Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989-9572

DOI:10.47750/jett.2025.16.04.04

Effects of High-Intensity Interval Training versus Small-Sided Games on Physical Performance in Young Football Players

Souheir Bouali[1], Mouhamed Amine Rahmoune[2], Okba Selmi[2,3], Khellaf Mohamed[4]

Journal for Educators, Teachers and Trainers, Vol.16(4)

https://jett.labosfor.com/

Date of Reception: 24 Feb 2025

Date of Revision: 20 Mar 2025

Date of Publication : 30 Apr 2025

Souheir Bouali[1], Mouhamed Amine Rahmoune[2], Okba Selmi[2,3], Khellaf Mohamed[4] (2025). Effects of High-Intensity Interval Training versus Small-Sided Games on Physical Performance in Young Football Players. ***Journal for Educators, Teachers and Trainers, Vol.16(4) 45-60***

Journal for Educators, Teachers and Trainers, Vol.16(4)

ISSN 1989-9572

https://jett.labosfor.com/

Effects of High-Intensity Interval Training versus Small-Sided Games on Physical Performance in Young Football Players

Souheir Bouali[1], Mouhamed Amine Rahmoune[2], Okba Selmi[2,3], Khellaf Mohamed[4]

[1]Laboratory of Analysis and Expertise of Sports Performance, Institute of Science and Technology of Physical and Sports Activities, Abdelhamid Mehri University of Constantine (Algeria).
[2]High Institute of Sports and Physical Education of Kef, University of Jendouba, El Kef (Tunisia).
[3]ResearchUnit, Sportive Sciences, Health and Movement, El Kef (Tunisia).
[4]Laboratory for Expertise and Analysis of Sports Performance «LEAPS» ISTAPS, Abdelhamid Mehri Constantine 2 University (Algeria).

E-mail of authors: souheirbouali@gmail.com[1], amine.iyad2040@gmail.com[2], okbaselmii@yahoo.fr[3], khellaf.mohammed@univ-constantine2.dz[4]

Abstract:

Football is a high-intensity sport demanding repeated efforts such as sprinting, rapid direction changes, and jumping. This study compared the effects of High-Intensity Interval Training (HIIT) and Small-Sided Games (SSG) on physical performance in young football players. Twenty-eight players (mean age: 17.5 ± 0.6 years) were randomly assigned to either HIIT (n=14) or SSG (n=14) groups. Over an 8-week period, both groups performed their respective training protocols twice a week. Pre- and post-training evaluations included the VAMEVAL test (for aerobic endurance), the five-jump test (5JT) for lower limb power, and the modified agility T-test. Results showed that HIIT led to a significant improvement in maximal aerobic speed (MAS) from 17.1 ± 0.67 km/h to 17.71 ± 0.41 km/h ($p < 0.001$, effect size (ES)= 1.26), while the SSG group improved MAS from 16.98 ± 0.83 km/h to 17.65 ± 0.51 km/h ($p < 0.001$, effect size = 0.95). The 5JT showed no significant change for HIIT ($p > 0.05$, ES = 0.1), but the SSG group improved from 11.8 ± 0.81 m to 12.3 ± 0.61 m ($p < 0.01$, ES = 0.33). Agility improved significantly in the SSG group (from 10.21 ± 0.36 to 9.91 ± 0.21 seconds, $p < 0.001$, ES = 0.75), whereas no significant change was observed in the HIIT group ($p > 0.05$, ES = 0.13). Additionally, the SSG group reported significantly higher physical enjoyment scores ($p < 0.001$, ES = 1.8). Both training methods improved aerobic performance, with Small-Sided Games (SSG) improving agility and lower limb power. These results suggest that combining both methods may optimize overall physical performance in young football players.

Keywords: High-Intensity Interval Training, Small-Sided Games, Aerobic performance, Agility, Lower limb power.

1. Introduction

Football is a sport that places significant physical demands on players through repeated high-intensity actions such as sprinting, repeated running efforts, rapid changes of direction, and jumping. As a result, training methods must closely replicate the physical demands encountered during competitive matches (Carril-Valdó et al., 2025; Buchheit & Laursen, 2013). In this context, players are required to maintain a high level of physical fitness to effectively cope with the intensity of the game (Silva et al., 2023).

Traditionally, coaches have relied on non-ball-based drills to enhance the physical conditioning of footballers (Selmi et al., 2018). High-intensity interval training (HIIT) has proven particularly effective in inducing muscular adaptations, notably by increasing mitochondrial enzyme activity, thereby enhancing energy production (Niknam et al., 2025). HIIT has also been shown to improve maximal oxygen uptake (VO_2max), running economy, and reduce lactate accumulation during submaximal efforts, contributing to improved aerobic performance (Buchheit & Laursen, 2013; Clemente et al., 2024).

More recently, research has demonstrated that football-specific exercises, such as small-sided games (SSGs), can maintain or even enhance physical capacity (Hill-Haas et al., 2011; Halouani et al., 2014; Luchesi et al., 2023; Owen et al., 2012; Selmi et al., 2020). Played on reduced-size pitches with fewer players, SSGs simultaneously engage physical, physiological, technical, and tactical components of the game (Clemente et al., 2021; Dellal et al., 2011; Nunes et al., 2024). For this reason, SSGs are widely used by coaches worldwide, as they faithfully replicate match demands while incorporating ball use, which encourages sport-specific engagement during training (Kunz et al., 2019; Selmi et al., 2020).

Moreover, several studies have shown that SSGs can elicit high levels of exertion, comparable to those experienced during matches, with heart rates reaching 80 to 90% of maximum heart rate (HRmax) (Impellizzeri et al., 2006; Halouani et al., 2014; Rampinini et al., 2007; Selmi et al., 2020). SSGs have also been shown to improve players' aerobic capacity and VO_2max (Hill-Haas et al., 2009; Selmi et al., 2020), while engaging similar energy systems to those activated during HIIT (Buchheit & Laursen, 2013; Clemente et al., 2024).

However, the intensity of effort during SSGs can vary significantly depending on multiple factors, including pitch size, number of players, playing rules, touch limitations, duration and number of repetitions, presence of goalkeepers, and ball availability (Clemente et al., 2021; Halouani et al., 2014; Owen et al., 2012).

To date, few studies have directly compared the effects of HIIT and SSG training on physical fitness and football-specific technical skills in youth players under the age of 16 (Selmi et al., 2017; Selmi et al., 2020). Notably, some reviews have reported that both methods yield similar benefits for aerobic capacity, power, speed, and football-specific performance, although their effects on neuromuscular qualities remain limited (Selmi et al., 2021). Therefore, the aim of the present study is to compare the effects of two training modalities (HIIT and SSG) on physical and physiological adaptations in young football players.

2. Methods

Participants

A total of twenty-eight soccer players from the same team in the national league participated in this study. The average training experience was 6.1 ± 1.31 years, with a weekly average of five training sessions and one match. Inclusion criteria were the absence of tobacco or alcohol use, and no history of acute or chronic diseases, ongoing medical treatments, or injuries. Goalkeepers were excluded from the study due to the unique nature of their physical training program. Participants were initially categorized based on their playing position (central defender, full-back, attacking midfielder, or forward) and then randomly assigned to one of two experimental groups: the SSG group (n = 14) and the HIIT group (n = 14). Random assignment was done using a coin toss method (Selmi et al., 2018). Prior to recruitment, a sample size calculation was conducted using G*Power software (Version 3.1.9.4, University of Kiel, Kiel, Germany). The analysis indicated that 28 participants would provide sufficient statistical power of 85.88%, which is adequate for detecting significant differences between the groups while minimizing the Type I error risk. Written informed consent was obtained from all participants, or their parents, to voluntarily take part in the study. The study received approval from the Human Research Ethics Committee and adheres to the institutional ethical standards for human research, in alignment with the Declaration of Helsinki. The participants' anthropometric characteristics are presented in table 1.

Table 1. Participants' anthropometric characteristics.

	Age (years)	Height (cm)	Weight (kg)	BMI ($kg.m^{-2}$)
RAMG (n=13)	17.4±0.6	177.9±3.8	70.3±5.5	22.3±1.1
RSAG (n=13)	17.6±0.5	177.5±2.8	69.9±4.6	22.2±1.0

The values are expressed as mean±SD. BMI: body mass index; RAMG: repeated agility method group; RSAG: repeated sprint ability group.

The study was conducted in Algeria during the 2023–2024 football season, over a period of eight weeks, immediately following the pre-season preparation phase. Two groups of players were formed, each following a specific training protocol either HIIT or SSG in addition to their regular training routine. These sessions were held twice per week, strictly supervised, and lasted 25 minutes following a standardized warm-up. Coaches provided equal supervision and motivation to both groups by offering verbal encouragement and football-specific technical instructions (Selmi et al., 2023; Sahli et al., 2020). Physical evaluations were conducted before and after the intervention period to assess the effects of the training programs on the players' physical condition. These assessments included anthropometric measurements, the VAMEVAL test to evaluate aerobic endurance, and the five-jump test (5JT) to assess lower limb power. All tests were administered by the same experimenters, at the same time of day for each participant, and under similar conditions, to ensure the reliability of the results and reduce the influence of daily biological fluctuations (Clemente et al., 2024). Players were instructed to avoid any strenuous physical activity the day before testing and to maintain consistent sleep and training routines throughout the study period (Selmi et al., 2017). Table 2 provides a summary of the training program implemented over the eight-week period.

Table 2. Description of the 6-week training program.

Week	Number of Sessions	HIIT Protocol	SSG Protocol
1–6	12	4 × 4 min (10″ work / 15″ rest) at 130% MAS 2 min passive rest between sets	4 × 4 min (4 vs. 4) at maximum effort 2 min passive rest between sets
7	-	Post-intervention testing	Post-intervention testing

MAS: Maximal Aerobic Speed; min: minute; s: second.

Small-Sided Games (SSG) and High-Intensity Interval Training (HIIT)

SSG were conducted on an outdoor natural grass field, with dimensions of 20 m × 28 m. The players participated in 4v4 matches, each lasting 4 minutes, followed by 2 minutes of passive recovery. The goal for the players was to perform at their best while maintaining possession of the ball for as long as possible. Two coaches were present to provide new balls as needed, ensuring the fluidity of the game (Selmi et al., 2020). These matches were played without a goalkeeper, and the

players were free to use the entire field to develop their tactical and technical skills (Selmi et al., 2023).

HIIT took place on the same type of outdoor field, where players ran a predetermined distance in 10 seconds of effort followed by 20 seconds of passive rest. This alternation between effort and recovery aimed to maximize the intensity and quality of the training. After each interval, players changed direction and ran the same distance in the opposite direction. The distance to be covered was individualized according to each player's maximal aerobic speed (MAS), set at 130% of their MAS (Selmi et al., 2020). This protocol was performed in four sets of 4 minutes, with a 2-minute passive recovery between each set. This approach optimally targeted both the aerobic and anaerobic capacities of the players while maintaining a high level of performance throughout the training session.

The Physical Enjoyment

To evaluate the participants' enjoyment of the physical training in this study, an 8-item scale was utilized, designed to assess the enjoyment of physical activity (Selmi et al., 2023). Participants were asked to rate their feelings toward the training they underwent using a 7-point Likert scale, where 1 represented "very enjoyable" and 7 signified "not enjoyable at all." The total score was calculated by summing the responses across all eight items, with a possible range from 8 to 56 points. A higher score indicated greater enjoyment of the physical activity. The internal consistency of the scale, as measured by Cronbach's α, was 0.87 for this study, indicating good reliability (Kendzierski & De Carlo, 1991; Mullen et al., 2011).

Physical Performance

Tests were assessed using the 5-Jump Test (5JT), Yo-Yo Intermittent Recovery Test (YIRT), and Modified Agility T-test. Participants were familiarized with the procedures, and the researchers were blinded to the study protocol during testing. Evaluations took place before and after the 8-week intervention, with the tests conducted over two days. On the first day, participants completed the Modified Agility T-test, followed by the 5JT after a 10-minute rest. On the second day, the YIRT was administered. A standardized 48-hour rest period was observed before testing, ensuring a consistent diet and sleep schedule to minimize external factors (Selmi et al., 2017). The 5JT measured explosive power and coordination of the lower limbs, with participants performing consecutive jumps on a natural grass surface. The total distance covered was measured to assess performance (Sassi et al., 2009). The YIRT evaluated aerobic endurance and recovery capacity during intermittent exercise. Participants completed 20-meter shuttle runs at progressively faster

speeds, with a 10-second passive recovery between stages. The test continued until participants could no longer maintain the required pace. The maximum velocity reached in the final stage was used to estimate Maximal Aerobic Speed (MAS), while the total distance covered provided an indication of endurance (Chtara et al., 2005). The Modified Agility T-test measured agility, with participants completing four directional changes: forward, sideways, and backward. They sprinted, shuffled, and ran backward in a set sequence, with agility times recorded using timing gates. Each participant completed three trials, and the best time was used for analysis (Sassi et al., 2009). A 10-minute warm-up, including sprinting, lateral movements, jumping, and dynamic stretching, preceded all tests.

Statistical Analyses

Statistical analyses were conducted using SPSS software (version 26.0 for Windows, SPSS Inc., Chicago, IL, USA). Data are presented as means ± standard deviation. Normality and homogeneity of variances were assessed using the Kolmogorov-Smirnov test. Paired t-tests were used to compare pre- and post-training results, while independent t-tests were applied to examine group differences in PACES scores, RPE, and physical performance. Effect size was calculated using the Hopkins threshold to assess the magnitude of differences between pre- and post-training. Effect size categories were classified as trivial (0 to 0.20), small (>0.20 to 0.50), moderate (>0.50 to 0.80), and large (>0.80). Statistical significance was accepted at the 95% confidence level ($p \leq 0.05$) (Hopkins et al., 2009).

3. Results

To ensure comparability between the two groups, baseline characteristics including age, height, body mass, and body fat percentage were measured. Consistent with the random assignment, no significant differences were found between the groups for these variables at baseline ($p > 0.05$, as determined by an independent t-test.

Physical enjoyment score is significantly higher in the SSG compared to the HIIT ($p < 0.001$, effect size (ES) = 1.8, considered a large effect) (Figure 1).

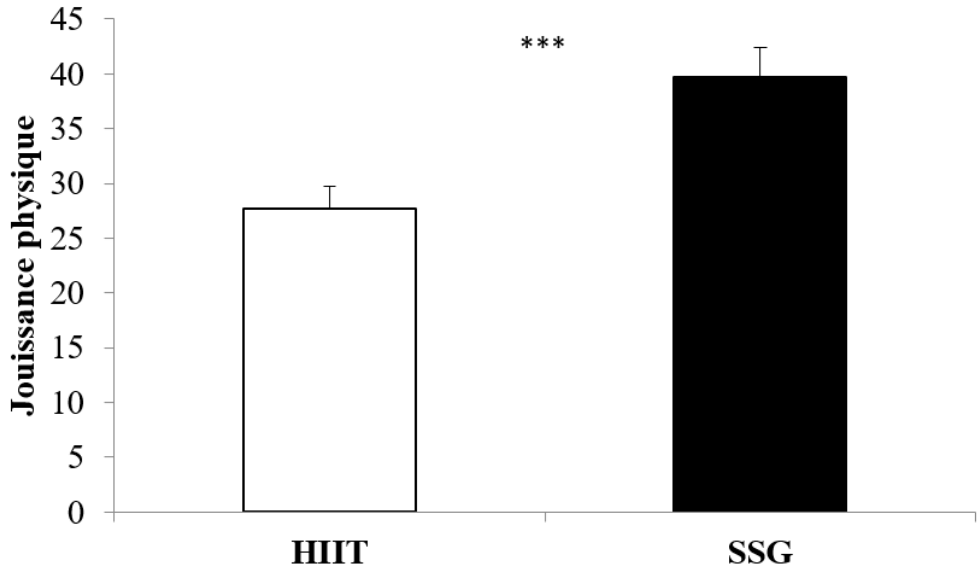

Figure 1. Comparison of physical enjoyment ratings between the SSG and HIIT groups. SSG: Small-sided games, HIIT: High-intensity interval training, ***p < 0.001.

The results show that HIIT training led to a significant improvement in maximal aerobic speed (MAS), with a large effect size (ES = 1.26), while the SSG group also improved MAS, but with a slightly smaller effect (ES = 0.95). No significant change was observed in the 5-jump performance for the HIIT group (ES = 0.1), whereas the SSG group showed a moderate improvement (ES = 0.33). Regarding agility, the SSG group recorded a notable improvement (ES = 0.75), in contrast to the HIIT group, which showed no significant progression (ES = 0.13) (table 1 and figure 2).

Table 3. Mean (± SD) values of physical performance variables for high-intensity interval training (HIIT) and small-sided games (SSG), assessed before (T0) and after (T1) the six-week training period.

Variable	Groupe	T1	T2	|d|	ES	Effet
MAS (Km/h)	HIIT	17.1 ± 0.67	17.71 ± 0.41	0.61 ***	1.26	Large
MAS (Km/h)	SSG	16.98 ± 0.83	17.65 ± 0.51	0.67 ***	0.95	Large
5JT (m)	HIIT	11.9 ± 0.81	11.8 ± 0.71	0.1	0.1	Trivial
5JT (m)	SSG	11.8 ± 0.81	12.3 ± 0.61	0.50**	0.33	Moderate
Agility T test (s)	HIIT	10.19 ± 0.50	10.15 ± 0.48	0.05	0.13	Trivial
Agility T test (s)	SSG	10.21 ± 0.36	9.91 ± 0.21	0.30 ***	0.75	Small

MAS: Maximal aerobic speed; 5JT : five jump test ; ES: effect size. * *p < 0.01; *** p < 0.001.

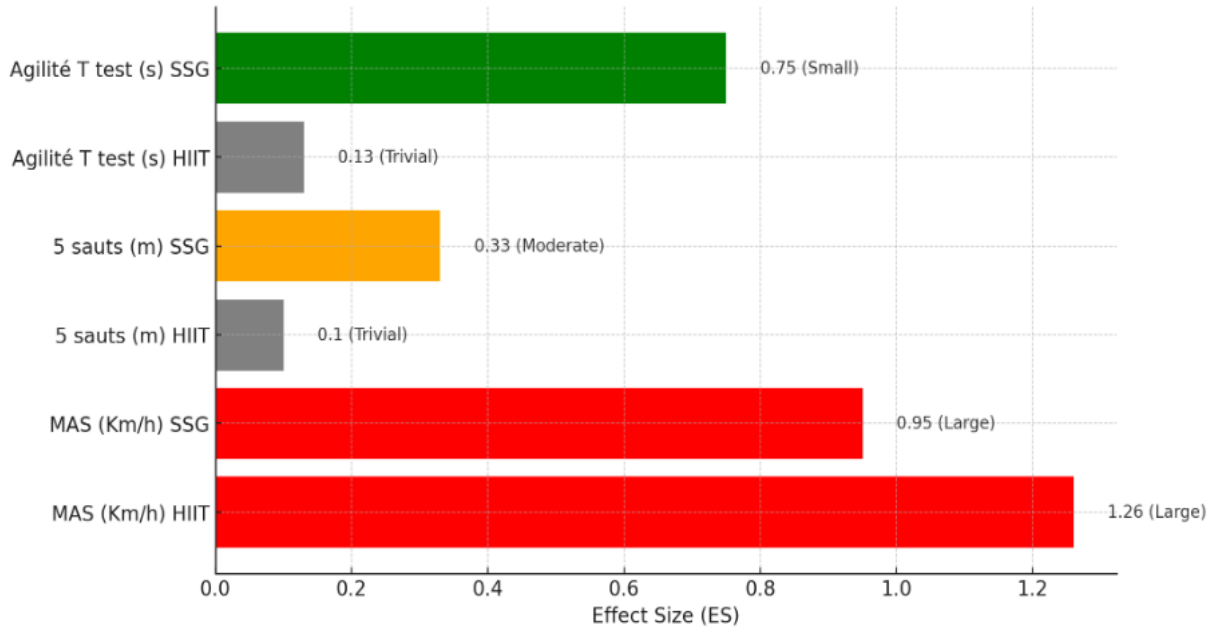

Figure 2. displaying the effect sizes (ES) for the different variables, along with their corresponding effect categories. The colors represent the magnitude of the effect, with "Large," "Moderate," "Small," and "Trivial" labeled next to each value.

4. Discussion

The primary objective of this study was to assess the impact of two different training protocols, namely SSG and IHIIT, on soccer players' physical performance and enjoyment. The results indicate that both methods effectively improved maximal aerobic speed (MAS), with each protocol offering distinct benefits. While HIIT led to a slightly larger improvement in MAS, SSGs also contributed to enhanced aerobic endurance while focusing on agility and lower limb power. These findings highlight the unique advantages of each method and provide valuable insights for practical application in training programs.

The results indicate that HIIT was more effective in improving MAS. The HIIT group demonstrated a significant improvement in MAS with a large effect size (1.26), which aligns with existing literature emphasizing the benefits of HIIT for aerobic capacity. Numerous studies have shown that HIIT significantly improves MAS and aerobic endurance in team sport athletes such as football players (Buchheit & Laursen, 2013; Hov et al., 2023). The interval-based training, due to its intensity and the stimulation of both aerobic and anaerobic systems, improves the body's ability to sustain prolonged effort, which is crucial for football performance.

In contrast, although the SSG group also showed improvement in MAS, this improvement was less pronounced (effect size = 0.95). SSG, while beneficial for technical, tactical, and football-

specific skills, appear to have a less significant impact on pure aerobic endurance compared to HIIT, which is more targeted towards this capacity. This difference can be explained by the fact that SSGs, despite being dynamic, include longer recovery phases that limit continuous aerobic intensity (Hill-Haas et al., 2011 ; Paprancová et al., 2024. Selmi et al., 2O20).

For other performance tests such as the 5-jump test (measuring lower limb power) and the modified agility test, notable differences between the two groups were also observed. The SSG group showed a moderate improvement in power (effect size = 0.33) and a significant improvement in agility (effect size = 0.75), whereas the HIIT group showed no significant changes in these areas. This suggests that SSGs, with their dynamic game format and the need for rapid movement and frequent direction changes, are more suited for developing agility and lower limb power than HIIT, which is more focused on power and aerobic endurance. Previous studies have demonstrated that SSGs are particularly effective in improving agility and motor coordination in match-simulated contexts (Casamichana et al., 2013; Wang et al., 2024 ; Wen et al., 2024).

An important aspect of this study was the measurement of participants' physical enjoyment. The SSG group reported a significantly higher enjoyment score compared to the HIIT group, with a large effect size (1.8). The enjoyment experienced by players is a crucial factor in maintaining long-term motivation and engagement in a training program. SSGs, which involve small-sided matches, offer players a more playful and engaging experience, which may explain their higher enjoyment compared to HIIT, which is often perceived as more monotonous and demanding. This finding is consistent with several studies that highlight enjoyment during exercise as a key factor in maintaining athletes' commitment to long-term training programs (Los Arcos et al., 2015 ; Selmi et al., 2020 ; Selmi et al., 2023). In particular, small-sided games, due to their social and competitive dimension, enhance emotional engagement and intrinsic motivation (Clemente et al., 2025 ; Farhani et al., 2024 ; López-Fernández et al., 2020).

The results suggest that enjoyment is a critical factor to consider when planning training programs, especially when the goal is to maintain player motivation and overall satisfaction (Selmi et al., 2023). It is possible that the players in the SSG group found more satisfaction in their training due to the social and competitive nature of the games, compared to those in the HIIT group, where the focus is more on individual performance in a high-intensity context (Selmi et al., 2020).

Practical implications

The results of this study offer valuable insights for football coaches. Both HIIT and SSGs are effective in improving aerobic endurance, each with its own strengths. HIIT enhances MAS and

the ability to sustain high-intensity efforts, which are crucial in modern football. Meanwhile, SSGs improve endurance, agility, and football-specific skills like quick decision-making and tactical adaptation. Additionally, the social and engaging nature of SSGs boosts player motivation and team cohesion. By integrating both methods, coaches can address multiple aspects of player performance, promoting both fitness and skill development.

Study limitations and future directions

While this study provides interesting results, there are some limitations. First, the sample size was relatively small (28 players), which may limit the generalizability of the findings. Additionally, the study did not measure other important aspects of fitness, such as recovery after exertion or chronic fatigue. Moreover, the evaluation of technical performance was limited by the lack of specific measures for skills such as passing, dribbling, or shooting, which are essential for soccer. Lastly, the duration of the intervention (8 weeks) is relatively short to observe long-term changes in some fitness qualities. Future studies could expand the sample size, extend the intervention period, and include more detailed measurements on recovery, fatigue, and technical performance. It would also be valuable to explore the combined effects of SSGs and HIIT on various aspects of performance to determine whether a combined approach could offer the benefits of both training methods.

Conclusion

Both HIIT and SSG effectively improved aerobic endurance in soccer players, with both methods enhancing MAS. The HIIT group showed a larger improvement in MAS, making it particularly effective for aerobic capacity. However, the SSG group also demonstrated significant gains, highlighting the value of small-sided games not only for endurance but also for improving lower limb power and agility. Thus, while HIIT targets endurance more directly, SSGs provide a more holistic approach by integrating power development and maintaining player engagement, suggesting that a combination of both methods could optimize overall performance.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication

Acknowledgments

The authors thank all youth female soccer players who participated in this study.

Conflict of interest

The authors declare no conflict of interest

References

1. Carril-Valdó, J. J., Ferrandis, J., Claver, F., Gil-Arias, A., & González-Rodenas, J. (2025). Comparison of physiological and physical demands between small-sided games and official matches in youth football players. Sport Sciences for Health, 1-8.
2. Silva, H., Nakamura, F. Y., Beato, M., & Marcelino, R. (2023). Acceleration and deceleration demands during training sessions in football: a systematic review. Science and Medicine in Football, 7(3), 198-213.
3. Niknam, A., Gaeini, A. A., Hamidvand, A., Jahromi, M. K., Oviedo, G. R., Kordi, M., & Safarpour, F. (2025). High-intensity functional training modulates oxidative stress and improves physical performance in adolescent male soccer players: a randomized controlled trial. BMC Sports Science, Medicine and Rehabilitation, 17(1), 38.
4. Clemente, F. M., Moran, J., Ramirez-Campillo, R., Beato, M., & Afonso, J. (2024). Endurance performance adaptations between SSG and HIIT in soccer players: A meta-analysis. International Journal of Sports Medicine, 45(03), 183-210.
5. 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*(06), 483-492.
6. Luchesi, M. S., Couto, B. P., Gabbett, T. J., Praça, G. M., Oliveira, M. P., & Sayers, M. G. (2023). The influence of the field orientation on physical demands in soccer small-sided games. International Journal of Sports Science & Coaching, 18(1), 143-151.
7. Buchheit, M., & Laursen, P. B. (2013). High-intensity interval training, solutions to the programming puzzle: Part I: cardiopulmonary emphasis. *Sports medicine*, *43*(5), 313-338.
8. Nunes, N. A., Santos, F., Coutinho, D., Olthof, S., & Sampaio, M. (2024). Coaches' perspectives of the use of small-sided games in the professional soccer training environment. Journal of Kinesiology and Exercise Sciences, 109(35), 27-39.
9. Hov, H., Wang, E., Lim, Y. R., Trane, G., Hemmingsen, M., Hoff, J., & Helgerud, J. (2023). Aerobic high-intensity intervals are superior to improve V̇O2max compared with sprint intervals in well-trained men. Scandinavian Journal of Medicine & Science in Sports, 33(2), 146-159.
10. Paprancová, A., Šimonek, J., Paška, L. U., & Krčmár, M. (2024). Impact of small-sided games and running-based high-intensity interval training on physical performance in female football players. Journal of Physical Education and Sport, 24(1), 113-122.

11. Wen, XiaoYuan, et al. (2024). Small-sided soccer games promote greater adaptations on vertical jump and change-of-direction deficit and similar adaptations in aerobic capacity than high-intensity interval training in females. Journal of Sports Science & Medicine, 23(2), 445.

12. Wang, R., Li, Q., & Xue, W. (2024). Effects of small-sided game training on lower limb explosive strength in handball players: a single-arm meta-analysis. Frontiers in Sports and Active Living, 6, 1477347.

13. Los Arcos, Asier, et al. (2015). Effects of small-sided games vs. interval training in aerobic fitness and physical enjoyment in young elite soccer players. PLoS ONE, 10(9), e0137224.

14. Selmi, O., Haddad, M., Majed, L., Khalifa, B., Hamza, M., & Chamari, K. (2017). Soccer training: high-intensity interval training is mood disturbing while small sided games ensure mood balance. *The Journal of sports medicine and physical fitness*, *58*(7-8), 1163-1170.

15. Clemente, F. M., Afonso, J., & Sarmento, H. (2021). Small-sided games: An umbrella review of systematic reviews and meta-analyses. PLoS ONE, 16(2), e0247067.

16. Iaia, F.M.; Rampinini, E.; Bangsbo, J. (2009). High-Intensity Training in Football. Int. J. Sports Physiol. Perform., 4, 291–306.

17. 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. J. Strength Cond. Res., 22, 1449–1457.

18. Selmi, O., Ouergui, I., Levitt, D. E., Nikolaidis, P. T., Knechtle, B., & Bouassida, A. (2020). Small-sided games are more enjoyable than high-intensity interval training of similar exercise intensity in soccer. *Open access journal of sports medicine*, 77-84.

19. Dupont, G.; Blondel, N.; Berthoin, S. (2003). Performance for short intermittent runs: Active recovery vs. passive recovery. Eur. J. Appl. Physiol., 89, 548–554.

20. Fiorenza, M.; Lemminger, A.K.; Marker, M.; Eibye, K.; Iaia, F.M.; Bangsbo, J.; Hostrup, M. (2019). High-intensity exercise training enhances mitochondrial oxidative phosphorylation efficiency in a temperature-dependent manner in human skeletal muscle: Implications for exercise performance. FASEB J., 33, 8976–8989.

21. Halouani, J.; Chtourou, H.; Gabbett, T.; Chaouachi, A.; Chamari, K. (2014). Small-sided games in team sports training: A brief review. J. Strength Cond. Res., 28, 3594–3618.

22. Hill-Haas, S.V.; Coutts, A.J.; Dawson, B.T.; Rowsell, G.J. (2010). Time-motion characteristics and physiological responses of small-sided games in elite youth players: The influence of player number and rule changes. J. Strength Cond. Res., 24, 2149–2156.

23. Dellal, A.; Hill-Haas, S.; Lago-Penas, C.; Chamari, K. (2011). Small-sided games in soccer: Amateur vs. professional players' physiological responses, physical, and technical activities. J. Strength Cond. Res., 25, 2371–2381.

24. Rampinini, E.; Impellizzeri, F.M.; Castagna, C.; Abt, G.; Chamari, K.; Sassi, A.; Marcora, S.M. (2007). Factors influencing physiological responses to small-sided soccer games. J. Sports Sci., 25, 659–666.

25. Selmi, O.; Marzouki, H.; Ouergui, I.; BenKhalifa, W.; Bouassida, A. (2018). Influence of intense training cycle and psychometric status on technical and physiological aspects performed during the small-sided games in soccer players. Res. Sports Med., 26, 401–412.

26. Hill-Haas, S.V.; Dawson, B.; Impellizzeri, F.M.; Coutts, A.J. (2011). Physiology of small-sided games training in football: A

27. Castellano, J.; Casamichana, D.; Dellal, A. Influence of game format and number of players on heart rate responses and physical demands in small-sided soccer games. J. Strength Cond. Res. 2013, 27, 1295–1303.

28. 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. J. Strength Cond. Res. 2012, 26, 2712–2720.

29. Los Arcos, A.; Vazquez, J.S.; Martin, J.; Lerga, J.; Sanchez, F.; Villagra, F.; Zulueta, J.J. Effects of Small-Sided Games vs. Interval Training in Aerobic Fitness and Physical Enjoyment in Young Elite Soccer Players. PLoS ONE 2015, 10, e0137224.

30. Selmi, O.; Khalifa, W.B.; Ouerghi, N.; Amara, F.; Zouaoui, M.; Bouassida, A. Effect of the Verbal Encouragement on Psychophysiological and Affective Responses during Small-Sided Games. Int. J. Environ. Res. Public Health 2020, 29, 8884.

31. Toh, S.H.; Guelfi, K.J.; Wong, P.; Fournier, P.A. Energy expenditure and enjoyment of small-sided soccer games in overweight boys. Hum. Mov. Sci. 2011, 30, 636–647.

32. Halouani, J.; Chtourou, H.; Dellal, A.; Chaouachi, A.; Chamari, K. Soccer small-sided games in young players: Rule modification to induce higher physiological responses. Biol. Sport 2017, 34, 163–168.

33. Hammami, A.; Kasmi, S.; Farinatti, P.; Fgiri, T.; Chamari, K.; Bouhlel, E. Blood pressure, heart rate and perceived enjoyment after small-sided soccer games and repeated sprint in untrained healthy adolescents. Biol. Sport 2017, 3, 219.

34. Dellal, A.; Drust, B.; Lago-Penas, C. Variation of activity demands in small-sided soccer games. Int. J. Sports Med. 2012, 33, 370–375.

35. Dellal, A.; Lago-Penas, C.; Wong Del, P.; Chamari, K. Effect of the number of ball contacts within bouts of 4 vs. 4 small-sided soccer games. Int. J. Sports Physiol. Perform. 2011, 6, 322–333.

36. Kennett, D.C.; Kempton, T.; Coutts, A.J. Factors affecting exercise intensity in rugby-specific small-sided games. J. Strength Cond. Res. 2012, 26, 2037–2042.

37. Castellano, J.; Casamichana, D.; Dellal, A. (2013). Influence of game format and number of players on heart rate responses and physical demands in small-sided soccer games. J. Strength Cond. Res., 27, 1295–1303.

38. 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. J. Strength Cond. Res., 26, 2712–2720.

39. Los Arcos, A.; Vazquez, J.S.; Martin, J.; Lerga, J.; Sanchez, F.; Villagra, F.; Zulueta, J.J. (2015). Effects of Small-Sided Games vs. Interval Training in Aerobic Fitness and Physical Enjoyment in Young Elite Soccer Players. PLoS ONE, 10, e0137224.

40. Selmi, O.; Khalifa, W.B.; Ouerghi, N.; Amara, F.; Zouaoui, M.; Bouassida, A. (2020). Effect of the Verbal Encouragement on Psychophysiological and Affective Responses during Small-Sided Games. Int. J. Environ. Res. Public Health, 29, 8884.

41. Toh, S.H.; Guelfi, K.J.; Wong, P.; Fournier, P.A. (2011). Energy expenditure and enjoyment of small-sided soccer games in overweight boys. Hum. Mov. Sci., 30, 636–647.

42. Halouani, J.; Chtourou, H.; Dellal, A.; Chaouachi, A.; Chamari, K. (2017). Soccer small-sided games in young players: Rule modification to induce higher physiological responses. Biol. Sport, 34, 163–168.

43. Hammami, A.; Kasmi, S.; Farinatti, P.; Fgiri, T.; Chamari, K.; Bouhlel, E. (2017). Blood pressure, heart rate and perceived enjoyment after small-sided soccer games and repeated sprint in untrained healthy adolescents. Biol. Sport, 3, 219.

44. Dellal, A.; Drust, B.; Lago-Penas, C. (2012). Variation of activity demands in small-sided soccer games. Int. J. Sports Med., 33, 370–375.

45. Dellal, A.; Lago-Penas, C.; Wong Del, P.; Chamari, K. (2011). Effect of the number of ball contacts within bouts of 4 vs. 4 small-sided soccer games. Int. J. Sports Physiol. Perform., 6, 322–333.

46. Hopkins, W., Marshall, S., Batterham, A., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine+ Science in Sports+ Exercise*, *41*(1), 3.

47. Farhani, Z., Amara, S., Aissa, M. B., Guelmami, N., Bouassida, A., & Dergaa, I. (2024). The variability of physical enjoyment, physiological responses, and technical-tactical performance according to the bout duration of small-sided games: a comparative study between female and male soccer players. *BMC Sports Science, Medicine and Rehabilitation*, *16*(1), 77.

48. Sahli, H., Selmi, O., Zghibi, M., Hill, L., Rosemann, T., Knechtle, B., & Clemente, F. M. (2020). Effect of the verbal encouragement on psychophysiological and affective responses during small-sided games. *International journal of environmental research and public health*, *17*(23), 8884.

49. Kennett, D.C.; Kempton, T.; Coutts, A.J. (2012). Factors affecting exercise intensity in rugby-specific small-sided games. J. Strength Cond. Res., 26, 2037–2042.