*Nenad Stojiljković[1], Marko Gušić[2], Slavko Molnar[2] and Slobodan Andrašić[3]*

# SMALL-SIDED GAMES VERSUS INTERVAL TRAINING IN ADOLESCENT SOCCER PLAYERS: EFFECTS ON SPEED, CHANGE OF DIRECTION SPEED AND JUMPING PERFORMANCE

*[1]Faculty of sport and physical education, University of Niš, Serbia;*
*[2]Faculty of sport and physical education, University of Novi Sad, Serbia;*
*[3]Faculty of Economics, University of Novi Sad, Serbia*

*Original research*

Abstract
The aim of this research was to determine the effects of small-sided games and interval training on vertical jump, speed and change of direction speed in adolescent soccer in adolescent soccer players. A total of 60 young male soccer players (aged 14–18 years) were recruited. Players were assigned to small-sided group (SSG), or high intensity interval group (HIT) during the last 8 weeks of the season. Physical performance tests included a squat jump (SJ), countermovement jump (CMJ) countermovement jump with arm movement (CMJAM), 5-m, 10-m and 20-m sprints and iIlinois test. HIT was performed over 40-m shuttles, with 15s-15s, intermittent runs. And for the SSG programme a team size of 3 or 4 players was used on different pitch size. Both groups improved in the 5-m sprint ($p < 0.05$). There was a significantly greater improvement in the 20-m sprint ($p < 0.05$, large effect), Illinois ($p < 0.05$, large effect), SJ ($p < 0.05$, moderate effect), and CMJ ($p < 0.05$, large effect) following the HIT training compared with the SSG. To conclude, during the last weeks of the season, HIT training improved or maintained fitness status in adolescent soccer players. On contrary, SSG training seems to only maintain or even decrease the physical performance in the end of the season among adolescent soccer players.

Key words: change of direction, power, sprint, team sport

## Introduction

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 (Buchheit, Mendez-Villanueva, Simpson, & Bourdon, 2010). Analyses in soccer revealed the intermittent nature of the game, and consequently, HIT was used to simulate the demands of a match-play (Dellal, Owen, Wong, Krustrup, van Exsel, & Mallo 2012; Iaia, Rampinini, and Bangsbo, 2009; Orendurff et al, 2004). High-intensity intermitent training (HIT) and Small-sided games (SSG) are very popular and effective form of exercise with small time requirement. It was stated that HIT training can improve not only maximal aerobic performance and VO2max (Wong, Chaouachi, Chamari, Dellal, & Wisloff,, 2010) but also solicit anaerobic metabolism (Dellal, Keller, Carling, Chaouachi, Wong, & Chamari, 2010). One paper found similar results for HIT and traditional aerobic conditioning for improving VO2max in female collegiate soccer players (Rowan, Kueffner, & Stavrianeas, 2012). More recently, Howard, & 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 Yo-Yo intermittent recovery test level 1. In one study, conducted on 14-year-old soccer players peak VO2 increased significantly following 5 weeks of HIT compared 5 weeks of high-volume training (Sperlich et al, 2011).
In contrast, small-sided games have been used for years in soccer. Nevertheless, SSG were only recently been the focus of scientific research because of the effects on

physical capacity while the technical and tactical parameters remain on the same level (Dellal et al, 2012). Moreover, coaches and players generally prefer the use of SSGs (Dellal, Lago-Penas, & Chamari, 2011). However, there are several variables that could influence the intensity of SSGs. These include rules, pitch size (Tessitore, Meeusen, Piacentini, Demarie, & Capranica, 2006), the presence of goalkeepers (Mallo, & Navarro, 2008), the number of players (Hill-Haas, Coutts, Dawson, & Rowsell, 2010), duration of the exercise (Jones, & Drust, 2007), the availability of replacement soccer balls (Rampinini, et al., 2007). Moreover, the SSGs elicit different physical and technical activities in amateur and professional soccer players (Dellal, et al., 2011). Aditionally, 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 depended.

**Table 1** Mean ± SD results of different body composition parameters before and after 8-week of HIT and SSG training

| | HIT group | | SSG group | |
|---|---|---|---|---|
| | Baseline | Final | Baseline | Final |
| Age | 15.5±0.46 | 15.7±0.46 | 15.7±0. 67 | 15.9± 0.67 |
| Height | 180.57±6.6 | 180.77±6.5 | 176.29±6.1 | 176.49±6.2 |
| Body mass | 71.89±9.12 | 72.72±8.73* | 63.41±9.71 | 64.45±8.61* |
| Body fat | 8.02±1.82 | 7.44±1.22* | 6.75±4.85 | 7.49±3.55 |
| Body fat % | 11.20±2.02 | 10.96±2.92 | 10.25±4.97 | 11.44±3.99* |
| BMI | 21.98±1.89 | 22.23±1.79 | 20.35±2.52 | 20.72±2.11 |
| Muscle mass | 36.42±5.02 | 37.01±4.99* | 31.93±4.11 | 32.08±4.16 |

*Data are presented as Mean ±SD*
** Significantly different from baseline, $p<0.05$*

Although the effects of SSGs versus HIT have been already compared in elite soccer players (Impellizzeri et al., 2006), according to authors knowledge studies that aim to compare the effects of SSG and HIT on physical performance in adolescent soccer players are limited. Moreover, the comparison of effects on speed and vertical jump has not been carried out, especially during the last weeks of the season in adolescent soccer players. Therefore, the aim of this research was to determine the effects of SSG and HIT on vertical jump, speed and change of direction speed in adolescent soccer players.

## Methods

### Participants

A total of 60 young male soccer players (aged 14–18 years) were recruited. Written informed consent was obtained from the players and their parents. All participants were from a professional soccer club and completed on average 10 h 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.

### Procedures

Players' anthropometric characteristics and components of fitness were measured in the morning, at least 12 h fasted and 24 h from the last high-intensity exercise effort. Measurements were taken in the late April with final measurement in June. All study procedures took place at a football club outdoor facility. The same instructors tested the same participants and the fitness tests were performed in the same order with identical equipment, positioning, and technique. All participants took part in one introductory session during which time proper form and technique on each fitness test were reviewed and practiced. During this session assistants demonstrated proper testing procedures and participants practiced each test. After the training program, the players were instructed to perform the tests in the same order as they did before the training program. Participants were asked not to perform any vigorous physical activity the day before or the day of any study procedure. Basic anthropometric characteristics (Body weight and Body height) were measured, in accordance with the IBP program, on the day of the testing. Before each testing, the participants performed a standard 20-minute warm-up. Standard warm up protocol consisted of 10 min of warm up running and 10 min of dynamic stretching and 5 x 30m of running exercises.

Fitness of players was estimated by the following tests: Squat and countermovement jumps (with and without arm movement): SJ CMJ and the CMJAM were determined using a force platform (Quattro Jump, version 1.04, Kistler Instrument AG, Winterthur, Switzerland) at a sampling rate of 500 Hz. Jump height

was determined as the center of mass displacement, calculated from the recorded force and body mass. Subjects began the SJ at a knee angle of 90, avoiding any downward movement, and they performed a vertical jump by pushing upward, keeping their legs straight throughout. The position of the feet was standardized during all tests at shoulder width. The CMJ was begun from an upright position, making a downward movement to a knee angle of 90 and simultaneously beginning to push-off. One minute of rest was allowed between 3 trials of each test, the largest jump being used in subsequent analyses.

Acceleration and maximum running speed. The running speed of players was determined using a 20-m sprint effort with photocell gates (Microgate, Polifemo Radio Light, Italy) placed 0.4 m above the ground, with an accuracy of 0.001 ms. The timer was automatically activated as participants crossed the first gate at the starting line with split times at 5 m, and 10 m. Players were instructed to run as quickly as possible over the 20-m distance from a standing start (crouched start positioned 0.5 m behind the timing lights). Acceleration was evaluated using the time to cover the first 5 m of the 20-m test. Participants performed two trials with at least 3 min of rest between them. The best performance of the two tests was used for analysis.

Illinois agility test: The length of the field is 10m, while the width (distance between the start and finish points) is 5m. Four cones were placed in the center of the testing area at a distance of 3.3m from one another. Four cones were used to mark the start, finish and two turning points. The subjects started the test lying face down, with their hands at shoulder level. The trial started on the "go" command, and the subjects began to run as fast as possible. The trial was completed when the players crossed the finish line without having knocked any cones over. Three trials were performed by every subject with the best score used for analysis.

### Training Program

Players were assigned to SSG, or HIT group during the last 8 weeks of the season. In addition to the SSG and HIT 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 HIT and SSG parts. Heart rate responses were monitored during the HIT and SSG training sessions to provide the mean HR percentage (%HRmean) and the percentage of maximal HR (%HRmax) reached during training sessions. The maximum HR was determined as the peak HR observed during the IFT30-15.

### Hit 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 (Buchheit, 2008).

**Table 2** HIT Training Program

| Week | Protocol | VIFT Based Intensity |
|---|---|---|
| 1 | 3 sets (5 reps of 15"-15" HIT) | 90% VIFT |
| 2 | 3 sets (5 reps of 15"-15" HIT) | 90% VIFT |
| 3 | 3 sets (8 reps of 15"-15" HIT) | 90% VIFT |
| 4 | 3 sets (8 reps of 15"-15" HIT) | 90% VIFT |
| 5 | 4 sets (6 reps of 15"-15" HIT) | 95% VIFT |
| 6 | 4 sets (8 reps of 15"-15" HIT) | 95% VIFT |
| 7 | 4 sets (6 reps of 15"-15" HIT) | 95% VIFT |
| 8 | 4 sets (6 reps of 15"-15" HIT) | 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 have 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). The exercise program was performed during 8 weeks. The sessions were performed in 4×4 and 3x3 method in a 20×15m, 25x18 field. The protocol included several rule changes in order to increase the intensity of play. Maximum of two touches were allowed during first ten minutes. Moreover, each time the ball goes went out of play, the coach immediately fed in another ball resulting in a constant flow to 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. Because data were normally distributed, the variables were analyzed using a 2-way repeated measures analysis of variance with training group (2 levels: SSG group and HIT group) and time effect (before and after training) as factors. When a significant interaction was noted, Bonferroni post hoc test was conducted. Differences were considered significant at $p \leq 0.05$. The ESs of ,0.09, 0.10–0.49, 0.50–0.79, and .0.80 were considered trivial, small, moderate, and large, respectively (Cohen, 2013). Statistical analyses were processed using SPSS Statistics (SPSS Inc., Chicago, IL, USA, version. 16.0).

## Results

The %HRmean during the training sessions in the SSGs training group ranged between 88.6 ± 1.4% and 92.1 ± 1.1 % HRmax, which was not significantly different ($p > 0.05$) than the corresponding HIT group values (90.4 ± 1.1% and 93.5 ± 0.9% HRmax). The %HRmax reached during SSGs was 93.3 ± 1.3%, similar to that recorded by HIT group (94.2 ± 1.5%). There were no significant baseline fitness differences between the groups ($p > 0.05$).

**Table 3** Mean ± SD results of different fitness parameters before and after 8-week of HIT and SSG training

| | HIT group | | SSG group | |
|---|---|---|---|---|
| | Baseline | Final | Baseline | Final |
| SJ | 39.17±4.51 | 42.01±4.14* | 41.44±4.77 | 41.69±4.28 |
| CMJ | 39.81±4.82 | 46.45±6.54* | 41.58±4.77 | 42.64±4.34 |
| CMJAM | 49.01±5.05 | 50.16±5.09 | 51.68±4.62 | 51.52±4.10 |
| SP5 | 1.15±0.05 | 1.12±0.03* | 1.12±0.09 | 1.08±0.09* |
| SP10 | 1.94±0.13 | 1.92±0.05 | 1.86±0.11 | 1.84±0.11 |
| SP20 | 3.36±0.21 | 3.22±0.11* | 3.27±0.18 | 3.23±0.14 |
| Illinois | 15.68±0.51 | 14.85±0.35* | 14.92±0.37 | 15.12±0.55 |

*Data are presented as Mean±SD;*
** Significantly different from baseline, $p<0.05$;*
*SJ- squat jump; CMJ- countermovement jump;*
*CMJAM- countermovement jump with arm movement;*
*SP5- 5m sprint; SP10- 10sprint; SP20- 20m sprint.*

There was a significant improvement in the 5-m sprint following training in both groups ($p < 0.05$, small to moderate effects). There was a significantly greater improvement in the 20-m sprint ($p < 0.05$, large effect), Illinois ($p < 0.05$, large effect), SJ ($p < 0.05$, moderate effect), and CMJ ($p < 0.05$, large effect) following the HIT training compared with the SSG. No significant within- or between group differences were found in CMJAM, and SP10 following training ($p > 0.05$, trivial effect).

## Discussion

The aim of this study was to examine the effects of SSG and HIT on vertical jump, speed and change of direction speed in adolescent soccer players. The main finding of our study was that HIT training was more effective than SSG in maintaining or improving speed, COD and vertical jump in adolescent soccer players during the last weeks of the season.

We expected similar effects of both training methods having in mind similar high cardiorespiratory responses (Dellal et al, 2008). However, because the HIT program was performed at a running intensity slightly higher than that of the SSGs, and because in HIT, COD is consistently required at high speed (Dellal et al, 2012), the HIT showed greater improvements in COD when compared with the SSG.

Speed is considered to be an important aspect of soccer players' performance (Radziminski, Rompa, Barnat, Dargiewicz, & Jastrzebski, 2013). Nevertheless, Hill-Haas, Coutts, Rowsell, & Dawson (2009) found no significant changes in speed based on their investigation following generic and small-sided game training in soccer. Similarly, Radziminski et al, (2013) found no significant changes in 10 m and 30 m sprint. However, aforementioned authors found a slight improvement in the 5-m sprint time in the running group and SSG ($p= 0.04$ and $p = 0.06$, respectively), which is in line with our results. This acceleration was improvement probably due to speed-developing exercises applied to the both groups' players. Moreover, limiting ball touches per possession leads to the increase speed of the game and ball circulation between teammates (Dellal et al., 2011; San Román-Quintana et al., 2013), as well as the speed movement of the opponents which may significantly contribute to the improved reactions in players.

Another finding of this study was the significantly greater improvement in jumping performances after HIT training compared with SSG. Los Arcos et al., (2015) found no significant group differences in CMJ, and only possibly small practical impairment was found for SSG group compared to interval training in the last weeks of the season. Similar results were found in previous studies performed during pre-season and at the start of the in-season period (Hill-Haas, et al, 2009; Impellizzeri et al, 2006; Reilly & White, 2004; Radziminski et al, 2013). However, on the contrary, Dello Iacono, Beato, & Unnithan, (2019) found significant improvement in jumping performances after SSG training in elite young soccer players. This improvement could be due to the repetitive and more frequent high intensity efforts performed during the SSG in mentioned study. This inconsistency of results comes from the fact that different variables could influence the intensity of SSG. Coaches of adolescent players in soccer should change the rules and formats of SSGs not only according to the objectives of the training and the period of the season but also according to the level of team (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011). This was confirmed by Sarmento et al, (2018) in recent systematic review stating that different study designs provide a broader knowledge about the possible manipulations of the variables, which leads to the lack of consistency between studies, thus making it difficult to use the results from specific groups of players.

## Conclusions

There were some limitations. First, the absence of a control group participating only in the regular training sessions and playing the official matches without any of the experimental protocols, delimits conclusions from this study. There was no power analysis to determine the sample size. However, this is due to the population from which professional soccer players can be drawn, team with a common training background and usual habits. Finally, future studies should also measure more soccer-specific tests, technical skill tests but also reactive agility tests.

In conclusion, during the last weeks of the season, HIT training in addition to the technical and tactical training, improved or maintained fitness status in adolescent soccer players. On contrary, compared to HIT training, SSG training seems to maintain or even decrease the physical performance in the end of the season among adolescent soccer players.

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**Corresponding Author:**
Nenad Stojiljković, PhD
Faculty of sport and physical education
University of Niš, Serbia
Čarnojevića 10a, 18000 Niš
**email**: snesadif@yahoo.com

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