



Combined Small-Sided Game and High-Intensity Interval Training in Soccer Players: The Effect of Exercise Order

by

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The aim of the present study was to compare combined small-sided game (SSG) and high-intensity interval training (HIT) with different order. Twenty-one semi-professional soccer players were divided into two groups: SSG+HIT (n = 10) and HIT+SSG (n = 11), and underwent similar four-week training programs. Players completed the 30-15 Intermittent Fitness Test (30-15_{IFT}) before and after the experiment; maximum speed (V_{IFT}) was recorded. During the experiment, seven sessions of SSG (3 vs 3) and HIT (15"-15" with 95-100% V_{IFT}) were implemented. Weekly accumulated training loads for both groups during the experiment were similar. Moderate improvements in V_{IFT} were observed in both SSG+HIT (+6.2%, 90% confidence limits, [CL] 4.6; 7.7 and Effect Size, [ES] +0.96) and HIT+SSG (+6.9%, 90% CL 4.6; 9.3 and ES +0.97) groups. Between-group difference in changes of V_{IFT} was trivial (+0.7%, 90% CL -1.8; 3.3 and ES +0.11). Combining SSG and HIT in different order elicited the same enhancement in high-intensity intermittent performance in soccer players.

Key words: high-intensity intermittent performance, internal training load, 30-15 Intermittent Fitness Test, Association Football, SSGs, session rating of perceived exertion.

Introduction

Today, soccer is more intensified and physically demanding than in the last decade, and players need to cover about 30% greater distances above the high-intensity threshold (Barnes et al., 2014). Accordingly, soccer players need to have a high fitness profile to cope with the natural intensified demands of a match (Barnes et al., 2014; Bradley et al., 2009; Smpokos et al. 2018). Although soccer players need to have a multifactorial fitness status to perform better in the match (Sporis et al., 2009), high-intensity intermittent fitness is of paramount importance because it improves performance (Buchheit and Laursen, 2013; Kalinowski et al. 2019), shortens the recovery time after the match (Rabbani and Buchheit, 2016) and reduces the risk of injury (McCall et al., 2014).

While long-term preparation periods (≥ 8 -10 weeks) are usually used to develop young players' fitness profiles in soccer academies (Arcos et al., 2015; Buchheit and Rabbani, 2014; Impellizzeri et al., 2006; Radziminski et al., 2013), professional players usually undergo training periods of shorter duration (≤ 5 weeks) to enhance their fitness status during the preseason/ preparation period (Campos-Vazquez et al., 2017; Owen et al., 2012). Therefore, more effective and time-efficient training strategies including high-intensity interval and game-based conditioning interventions have usually been of special interest among practitioners (Buchheit et al., 2009; Campos-Vazquez et al., 2017; Dellal et al., 2012; Harrison et al., 2015; Rabbani and Buchheit, 2015).

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High-intensity interval training (HIT) as an effective and time-efficient method has been shown to improve intermittent running performance in soccer players (Buchheit and Rabbani, 2014; Helgerud et al., 2001; Impellizzeri et al., 2006). These fitness enhancements have also been reported to have some transferal effects to real match performance in soccer players (Helgerud et al., 2001; Impellizzeri et al., 2006). However, the lack of specificity has been noted as a limitation of running-based HIT interventions (Clemente et al., 2014b). Therefore, small-sided games (SSGs) have been introduced as a specific alternative to running-based HIT that simultaneously improves technical/tactical skills and fitness abilities of soccer players (Clemente et al., 2014a; Hill-Haas et al., 2011). However, higher inter-subject variabilities have been observed in SSGs than in HIT, suggesting a limitation of SSGs when individualizing training (Dellal et al., 2008).

Therefore, it seems that implementing SSGs or HIT, rather than using one of these alone, could have some inherent limitations with improving high-intensity intermittent running performance in soccer players. Indeed, the lack of specificity (Clemente et al., 2014b) and higher inter-subject variabilities (i.e., less standardization of training) (Dellal et al., 2008) have been highlighted as limitations of running-based HIT and SSG interventions, respectively. Interestingly, Harrison et al. (2015) have recently shown that combining SSGs and HIT is a more efficient strategy than implementing SSGs alone. Indeed, while participants in a group which combined both training methods showed large improvements in performance of the 30-15 Intermittent Fitness Test (30-15_{IIFT}, V_{IIFT}) (6.6%), those who trained using only SSGs experienced only a small enhancement (4.2%) (Harrison et al., 2015). Therefore, it seems that implementing a combined approach (SSG+HIT) is characterized by both the specificity (when using SSGs for sport-specific conditioning) (Hill-Haas et al., 2011) and individualization of training intervention (when using speed-based HIT for standardizing training stimuli at the individual level) (Rabbani and Buchheit, 2015) and would be a better option, particularly during pre-season preparations when there is a limited amount of time available to improve soccer players' fitness levels (Campos-Vazquez et al., 2017; Owen et al., 2012).

Sánchez et al. (2018) have recently compared the acute effects of SSGs when used in the early or late parts of a training session and reported that the time point of within-session SSG implementation may be a detrimental factor for acute physiological and/or performance responses. Therefore, changes in soccer players' fitness are induced by a combined SSG and HIT approach within a training session that may vary based on the order of their implementation (i.e., starting with SSG and then performing HIT or vice-versa). Some coaches may prefer to have fresh players in SSGs within a training session to optimize technical/tactical learning, but others may use SSGs after HIT to have players performing technical/tactical tasks under fatigue conditions (Van Cutsem et al., 2017). To the best of our knowledge, however, whether altering the order of combined SSGs and HIT, within training sessions, changes players' performance outcomes is yet to be determined. The results of such investigation would help practitioners gain evidence to determine whether they should be sensitive to the order of SSG or HIT implementation when using a combined approach. Comparing the effect of combined SSG and HIT interventions with different within-session order will also help researchers to better understand the effect that manipulating the order of these training strategies has on training outcomes. Therefore, the aim of the present study was to compare combined SSG and HIT training methods in different order during four weeks of pre-season preparation in soccer players.

Methods

Participants

Twenty-one male semi-professional soccer players participated in the present study. Before commencing the experiment, the participants were divided into two groups: SSG+HIT ($n = 10$, mean \pm SD, V_{IIFT} : 19.5 ± 1.1 km·h⁻¹, age: 23.2 ± 2.2 years; body height: 179.6 ± 8.1 cm; body mass: 72.9 ± 7.5 kg; years of training experience: 6.2 ± 3.1) and HIT+SSG ($n = 11$, mean \pm SD, V_{IIFT} : 19.1 ± 1.2 km·h⁻¹, age: 24.1 ± 3.7 years; body height: 179.3 ± 8.2 cm; body mass: 69.1 ± 8.8 kg). All players were selected from a single soccer team competing in the second division of the Iran soccer league. Before commencing the experiment, all subjects signed a written informed consent form after being informed of the potential risks and benefits of

participating in the study. All procedures were approved by a local research ethics committee, and the study protocol conformed to the Declaration of Helsinki.

Procedures

Testing

Players' high-intensity intermittent running performance was assessed using the 30-15_{IFT} before and after the four-week preparation phase (Buchheit, 2008). The 30-15_{IFT} is a field-based progressive maximal test with each stage consisting of 30 s running and 15 s recovery (Buchheit, 2008). The tests were performed between 4:00 and 5:00 p.m. under similar temperature conditions (24-26°C) on artificial turf. A 10-min general warm-up consisting of five minutes of jogging (forward, backward, and sideways) and five minutes of dynamic stretching preceded the maximal tests. A familiarization session had been also conducted to help players get acquainted with the maximal test protocol. The last stage reached during the 30-15_{IFT} (V_{IFT}) by each individual player was considered as his high-intensity intermittent fitness level. The 30-15_{IFT} was separated from vigorous training sessions by at least 72 hours. The wellness status of all players was monitored using self-reported measures (i.e., sleep, stress, fatigue, and soreness) to ensure the freshness of players before they performed the tests.

Training

The training period lasted four weeks during the summer. For both groups, training took place between 3:00 and 5:00 p.m. with a temperature range of 24 to 30°C. Aside from the order in which SSGs and HIT were implemented, both groups underwent similar technical/tactical and conditioning sessions. All training sessions were performed on a similar natural turf. The training period included four microcycles, with each microcycle lasting one week. The first and second microcycles consisted of three and five training sessions, respectively. The third and fourth microcycles both consisted of four training sessions. During the experiment, seven high-intensity sessions were implemented (Table 1). In the third and fourth microcycles, two non-official matches were played (Figure 1). All individual players played for one half (45 minutes) during each of these matches. The session rating of perceived exertion (sRPE) was recorded as the

internal training load during all training and match sessions (Impellizzeri et al., 2004) (Figure 2). The Borg's CR-10 scale was used in which 1 was very light activity and 10 was the maximal exertion in order to determine the perception of effort from the session. The value rated by the player was multiplied by the time of session in minutes (Impellizzeri et al., 2004). Players rated individually the session to minimize the influence of hearing or observing ratings of their colleagues (Clemente et al., 2017). The players were previously familiarized with the scale to increase the accuracy of the ratings.

Both SSG and HIT interventions consisted of two sets of three minutes of activity which were interspersed with three minutes of rest (work-to-rest ratio of 1:1). During all SSG sessions, only two touches were allowed while coach encouragements were provided. The floater in the pitch gave only a numerical advantage to the team with possession of the ball. Goals had the official dimensions. The pitch dimensions (25 × 35 m) were constant in all SSG exercises during the experiment; thus with an individual playing area of ~97 m² (including goalkeepers and the floater). Basal V_{IFT} was used as a reference for individuating HIT sessions which were performed in a linear condition without change of directions (Table 1)

Statistical Procedures

Data in the text and figures are presented as means with standard deviations (SD) or 90% confidence intervals (CI) when specified. Within-group changes in V_{IFT} and between-group differences in changes of V_{IFT} and sRPE (accumulated and weekly) were analyzed using magnitude-based inference (MBI) (Hopkins et al., 2009). Probabilities were also calculated to see whether the true changes/differences were lower than, similar to, or higher than the smallest worthwhile changes/differences (SWC, $0.2 \times$ between-subjects SD) (Hopkins et al., 2009). The Pearson correlation coefficient was calculated to assess the basal fitness level and the percentage of changes in V_{IFT} in all players. The magnitude of the correlation (r , 90% CI) was interpreted quantitatively as trivial (<0.1), small (0.1-0.29), moderate (0.3-0.49), large (0.5-0.69), very large (0.7-0.89) or nearly perfect (0.9-0.99) (Hopkins et al., 2009).

Results

Both groups showed moderate improvements in V_{IFT} following the experiment (Table 2). Between-group difference in changes of V_{IFT} , however, was trivial (Figure 3). The difference between the accumulated sRPE of the two groups was unclear and trivial (-2.1%, 90% confidence limits, [CL] -14.6; 12.2 and Effect Size -

0.10, CL -0.76; 0.56) (Figure 3). Between-group differences in sRPE were also unclear and trivial for all weeks (Figure 3). A large inverse relationship ($r = -0.52$, CL -0.75; -0.19) was observed between the basal fitness level and the percentage of changes in V_{IFT} in all soccer players.

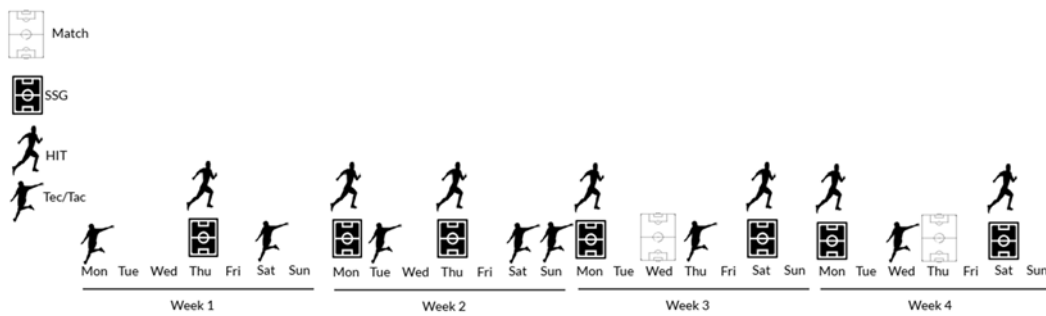


Figure 1

Training schedule during the experimental period.

Note. SSG: small-sided game; HIT: high-intensity interval training; Tec/Tac: technical and tactical training.

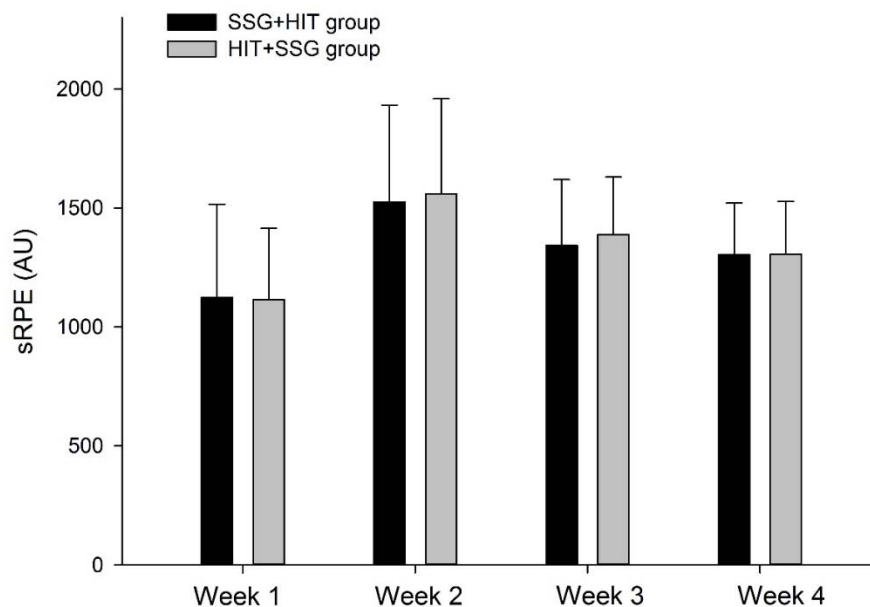


Figure 2

Weekly internal training loads during the experiment.

Note. sRPE: session rating of perceived exertion, SSG: small-sided game, HIT: high-intensity interval training.

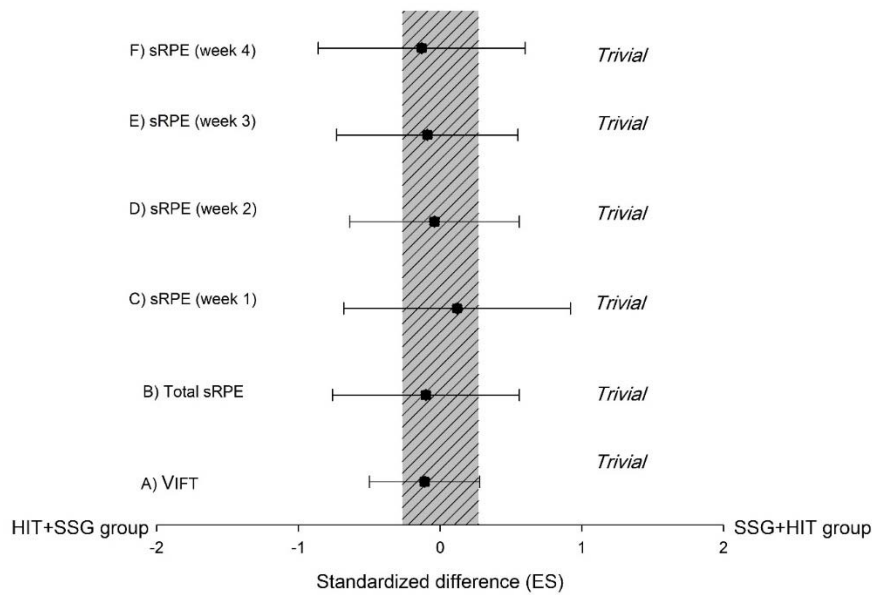


Figure 3

Between-group differences in charges of VIFT and internal training loads.

Note: sRPE: session rating of perceived exertion, SSG: small-sided game, HIT: high-intensity interval training, ES: effect size.

Table 1

Characteristics of small-sided games (SSG) and high-intensity interval training (HIT) programs

Week	Session	SSG	HIT
1	1	2 × (3 min of 3 vs 3 + GK+ F)	2 × (3min of 15"-15" at 95% of V _{IFT})
2	2	2 × (3 min of 3 vs 3 + GK+ F)	2 × (3min of 15"-15" at 95% of V _{IFT})
	3	2 × (3 min of 3 vs 3 + GK+ F)	2 × (3min of 15"-15" at 95% of V _{IFT})
3	4	2 × (3 min of 3 vs 3 + GK+ F)	2 × (3min of 15"-15" at 95% of V _{IFT})
	5	2 × (3 min of 3 vs 3 + GK)	2 × (3min of 15"-15" at 100% of V _{IFT})
4	6	2 × (3 min of 3 vs 3 + GK)	2 × (3min of 15"-15" at 100% of V _{IFT})
	7	2 × (3 min of 3 vs 3 + GK)	2 × (3min of 15"-15" at 100% of V _{IFT})

GK: presence of goalkeepers, F: one flouter in the pitch, V_{IFT}: Maximum speed reached in the last stage of the 30-15 Intermittent Fitness Test

Table 2
Within-group changes in high-intensity intermittent running performance

Group	Pre V _{IFT} (km·h ⁻¹)	Post V _{IFT} (km·h ⁻¹)	% difference (90% CL)	Standardized difference (90% CL) rating	% greater/similar/lower (90% CL) probability
SSG+HIT	19.55 (1.12)	20.75 (1.09)	6.2 (4.6; 7.7)	0.96 (0.72; 1.18) Moderate	100/0/0 Almost certain
HIT+SSG	19.18 (1.23)	20.50 (1.10)	6.9 (4.6; 9.3)	0.97 (0.65; 1.29) Moderate	100/0/0 Almost certain

SSG: Small-sided game, HIT: High-intensity interval training, V_{IFT}: Maximum speed reached in the last stage of the 30-15 Intermittent Fitness Test, CL: Confidence limits.

Discussion

In the present study, we compared the effect of implementing a combined SSG and HIT approach with different order within sessions on high-intensity intermittent running performance of soccer players. The main result is that while players in both groups whether starting with SSG (SSG+HIT) or HIT (HIT+SSG) experienced a moderate improvement in VIFT, there was a trivial difference in between-groups analyses.

Between-group differences in accumulated and weekly sRPEs were all trivial (Figure 3 and Table 2), suggesting that both groups tolerated similar internal training loads during the experiment. The magnitude of improvements in high-intensity intermittent running performance within groups (~ 7%, ES; 0.97) agreed with previously reported moderate enhancements following short time preparations in professional soccer players (Campos-Vazquez et al., 2017). The

players' high-intensity intermittent running performance improvements in the present study, however, were slightly lower (i.e., moderate vs. large effect) than changes of VIFT in combined groups in a study by Harrison et al. (2015). The less improvement may be pertinent to the lower number of high-intensity sessions performed in the present study (i.e., 7 vs. 12 sessions) and the lower basal fitness level of young players in VIFT (i.e., ~ 18.3 vs. 19.3 km·h⁻¹) in the study of Harrison et al. (2015). Indeed, it has been demonstrated that lower basal levels correlate with higher improvements in fitness status (Mann et al., 2014); the inverse moderate correlation ($r = -0.52$) observed in the present study between the initial VIFT levels of players and the subsequent changes following the interventions supports this.

While HR-based HIT interventions have not been successful in improving aerobic performance of soccer players in some studies (Jastrzebski et al., 2014; Radziminski et al., 2013),

VIFT-based HIT approaches have always been beneficial (Buchheit et al., 2009; Campos-Vazquez et al., 2017; Dellal et al., 2012; Harrison et al., 2015; Rabbani and Buchheit, 2015). Therefore, the results of the present study together with findings from previous studies in which VIFT has been used as a reference for individualizing HIT (Buchheit et al., 2009; Campos-Vazquez et al., 2017; Dellal et al., 2012; Harrison et al., 2015; Rabbani and Buchheit, 2015) suggest that using speed-based HIT is an efficient method for improving high-intensity intermittent running performance. Interestingly, the superiority of using the VIFT-based approach over the heart rate-based HIT approach has been recently highlighted in soccer players (Arazi et al., 2017; Rabbani and Buchheit, 2015). Indeed, VIFT not only highlights the aerobic power of players, but is also sensitive to acceleration, deceleration, anaerobic speed reserve, change of direction and recovery ability (Buchheit, 2008), causing the higher standardization of HIT individualization rather than targeting the cardiovascular system per se (Buchheit and Laursen, 2013).

A limitation of the present study is that only one dependent variable (high-intensity intermittent running performance) was measured. Other important soccer-specific fitness characteristics (e.g., acceleration speed, sprinting, jumping, repeated sprint ability) may respond differently to opposite order of SSG and HIT implementation in the combined approach. Supporting these statements, a recent study comparing the acute effects of SSGs in the early or late parts of a training session showed that the time point of SSG implementation within a training session might be a detrimental factor for physiological and/or performance responses (Sánchez et al., 2018). Implementing HIT before SSGs within training sessions may improve repeated sprint ability more than the opposite condition due to performing accelerations and sprints in a fatigued condition in the game. On the

other hand, implementing SSGs before HIT may result in greater improvements in speed-related components (e.g., acceleration, change of direction and sprints) and may also cause better tactical learning since players are fresh and can perform with their maximal potential during the SSG. Future studies involving more physiological and performance variables would help practitioners to better understand the longitudinal outcomes following combined SSG and HIT interventions with different order within training sessions. Another limitation of the present study is the low number of training sessions implemented by the soccer team in this study (i.e., three to five sessions per week). Indeed, while professional teams usually train for almost all weekly days or even sometimes have double training sessions per day during preparation phases, this was not the case in our study. Future studies in professional teams with higher training loads may help better understand the possible differences of implementing combined SSG and HIT training with different order. Conducting more investigations to compare the effects of combined SSG and HIT interventions with different order on multiple variables, including acceleration, change of direction, maximal sprint, and repeated sprint ability, is also recommended.

Practical Implications

The present study showed that while combined SSG and HIT training is an efficient approach during short time preparations (i.e., 4 weeks), implementing it using different order may produce the same high-intensity intermittent running performance outcome in soccer players. Therefore, manipulating the order of exercises in a combined approach, when aiming to improve high-intensity intermittent running performance, may be left to practitioners' discretion based on their preference of having either fresh or fatigued players in the SSG part of a training session.

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