Sport* (pp. 211-221).

Dellal, A.; Keller, D.; Carling, C.; Chaouachi, A.; Wong, d.P.; Chamari, K. Physiologic effects of directional changes in intermittent exercise in soccer players. *The Journal of Strength & Conditioning Research* 2010, *24*, 3219-3226.

Dellal, A.; Lago-Penas, C.; Wong, D.P.; Chamari, K. Effect of the number of ball contacts within bouts of 4 vs. 4 small-sided soccer games. *International Journal of Sports Physiology and Performance* 2011, *6*, 322-333.

Dellal, A.; Varliette, C.; Owen, A.; Chirico, E.N.; Pialoux, V. Small-sided games versus interval training in amateur soccer players: effects on the aerobic capacity and the ability to perform intermittent exercises with changes of direction. *The Journal of Strength & Conditioning Research* 2012, *26*, 2712-2720.

Gravina, L., Gil, S. M., Ruiz, F., Zubero, J., Gil, J., & Irazusta, J. (2008). Anthropometric and physiological differences between first team and reserve soccer players aged 10-14 years at the beginning and end of the season. *The Journal of Strength & Conditioning Research*, *22*(4), 1308-1314.

Gravina, L.; Gil, S.M.; Ruiz, F.; Zubero, J.; Gil, J.; Irazusta, J. Anthropometric and physiological differences between first team and reserve soccer players aged 10-14 years at the beginning and end of the season. *The Journal of Strength & Conditioning Research* 2008, *22*, 1308-1314.

Howard, N.; Stavrianeas, S. In-Season High-Intensity Interval Training Improves Conditioning In High School Soccer Players. *International Journal of Exercise Science* 2017, *10*, 713-720.

Iaia, F.M.; Ermanno, R.; Bangsbo, J. High-intensity training in football. *International journal of sports physiology and performance* 2009, *4*, 291-306.

Impellizzeri, F.M.; Marcora, S.M.; Castagna, C.; Reilly, T.; Sassi, A.; Iaia, F.; Rampinini, E. Physiological and performance effects of generic versus specific aerobic training in soccer players. *International journal of sports medicine* 2006, *27*, 483-492.

Janssens, M., Van Renterghem, B., & Vrijens, J. (2001). 42 ANTHROPOMETRIC CHARACTERISTICS OF 11-12 YEAR OLD FLEMISH SOCCER PLAYERS. *Science and Football IV*, 258.

Jeffreys, I. The use of small-sided games in the metabolic training of high school soccer players. *Strength & Conditioning Journal* 2004, *26*, 77-78.

Mercer, T.; Gleeson, N.; Mitchell, J. Fitness profiles of professional soccer players before and after pre-season conditioning. *science and Football* 1997, *3*, 112-117.

Milsom, J.; Naughton, R.; O'Boyle, A.; Iqbal, Z.; Morgans, R.; Drust, B.; Morton, J.P. Body composition assessment of English Premier League soccer players: a comparative DXA analysis of first team, U21 and U18 squads. *Journal of sports sciences* 2015, *33*, 1799-1806.

Orendurff, M.S.; Walker, J.D.; Jovanovic, M.; Tulchin, K.L.; Levy, M.; Hoffmann, D.K. Intensity and duration of intermittent exercise and recovery during a soccer match. *The Journal of Strength & Conditioning Research* 2010, *24*, 2683-2692.

Ostojic, S.M. Seasonal alterations in body composition and sprint performance of elite soccer players. *Journal of Exercise physiology online* 2003, *6*.

R Matković, B.; Mišigoj-Duraković, M.; Matković, B.; Janković, S.; Ružić, L.; Leko, G.; Kondrič, M. Morphological differences of elite Croatian soccer players according to the team position. *Collegium antropologicum* 2003, *27*, 167-174.

Rahkila, P.; Luhtanen, P. Physical fitness profile of Finnish national soccer teams candidates. *Science and football* 1991, *5*, 30-34.

Reilly, T.; Bangsbo, J.; Franks, A. Anthropometric and physiological predispositions for elite soccer. *Journal of sports sciences* 2000, *18*, 669-683.

Rhodes, E.; Mosher, R.; McKenzie, D.; Franks, I.; Potts, J.; Wenger, H. Physiological profiles of the Canadian Olympic Soccer Team. *Canadian journal of applied sport sciences. Journal Canadien des sciences appliquées au sport* 1986, *11*, 31-36.

Rico-Sanz, J. Body composition and nutritional assessments in soccer. *International Journal of Sport Nutrition* 1998, *8*, 113-123.

Rico-Sanz, J.; Frontera, W.R.; Molé, P.A.; Rivera, M.A.; Rivera-Brown, A.; Meredith, C.N. Dietary and performance assessment of elite soccer players during a period of intense training. *International Journal of Sport Nutrition* 1998, *8*, 230-240.

Rowan, A.E.; Kueffner, T.E.; Stavrianeas, S. Short duration high-intensity interval training improves aerobic conditioning of female college soccer players. *International Journal of Exercise Science* 2012, *5*, 6.

Silvestre, R.; West, C.; Maresh, C.; Kraemer, W. Body composition and physical performance in men's soccer: a study of a National Collegiate Athletic Association Division I team. *Journal of strength and conditioning research* 2006, *20*, 177-183.

Sotiropoulos, A.; Travlos, A.K.; Gissis, I.; Souglis, A.G.; Grezios, A. The effect of a 4-week training regimen on body fat and aerobic capacity of professional soccer players during the transition period. *The Journal of Strength & Conditioning Research* 2009, *23*, 1697-1703.

Sperlich, B.; De Marées, M.; Koehler, K.; Linville, J.; Holmberg, H.-C.; Mester, J. Effects of 5 weeks of high-intensity interval training vs. volume training in 14-year-old soccer players. *The Journal of Strength & Conditioning Research* 2011, *25*, 1271-1278.

Williams, A. M., Drust, B., Williams, M. A., & Ford, P. (Eds.). (2013). *Science and soccer: Developing elite performers*. Routledge.

Wong, P.-l.; Chaouachi, A.; Chamari, K.; Dellal, A.; Wisloff, U. Effect of preseason concurrent muscular strength and high-intensity interval training in professional soccer players. *The Journal of Strength & Conditioning Research* 2010, *24*, 653-660.

IGRE NA MALOM PROSTORU (SSG) NASUPROT INTERVALNOM TRENINGU KOD MLADIH FUDBALERA: EFEKTI NA TELESNU KOMPOZICIJU

Cilj ove studije bio je utvrditi efekte igara na malom prostoru (SSG) i visoko intenzivnog intervalnog treninga (HIIT) na telesnu kompoziciju kod mladih fudbalera. Ukupan broj učesnika u ovoj studiji bio je 60 (Uzrast: 15.6±0.6 godina). Za procenu telesne kompozicije korišćene su sledeće varijable: telesne masti, procenat telesnih masti (BF%), mišićna masa, telesna masa, ukupna količina vode (TBW) i BMI. Igrači su bili nasumično raspoređeni u SSG ili HIIT grupu tokom poslednjih osam nedelja u sezoni. HIIT grupa pokazala je značajno poboljšanje telesnih masti i procenta telesnih masti ($p \leq 0.05$),dok promene nisu uočene u telesnoj masi, BMI, telesnoj vodi i mišićnoj masi u obe grupe. Zaključili smo da je HIIT trening poboljšao ili zadržao postojeći status telesne kompozicije mladih fudbalera. S druge strane, SSG trening je povećao telesne masti i time uticao na performanse igrača na kraju sezone.

Ključne reči: *fudbal, kondicija, sezona, telesna kompozicija, efekti*