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Original article

EFFECTS OF SMALL-SIDED GAMES AND HIGH INTENSITY INTERVAL TRAINING ON TRAINING LOAD AND PHYSIOLOGICAL RESPONSES IN AMATEUR SOCCER PLAYERS

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Abstract

Aim. This study was designed to compare the effects of 8-weeks of small-sided games versus high-intensity interval training on the internal training-load and physiological responses in the amateur soccer players' Under-17.

Methods.15 participants (aged 16.2 ± 0.2years, height 173 ± 2.5cm, weight, 56.4 ± 2.4Kg, body mass index 19.01 ± 1.3Kg/m2) performed pre and post measurements in training program for 8-weeks of small-sided games and high-intensity interval training. Measuring sessions in (resting heart-rate, maximum heart-rate, reserve heart-rate bpm and training-load with Borg rating of perceived exertion scale.

Results. The results indicated that the small-sided games (4vs4) displayed significantly higher heart-rate values in (maximum heart-rate, reserve heart-rate) and rating of perceived exertion indicators (monotony and constraint) compared with the high-intensity interval training (30/30s) ($p < 0.05$), in contrast to resting heart-rate and weekly load, which did not record statistical differences between both groups ($p < 0.05$).

Conclusions. These results indicate that the small-sided games (4vs4) group achieved greater improvements than the high-intensity interval training (30/30s) group, However, coaches should be aware that both training methods are applicable methodologies to improve in season heart-rate responses and training-load in amateur soccer players' under-17.

Keywords: Internal training-load, Heart-rate, Small-sided games, High-intensity interval training, amateur

Introduction

During a soccer match, at least 90 minutes, players typically cover a total distance (TD) of10-12 km, with especially 300 to 400 m in sprinting (Dellal et al., 2008). In fact, soccer game is a highly intermittent sport characterized by the repetition of short high-intensity movements and active rest needs a well-developed aerobic pathway, as it forms the basis of players' ability to recover between intense bouts.

Many training models have been employed to improve physical performance characteristics in soccer, such as high-intensity interval training (HIIT) used various training strategies to improve players' physical capacity (Dellal et al., 2008), (S. V. Hill-Haas et al., 2009). One of the recent and popular training strategies used is small-sided games (Dellal et al., 2008), (Reilly T and White C, 2004).

Small-sided games are compatible with soccer-specific match demands as regards technical-tactical skills and physical demands (endurance, repeated sprint, acceleration, and deceleration)(Aguiar et al., 2012). In fact, small-sided games can manipulate in terms of size of the pitch, number of players, and rules of the game (T. Gabbett et al., 2009), (Little & Williams, 2007), in order to develop simultaneously technical, tactics, and physical skills (T. J. Gabbett & Mulvey, 2008), (GAMBLE, 2004), (Little, 2009).

To accurate comparison of HIIT strategies, previous studies have compared the effects of different HIIT strategies with (SSGs) or without ball (RSA) on physical and physiological responses (Reilly T and White C, 2004), (Impellizzeri et al., 2006). Indeed, Reilly & White (Reilly T and White C, 2004) compared the effect of two models of HIIT training (sprint interval training (SIT) vs SSGs) on 18 young professional soccer players. They showed that both SIT and SSGs (5v5) with the same time pattern for working (4×6 minutes at 85–90% of the maximum heart rate (HR-max)), active recovery: 50–60% HR-max) are effective at improving aerobic and anaerobic fitness (Impellizzeri et al., 2006). Similarly, Hill-Haas et al, (S. V. Hill-Haas et al., 2009), showed no

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significant differences between different types of SSGs (3v3, 4v4, and 5v5) in terms of intensity (% HR-max), high maximal oxygen uptake [VO_2max], rating of perceived exertion [RPE], and concentration of lactate [La]).

Previous studies were clearly demonstrated that SSGs could be used as an effective training mode to enhance aerobic fitness and match performance in soccer players, and the intermittent exercise was characterized according to their intensity, duration of exercise, number of repetitions and the recovery intervals which cause a different physiological stress level and fatigue (Billat, 2001). Proved that the alternation of 30s intervals at the speed associated with maximal VO_2max oxygen uptake with 30s of active recovery (50% of VO_2max) is an effective form of exercise to sustainably solicit VO_2max. However, during intermittent exercises, the intensity of the recovery intervals is more dicult to calibrate because a too low intensity reduces the level of cardio ventilator stress and a too intense recovery induces a sign cant participation of lactic anaerobic metabolism (Canetti et al., 1969).

Some studies have shown that this type of training may have a positive influence on the aerobic capacity (Stephen V. Hill-Haas et al., 2011), (Impellizzeri et al., 2006), reported that both generic (e.g., intermittent running) and small-sided games training improves the distance covered in the Yo-Yo Intermittent Recovery Test Level 1 (YYIRTL1), which is considered a soccer-specific endurance test. Furthermore, Sassi et al. (Sassi R, Reilly T, 2004), reported that generic and specific interval training strategies, during 12-week, improve endurance between14-15% in both strategies. Additionally, Reilly & White (2004), reported that the small-sided games are acceptable substitutes for formal interval training to maintain physical fitness during the competitive season.

Exercise intensity in SSGs has typically been assessed via heart rate (HR), blood lactate concentration and rating of perceived exertion (RPE). Indeed, HR is the most common measure used for objectively monitoring training intensity in many sports (Nordhamn et al., 2000), and several studies have shown HR to be a valid indicator of exercise intensity in football (Radespiel-Tröger et al., 2003), (She et al., 2015). For example, the mean HR and oxygen consumption (VO_2) relationship have been reported to be similar during treadmill based intermittent exercise that reproduced the demands of a football game (Radespiel-Tröger et al., 2003). Similarly, several studies have shown that the HR/VO_2 relationship established in the laboratory is similar to the HR/ VO_2 relationship measured at different intensities during football specific exercises (5vs5 SSGs) (She et al., 2015).

Collectively, the findings indicate that HR is a valid measure of exercise intensity during football. Nowadays, SSGs are often used in soccer training to combine physiological, technical and tactical demands. To maximize adaptations during the demanding schedules of top-level soccer players, coaches should be able to carefully judge the impact of different SSG variables on training intensity in order to control training load (S. V. Hill-Haas et al., 2009), reviewed various factors influencing SSGs (e.g. pitch size or number of players) (Radespiel-Tröger et al., 2003).

Therefore, this study aimed to compare effects of small-sided games vs high intensity interval training on the internal training load (TL) and physiological responses on a team per season for a U-17 team in the same amateur football club. To our knowledge, there are very few studies evaluating and comparing both training methods on internal TL parameters and training heart rate between two groups of players of the same age and from the same football club, and such investigation is required to assess the physical exertion of players during training. Thus, a preference for training with small-sided games in terms of internal load (TL), weekly intensity, as well as heart rate was reported.

Methods

Participants

The data are presented from 15 youth soccer players (age 16.2±0.2, weight 56.4±2.4kg, High 173±2.5cm, BMI 19.01±1.3kg/m²) representing a team Under-17 Football (USTebessa) all players have over 6 years' experience of training, and competing at LFAF for youth. Random allocation within each pair to either a small-sided training group (EG (SSG), N=08, age 16.5±0.53, height 170±0.06cm, weight 58.1±7.17Kg and BMI 20±2kg/m^2) or a HIIT group (EG (HIIT), N=07, age 16.14±0.37, height 172±0.07cm, weight 57.44±6.2kg and BMI 19.51±1.72kg/m^2) (Table 1).

Table 1. Demographic characteristics of study sample

Sample	Number	Age	Height (cm)	Weight (kg)	BMI	Level
EG (SSG)	08	16.5±0.53	170±0.06	58.1±7.17	20±2.00	Amateur

EG (HIIT)	07	16.14±0.37	172±0.07	57.44±6.2	19.51±1.72

Note: EG: Experimental Groupe, SSG: Small-Sided Game, HIIT:High-Intensity Interval Training, BMI: Body Mass Index

Study program

This Study was made during the first weeks of the season 2020/2021 in the Algerian amateur football division for the youth categoriesafter a pre-season conditioning to avoid variations in player's physical fitness. This investigation took place over 8 weeks contains pre- and post-measurements with sixteen training units of SSG or HIIT, eight technical tactical sessions and eight preparation matches, the practice time was always (16:30p.m.) at the same time of the day to minimize the influence of circadian variations on performance.

During the entire duration of the study, players had the same type and volume of basketball training and HIIT or SSG were added to the training sessions to ensure that the differences observed could only be due to this additional training. Player's physical fitness. Additionally, during the training period, both training programs followed a periodization plan based on progression, considering the over training loads after each week, the type of recoveryand the pitch area for the SSG to optimize final performance. The HIIT training sessions consisted of intermittent running (30/30s) at 95%, 100% and 105% MAS of players followed by 15 seconds of active recovery (jogging). While the type of SSG used was 4v4 on full length (30m), and half width (20m) court.

Measurements & (TL) Quantification

Anthropometric measurements: The weight was measured in kg to the nearest 0.1kg using a regularly calibrated electronic balance. It is recommended to leave without shoes and in light clothing. Height was measured in centimetres to the nearest 0.5cm using a wall chart. The body mass was estimated to be near 0.1kg and the height to be close to 0.1cm.BMI was calculated as body weight (in kilograms)without shoes and with light clothing, divided by height (in meters) squared (Nordhamn et al., 2000).

Heart rate: The HR recording is done simultaneously by cardio frequency meter type T31 coded ™ belt (Polar Electro, Kempele, Finland) (Radespiel-Tröger et al., 2003). HR recordings were averaged every 5s on the YYRITL1 physical test set before and after, resting HR bpm and maximum HR bpm were recorded during the test and reserve HR bpm was calculated by Formula of karvonen target Heart Rate Intensity $Zone = [(\max HR - restingHR) \times \%Intensity] + restingHR$(She et al., 2015).

Quantification of Training Load: Internal TL (Rating of Perceived Exertion [RPE]): The TL was quantified daily using the session rating of perceived exertion (s-RPE) using Borg's 0–10 scale(Gomez et al., 2001), with "10" representing the most intense level, and "0" the least. Data were collected 15–20 min after each training session. Players were familiarised with the Borg scale since at least, the beginning of the season in question. The club's strength and conditioning coach verified each player's answers for accuracy. The s-RPE was calculated by multiplying the training session duration (minutes) by session RPE according to (Foster C et al, (Herman et al., 2006). It was then measured and presented in arbitrary units (AU) (Herman et al., 2006).

Table 2. Sessions characteristics of (SSG & HIIT)

TMs	Form	Surface	Space	Space for player	TW min	RBR min	Sets	RBS min	Session TW min	RPE	Heart rate
SSG	4vs4	30×20	600 m^2	75 m^2	4×3	1	2	3	24 mn	RPE	Reserve HR
HIIT	30/30s	100% MAS	Change of direction Running		4×3	1	2	3	24 mn	RPE	Maximum HR

Note: TMs: Training methods, MAS: Maximal Aerobic Speed, RBR: Recovery Between Repetitions, RBS: Recovery Between Sets, TW: Time of Work

Statistical analysis

Data are summarized as the mean and standard deviation of the mean$mean \pm SD$. Statistical analysis was performed using IBM SPSS version 22 statistical software. After a normal distribution test (Kolmogorov-Smirnov test), and in application theT-student test for dependent samples was used to compare all parameters measured before and after training, pre and post-test between training groups. A p value <0.05 was accepted as the minimum statistical significance, and it was calculated when calculating the ES, the pooled standard deviations (SD) were used$Cohen's D = [M1 - M2]/PooledSD$. Cohen's effect size (ES) statistic was used to determine the practical significance of observations(Jurišic et al., 2021). ES was classified as follows: 0.02 was defined as very small, 0.52 was defined as medium, 0.86 was defined as large (Ben-Shachar et al., 2020).

Results

During the 8-weeks of the experimental period, all players were able to complete the study according to the previously described study design and methodology. No injuries have been observed during the experimental period.

The heart rate responses during exercises measured among the two experimental groups (SSG & HIIT) before and after the training programs are illustrated in (Table3). Among SSG group, we recorded a significant improvement in maximum HR (P=0.001) and reserve HR(P=0.002) with no significant changes in the resting HR (P=0.6). However, for the HIIT group we recorded significantly improved only in the maximum HR (P=0.02).

Table 3. Heart rate responses during exercises measured between the two experimental groups (SSG & HIIT) before and after the training programs (N = 15)

Sample	HR-Measurements	Pre-measurements	Post-measurements	P value	ES
EG-SSG exercise (4vs4)	Resting HR bpm	64.37 ± 4.24	64.75 ± 4.24	0.6	0.08
	Maximum HR bpm	181.75 ± 4.13	179.0 ± 5.50	0.001**	0.5
	Reserve HR bpm	117 ± 5.71	107.50 ± 3.77	0.002**	0.7
EG-HIIT exercise (30/30s)	Resting HR bpm	67.24 ± 3.04	65.42 ± 3.35	0.2	0.2
	Maximum HR bpm	187.1 ± 5.14	181.28 ± 3.81	0.02*	0.5
	Reserve HR bpm	119.71±6.47	115.85±5.63	0.1	0.3

Table 4. Post training measurements of heart rate responses during exercises among the two experimental groups (SSG & HIIT) (N = 15)

HR Measurements	Resting HR bpm		Maximum HR bpm		Reserve HR bpm	
	Pre	Post	Pre	Post	Pre	Post
EG-SSG (4vs4)	64.38 ± 4.24	64.75 ± 4.24	181.75 ± 4.13	179 ± 5.50	117.38 ± 5.18	114.25 ± 5.82
EG-HIIT (30/30s)	67.43 ± 2.82	65.42 ± 3.11	187.14 ± 4.76	181.25 ± 4.2	119.71 ± 5.99	115.82 ± 6.45
Control	65.25±1.39	68.88±6.29	167.50±8.07	169.88±8.07	102.25±8.87	111±9.47
Groups	0.25 (0.12)		<0.0001(0.63)		<0.0001 (0.59)	
Time	0.474 (0.03)		0.036(0.19)		0.038(0.189)	
Time*groups	0.062(0.23)		0.006(0.39)		0.678(0.036)	

Post-Hoc
Reserve HR bpm: control vs HIIT: p <0.0001; control vs SSG: p <0.0001; HIIT vs SSG: p = 0.551
Maximum HR: control vs HIIT: p <0.0001; control vs SSG: p <0.0001; HIIT vs SSG: p = 0.170

Table 4. Present the results obtained of heart rate responses after the training programs between the two experimental groups (SSG & HIIT). We recorded a significant difference between the two groups for the

maximum HR (P = 0,001) and reserve HR (P = 0.008) in favour of the SSG group. While, no significant differences was observed in the resting HR (p <0,05).

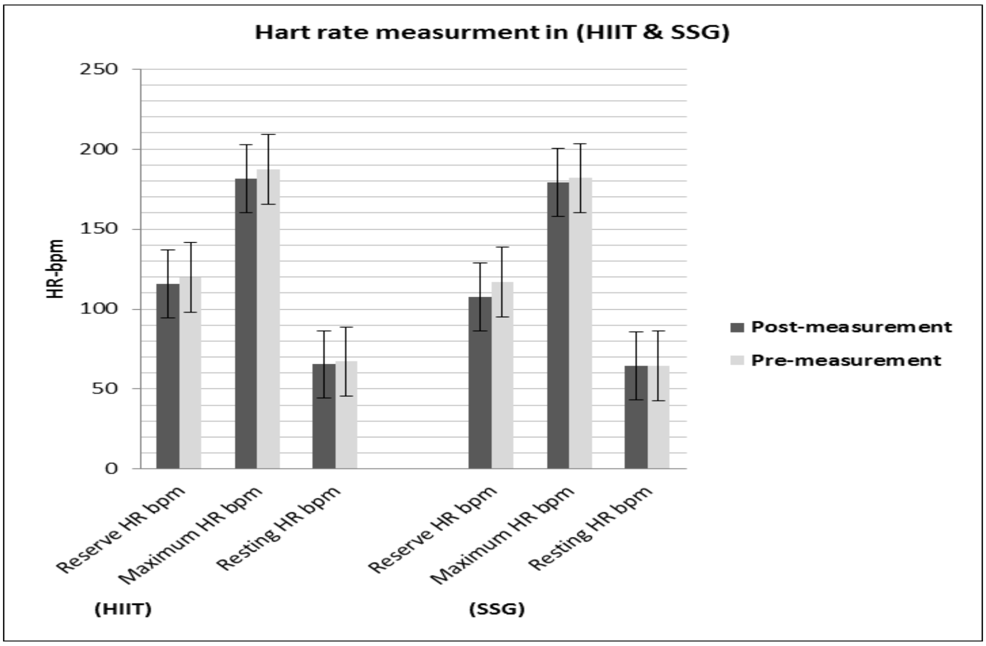

Figure 1. Show the heart rate measurement in small-sided games and High-Intensity Interval

Training RPE indicators responses between the two Experimental groups (SSG & HIIT) during the training program are reported in (Table 5). We recorded a significant improvement in favour of the SSG group in each of the RPE AU (P= 0.02), Monotony (P= 0.01) and Constraint (P= 0.005). While there were no significant differences (p > 0,05) in the weekly load between them.

Table 5. RPE indicators responses between the two experimental groups (SSG & HIIT) during the training programs (N = 15)

RPE indicators	EG-SSG exercise (4vs4)	EG-HIIT exercise (30/30)	Control	P value	ES
RPE (AU)	3.5 ± 0.3	4.1 ± 0.5	3±0.13	<0.0001	0.44
Weeklyload	1880.39±155.82	1845.86±155.39	1452.79±120.04	<0.0001	1.16
Monotony	1.40±0.19	1.65±0.28	1.80±0.42	0.069	0.30
Constraint	2623.42±575.59	3116.05±655.48	2597.53±536.01	0.160	0.29

Post-Hoc
RPE: control vs HIIT: p <0.0001; control vs SSG: p = 0.003; HIIT vs SSG: p = 0.002
Weekly load: control vs HIIT: p <0.0001; control vs SSG: p <0.0001; HIIT vs SSG: p = 0.638

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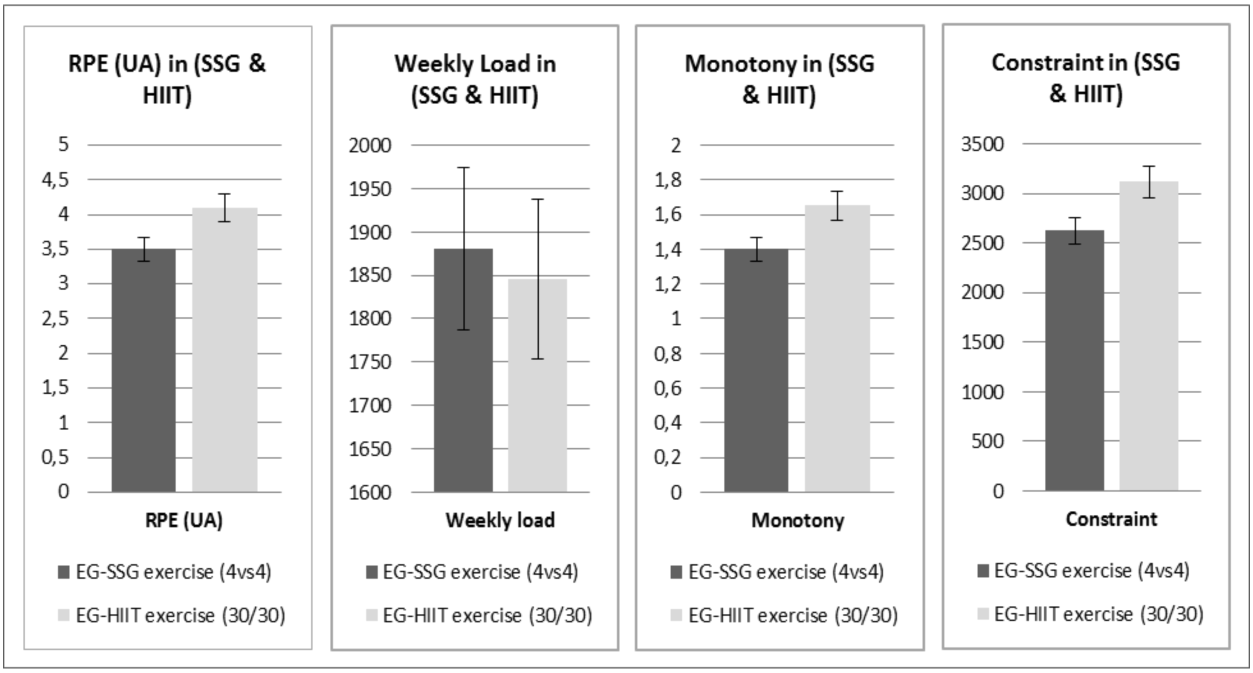

Figure 2. Show the RPE indicators responses in small-sided games and High-Intensity Interval Training

Discussions

The present study aims to compare the small-sided games (SSG) versus high-intensity interval training (HIIT) on the internal training load (TL) and physiological responses on the amateur soccer players U-17. The results indicated that both training methods (SSG and HIIT), after eight weeks of training, produced improvement in internal training load (TL) and physiological responses but the SSG group achieved greater improvements than the HIIT group.

Several studies have compared the physiological responses between generic interval training with football specific SSG training drills. Indeed, many studies have shown that the exercise intensity achieved during SSGs are similar to generic fitness training drills of similar duration (Balsom, Lindholm, Nilsson & Ekblom, 1999). For example, Sassi et al (2004). Compared the acute physiological responses of two formats of 4 versus 4 and 8 versus 8 SSGs with interval running (4×1000 meter repeats, separated by 150 seconds of recovery), using 11 elite professional players from a Spanish first division football club.Although there was no systematic manipulation of pitch area, game format (player number) or rule modifications in this study, the SSG formats elicited a greater %HR-max response compared with the interval running (91% vs 85% HR max) (Sassi R, Reilly T, 2004). More recently (Dellal et al., 2008), compared the HR response of short-duration (5 to 30-second efforts) high-intensity interval running with a variety of SSG formats, using ten elite footballers from a French first division football club. In contrast to the previous studies, only the two versus two (no goalkeepers) and eight versus eight (including goalkeepers) SSG formats generated similar HR responses compared with the short-duration interval running protocols. The 1 versus 1 (no goalkeepers) and 4 versus 4 (including goalkeepers) formats generated the lowest HR responses of both the SSGs and interval running (Dellal et al., 2008). In general, the results of these studies demonstrated that many smaller-format SSGs played on a relatively large pitch area per player, can elicit similar intensities to both long duration interval running(Sassi R, Reilly T, 2004),and short-duration high-intensity interval protocols (Dellal et al., 2008). However, it appears that the variability in exercise stimulus is greater in SSGs compared with generic interval training, which may be due to the unstructured and stochastic nature of the movement demands in SSGs.

It was found through the results of the study that there are several data in terms of monitoring effort and heart rate, as well as in terms of physical, and the study of (Chamari et al., 2005), investigated the effect of 8-weeks of training (twice per week) involving 15 young male soccer players on physiological responses to SSG. Once per week, players performed 4*4-minute bouts on the Hoff track at 90–95% HR-max, separated by 3-minute active recovery at 60–70% of HR-max. During the second session on the following day, players participated in 4vs4 SSG on a 20-m square pitch at the same intensity as session 1. The 3-minute active recovery involved 2 players passing and juggling with the ball. This training regime resulted in an increase in VO2max of 7.5% and a decrease in running economy of 14% while running at 7km.h(Jurišic et al., 2021). Sub maximal HR also decreased by 9 b.min^{-1}(Sassi R, Reilly T, 2004).Compared the responses of repetitive interval running with SSG (i.e., 4vs4 and 8vs8) training in top European league soccer players. Repetitive running consisted of 4*1,000 m runs, separated by 150 seconds of recovery. The authors concluded that SSG with the ball provided physiological training stimuli comparable with interval training without the ball. This was supported by the higher intensity observed, expressed as HR, during SSG (178±7 b.min^{-1}) than repetitive running (167±4 b.min^{-1}).

SSG have a great impact and response on the players in terms of physiology as proved by the study of (Dellal et al., 2012) compared the effects of soccer SSG vs. high-intensity intermittent training (HIIT) on the performance in a continuous aerobic test (Vameval) and in an intermittent test with changes of direction (30-15intermittent fitness test [30-15 IFT]). 22 amateur soccer players were divided into 3 groups (HIIT [n=8], SSG [n=8], and a control group [CG; n=6]). The SSG group performed 2 forms of training 2vs2 and 1vs1 on 2 different pitch areas (20 m× 20m and 15m× 10m, respectively), whereas the HIIT group performed 3 types of intermittent runs with passive recovery (30s– 30 s, 15s– 15s, and 10s– 10s). Both groups conducted 9 sessions of training for 6-weeks. High-intensity intermittent training and SSG groups showed significantly improved Vameval (5.1 and 6.6%, respectively) and 30-15 IFT (5.1 and 5.8%, respectively) performances, whereas no changes were observed for the CG Also, there were no differences between the 3 groups in the HR-max, HR-rest, and RPE before and after training. These results demonstrate that both SSG and HIIT training were equally effective in developing the aerobic capacity and the ability to perform intermittent exercises with change of direction in male amateur soccer players.

Some of these factors have been investigated to a large extent, for example the pitch dimensions (Owen et al., 2004), and the number of players (Torres-Ronda et al., 2015). Other factors, however, such as coach encouragement, have not been addressed sufficiently. There are only few studies, comparing the physiological response and rate of perceived exertion (RPE) during SSGs with and without coach encouragement (Impellizzeri et al., 2006). In these studies, the heart rate response showed no or only a moderate effect, but all findings confirmed an increased RPE when consistent coach feedback was provided. Highly demanding SSGs will potentially increase perceived exertion and may induce mental fatigue, thereby limiting the game performance of the players, as shown by (Smith et al., 2015).

Accordingly, the authors concluded that training with SSG works to maintain and allows the development of players in terms of physicality, as well as this compared with high-intensity reciprocal training as stated in many studies. In terms of training intensity via RPE, the results showed that there is a weekly high-intensity between SSG and HIIT between the averages, and there is no statistical significance and this was proven by the study of (Dellal et al., 2012).

These outcomes provide information to soccer coaches that situational conditioning training (small-sided games) can improve some kinds of physiological and physical performance essential to soccer similar and sometimes even better than traditional conditioning training (high-intensity interval training) like our results for (4vs4) in Physical preparation for the amateur soccer players under-17.

Conclusions

The results of our study showed that physiological and TL SSG may be useful for training to improve the fitness of football players because they can elicit HR responses around [80% and 90%] of HR-max. This indicates that SSG is more suitable for increasing physiological stress. This information is useful for coaches because they can modify or introduce rules to SSG through space, number of players and working time to adapt them to the requirements of the competition to increase the requirements of the heart and blood vessels. In addition, the results proved the existence of statistically significant differences between GE-SSG VS GE-HIIT. There was also a significant improvement for the HIIT group. The TL was not as different as expected; however, the four-sided SSG presented higher values and higher variability. HIIT provided good values and marked improvement for the players.

Therefore, all coaches must pay attention to these aspects, monitor the load during training and competition, and consider the physiological aspect.

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References

Aguiar, M., Botelho, G., Lago, C., MaçAs, V., & Sampaio, J. (2012). A review on the effects of soccer small-sided games. *Journal of Human Kinetics*, *33*(1), 103–113. https://doi.org/10.2478/v10078-012-0049-x.

Balsom, P., Lindholm, T., Nilsson, J., & Ekblom, B. (1999). Precision football. *Kempele, Finland: Polar Electro Oy*.

Ben-Shachar, M., Lüdecke, D., & Makowski, D. (2020). effectsize: Estimation of Effect Size Indices and Standardized Parameters. *Journal of Open Source Software*, *5*(56), 2815. https://doi.org/10.21105/joss.02815.

Billat, L. V. (2001). Interval training for performance: A scientific and empirical practice. Special recommendations for middle- and long-distance running. Part I: Aerobic interval training. *Sports Medicine*, *31*(1), 13–31. https://doi.org/10.2165/00007256-200131010-00002.

Canetti, G., Fox, W., Khomenko, A., Mahler, H. T., Menon, N. K., Mitchison, D. A., Rist, N., & Smelev, N. A. (1969). Advances in techniques of testing mycobacterial drug sensitivity, and the use of sensitivity tests in tuberculosis control programmes. *Bulletin of the World Health Organization*, *41*(1), 21–43.

Chamari, K., Hachana, Y., Kaouech, F., Jeddi, R., Moussa-Chamari, I., & Wisløff, U. (2005). Endurance training and testing with the ball in young elite soccer players. *British Journal of Sports Medicine*, *39*(1), 24–28. https://doi.org/10.1136/bjsm.2003.009985.

Dellal, A., Chamari, K., Pintus, A., Girard, O., Cotte, T., & Keller, D. (2008). Heart rate responses during small-sided games and short intermittent running training in elite soccer players: A comparative study. *Journal of Strength and Conditioning Research*, *22*(5), 1449–1457. https://doi.org/10.1519/JSC.0b013e31817398c6.

Dellal, A., Varliette, C., Owen, A., Chirico, E. N., & Pialoux, V. (2012). 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. *Journal of Strength and Conditioning Research*, *26*(10), 2712–2720. https://doi.org/10.1519/JSC.0b013e31824294c4.

Gabbett, T. J., & Mulvey, M. J. (2008). Time-motion analysis of small-sided training games and competition in elite women soccer players. *Journal of Strength and Conditioning Research*, *22*(2), 543–552. https://doi.org/10.1519/JSC.0b013e3181635597.

Gabbett, T., Jenkins, D., & Abernethy, B. (2009). Game-Based Training for Improving Skill and Physical Fitness in Team Sport Athletes. *International Journal of Sports Science & Coaching*, *4*(2), 273–283. https://doi.org/10.1260/174795409788549553.

GAMBLE, P. (2004). Football Players. *Strength And Conditioning*, *18*(3), 491–497.

Gomez, M., Behm, D. G., Haddad, M., Foster, C., Florhaug, J. A., Franklin, J., Gottschall, L., Hrovatin, L. A., Parker, S., Doleshal, P., & Dodge, C. (2001). A New Approach to Monitoring Exercise Training Related papers Monit oring Training Load, Recovery, Overt raining and Upper respirat ory Infect ion in Taekwondo A New Approach to Monitoring Exercise Training. *Journal of Strength and Conditioning Research*, *15*(1), 109–115.

Herman, L., Foster, C., Maher, M., Mikat, R., & Porcari, J. (2006). Validity and reliability of the session RPE method for monitoring exercise training intensity. *South African Journal of Sports Medicine*, *18*(1), 14. https://doi.org/10.17159/2078-516x/2006/v18i1a247.

Hill-Haas, S. V., Coutts, A. J., Rowsell, G. J., & Dawson, B. T. (2009). Generic versus small-sided game training in soccer. *International Journal of Sports Medicine*, *30*(9), 636–642. https://doi.org/10.1055/s-0029-1220730.

Hill-Haas, Stephen V., Dawson, B., Impellizzeri, F. M., & Coutts, A. J. (2011). Physiology of small-sided games training in football: A systematic review. *Sports Medicine*, *41*(3), 199–220. https://doi.org/10.2165/11539740-000000000-00000.

Impellizzeri, F. M., Marcora, S. M., Castagna, C., Reilly, T., Sassi, A., Iaia, F. M., & Rampinini, E. (2006). Physiological and performance effects of generic versus specific aerobic training in soccer players. *International Journal of Sports Medicine*, *27*(6), 483–492. https://doi.org/10.1055/s-2005-865839.

Jurišic, M. V., Jakšic, D., Trajkovic, N., Rakonjac, D., Peulic, J., & Obradovic, J. (2021). Effects of small-sided games and high-intensity interval training on physical performance in young female handball players. *Biology of Sport*, *38*(3), 359–366. https://doi.org/10.5114/BIOLSPORT.2021.99327.

Little, T. (2009). Optimizing the use of soccer drills for physiological development. *Strength and Conditioning Journal*, *31*(3), 67–74. https://doi.org/10.1519/SSC.0b013e3181a5910d.

Little, T., & Williams, A. G. (2007). Measures of exercise intensity during soccer training drills with professional soccer players. *Journal of Strength and Conditioning Research*, *21*(2), 367–371. https://doi.org/10.1519/R-19445.1.

Nordhamn, K., Södergren, E., Olsson, E., Karlström, B., Vessby, B., & Berglund, L. (2000). Reliability of anthropometrie measurements in overweight and lean subjects: Consequences for correlations between anthropometric and other variables. *International Journal of Obesity*, *24*(5), 652–657. https://doi.org/10.1038/sj.ijo.0801216.

Owen, A., Twist, C., & Ford, P. (2004). Small-Sided Games : the Physiological and Technical Effect of Altering Pitch Size and Player Numbers. *Insight*, *7*(2), 50–53.

Radespiel-Tröger, M., Rauh, R., Mahlke, C., Gottschalk, T., & Mück-Weymann, M. (2003). Agreement of two different methods for measurement of heart rate variability. *Clinical Autonomic Research*, *13*(2), 99–102. https://doi.org/10.1007/s10286-003-0085-7.

Reilly T and White C. (2004). Small-sided games as an alternative to interval training for soccer players. *J Sports Sci*, *22*, 355–358.

Sassi R, Reilly T, I. F. (2004). A comparison of small sided games and interval training in elite professional soccer players. *J Sports Sci*, *22*, 562.

She, J., Nakamura, H., Makino, K., Ohyama, Y., & Hashimoto, H. (2015). Selection of suitable maximum-heart-rate formulas for use with Karvonen formula to calculate exercise intensity. *International Journal of Automation and Computing*, *12*(1), 62–69. https://doi.org/10.1007/s11633-014-0824-3.

Smith, M. R., Coutts, A. J., & Marcora, S. M. (2015). *Mental Fatigue Impairs Soccer-Specific Physical and Technical Performance*. *August*. https://doi.org/10.1249/MSS.0000000000000762.

Torres-Ronda, L., Gonçalves, B., Marcelino, R., Torrents, C., Vicente, E., & Sampaio, J. (2015). Heart rate, time-motion, and body impacts when changing the number of teammates and opponents in soccer small-sided games. *Journal of Strength and Conditioning Research*, *29*(10), 2723–2730. https://doi.org/10.1519/JSC.0000000000000932.