

Effect of small-sided game versus high-intensity interval training method in increasing anaerobic endurance in youth football athletes (15-17 years)

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Abstract

Background and Study Aim Small-sided games and high-intensity interval training programs are efforts to improve the anaerobic endurance of soccer players for optimal performance. However, training programs are often less effective. Therefore, this study aims to examine the effect of modified small-sided games and high-intensity interval training programs on improving anaerobic endurance and to compare the effectiveness of small-sided games versus high-intensity interval training results.

Material and Methods Thirty players aged 15-17 participated in the study. The research design used was a pre-experimental two-group pretest-posttest. The instrument adopted was the running-based anaerobic sprint test. Data were analyzed using paired sample t-tests to determine the effect of the training program, and independent t-tests were conducted to determine the effectiveness of small-sided games versus high-intensity interval training methods.

Results The results of the data normality test showed a significance value greater than 0.05, indicating that the data were normally distributed. The effect of the small-sided games training program and high-intensity interval training was tested using paired sample t-tests. The significance values were 0.00 for small-sided games and 0.27 for high-intensity interval training, indicating an increase in anaerobic endurance performance. The independent t-test comparing small-sided games and high-intensity interval training obtained a significance value less than 0.05, specifically 0.83, indicating no significant difference in results between the two methods.

Conclusions The study's findings showed that both small-sided games and high-intensity interval training programs significantly improved anaerobic endurance performance. However, the comparison of the effectiveness of the two methods did not show a significant difference. Both methods are equally effective in improving anaerobic endurance. These results underline that small-sided games and high-intensity interval training can be used to enhance anaerobic endurance performance.

Keywords: small-side games, high-intensity interval training, physique, anaerobic, football.

Introduction

Many soccer training programs fail to effectively enhance the anaerobic endurance of players. This leads to suboptimal performance on the field. Traditional methods often lack the intensity and specificity required for significant improvement. This issue is particularly pronounced in the training of adolescent athletes. Properly tailored programs are essential for their development.

The optimisation of ideal modern football performance involves many aspects, including technique, tactics, and endurance capacity [1]. Physical aspects are critical for success in football. The assessment of physical aspects is crucial not only for adult athletes but also for adolescent athletes to achieve optimal performance [2]. Physicality is essential and must be continuously developed in football [3]. It serves as the main foundation of

training [4, 5] to increase the success of technical, tactical, and strategic aspects [6].

Given the intensive nature of football, which requires consistent performance throughout the match [7], effective training variations are necessary to maintain physical readiness. Extensive studies have been conducted on training methods to improve physical aspects [8, 9]. These studies help find innovative solutions for training athletes. Exercises such as interval training and small-sided games (SSG) are frequently used as alternatives to enhance anaerobic energy metabolism. These exercises support essential movements in football, such as running, jumping, and changing direction [10].

Small-sided games (SSG) are a revolutionary form of training conducted in a small area with modified rules [11, 12]. SSG training is designed with attention to player area, field size, number of players, phase type, work and rest breaks, game rules, the inclusion or exclusion of goalkeepers, unpredictable player performance stimuli, and coach

feedback [8]. This approach aims to modify the type of training regardless of age, gender, experience, and level of competition [8, 11]. Previous research states that SSG training involves real motion actions and technical awareness to improve youth football-specific functions and skills [13, 14]. In addition, SSG forces players to work extra hard and exhibit play under pressure, involving physiological demands and great attention that triggers fatigue [13, 15]. Thus, SSG is widely used to facilitate the improvement of players' physical and physiological performance under high pressure [16].

High-intensity interval training (HIIT), one of the most popular innovative exercise methods, adopts an intense and intermittent form of exercise with interspersed rest periods. HIIT usually provides time efficiency and significant improvements in both aerobic and anaerobic performance [17, 18]. Previous research suggests that HIIT can increase anaerobic and aerobic activity, enhance cardiopulmonary capacity, and promote body fat loss [7, 19].

Several studies convey the differences between the small-sided games (SSG) training method and high-intensity interval training (HIIT). SSG training, carried out using a ball in a small area, aims to improve technical, tactical, and motivational abilities [20]. In contrast, HIIT, conducted without a ball, focuses on increasing endurance capacity [21]. Additionally, many studies have compared SSG and HIIT training methods for team sports such as football [1, 13, 14].

An analysis of the research has shown that few studies investigate the effectiveness of training methods between small-sided games (SSG) and high-intensity interval training (HIIT) for adolescent football players. Therefore, there is an obvious need to continue research in this direction.

In this context, the first hypothesis is that both SSG and HIIT methods influence the improvement of anaerobic endurance performance. The second hypothesis is that SSG and HIIT methods have the same effectiveness in improving anaerobic endurance performance. Therefore, this study aims to examine the effect of modified small-sided games and high-intensity interval training programs on improving anaerobic endurance and to compare the effectiveness of small-sided games versus high-intensity interval training results.

Materials and Methods

Participants

Thirty youth football players participated in the study (aged 15-17 years), which was conducted in Yogyakarta, Indonesia. All players belonged to the FC UNY Academy club and had competed at the regional level for their age group. The players were divided into two groups: the small-sided games (SSG) group (n=15) and the high-intensity interval training (HIIT) group (n=15). All players

were informed about the study's procedures, requirements, benefits, and risks.

Research Design

This study used a pre-experimental design, specifically a two-group pretest-posttest design. In the initial stage, the players underwent a pretest before receiving any treatment or intervention. After that, the players were involved in the small-sided games (SSG) based training method for group one and the high-intensity interval training (HIIT) program for group two to improve anaerobic endurance. In the final stage, the players underwent a posttest. The results of the pretests and posttests of each group were then calculated to determine the improvement before and after the SSG and HIIT exercise programs. After comparing the pretest and posttest results within each group, comparisons were made between the SSG and HIIT groups.

Data were collected using valid and specific instruments. Anaerobic endurance performance ability was assessed using the running-based anaerobic sprint test (RAST) [22]. The RAST has a validity of 0.897 and a reliability of 0.919 [23].

Protocol Design

The implementation phase of the training program for each group was conducted three times a week (Monday, Wednesday, and Friday) over the six-week training period. Each training session started with a warm-up phase, followed by a game/program implementation phase, a tactical phase, and ended with a cool-down phase. The program was consistently applied throughout the study period. Table 1 shows the implementation of the program's small-sided games (SSG) phase, and Table 2 shows the implementation of the high-intensity interval training (HIIT) phase. In group one (SSG), the intensity, repetitions, distance, and rest time varied each week. For group two (HIIT), the intensity, repetitions, and rest periods also varied each week, reflecting changes in competition demands.

Statistical Analysis

Statistical data analysis of the study used the Shapiro-Wilk test to assess data normality. Differences in pretest and posttest results within each group were compared using paired sample t-tests. The statistical significance of the study was set at $p < 0.05$. In addition, an independent t-test was conducted to compare the training effects between group one (small-sided games, SSG) and group two (high-intensity interval training, HIIT). Statistical data analysis was performed using SPSS version 25.0 for Windows.

Results

The effectiveness of the small-sided games (SSG) and high-intensity interval training (HIIT) programs was assessed using the Paired Sample T-test. Figure

Table 1. Small-sided games program

Week	Meeting	Type of SSG activity	Training description
1	1-3	5 vs 5	Repetitions: 3; One repetition time: 2 minutes; Rest between reps: 2 minutes (1:1); Sets: 3; Rest between sets: 4 minutes (1:2); Area: 20x10 meters; Intensity: 75%
2	4-6	4 vs 4	Repetitions: 3; One repetition time: 2 minutes; Rest between reps: 2 minutes (1:1); Sets: 3; Rest between sets: 4 minutes (1:2); Area: 15x10 meters; Intensity: 80%
3	7-10	3 vs 3	Repetitions: 3; One repetition time: 2 minutes; Rest between reps: 2 minutes (1:1); Sets: 4; Rest between sets: 4 minutes (1:2); Area: 15x10 meters; Intensity: 80%
4	11-13	2 vs 2	Repetitions: 3; One repetition time: 1 minute; Rest between reps: 1 minute (1:1); Sets: 4; Rest between sets: 3 minutes (1:3); Area: 15x10 meters; Intensity: 90%
5	14-16	1 vs 1	Repetitions: 4; One repetition time: 1 minute; Rest between reps: 1 minute (1:1); Sets: 4; Rest between sets: 3 minutes (1:3); Area: 10x10 meters; Intensity: 95%
6	17-20	3 vs 3	Repetitions: 4; One repetition time: 2 minutes; Rest between reps: 2 minutes (1:1); Sets: 4; Rest between sets: 4 minutes (1:2); Area: 10x10 meters; Intensity: 80%

Table 2. High-intensity interval training program

Week	Meeting	Reps	Training description
1	1-3	6	Rest between reps: 1:2; Area: 30m long x 13m wide; Intensity: 75%
2	4-6	6	Rest between reps: 1:2; Area: 30m long x 13m wide; Intensity: 80%
3	7-10	6	Rest between reps: 1:2; Area: 30m long x 13m wide; Intensity: 80%
4	11-13	5	Rest between reps: 1:3; Area: 30m long x 13m wide; Intensity: 90%
5	14-16	5	Rest between reps: 1:3; Area: 30m long x 13m wide; Intensity: 95%
6	17-20	6	Rest between reps: 1:2; Area: 30m long x 13m wide; Intensity: 80%

Table 3. Pretest-posttest normality test for small-sided games and high-intensity interval training

Group	Variable	n	Sig.
Pre-test	SSG	15	0.848
Pre-test	HIIT	15	0.730
Post-test	SSG	15	0.703
Post-test	HIIT	15	0.146

Note: Normality data using the Shapiro-Wilk test for small-sided games (SSG) and high-intensity interval training (HIIT) are generally distributed with significance > 0.05.

Table 4. Paired sample test results of small-sided games and high-intensity interval training

Variable	Mean	Std. Deviation	Sig.
Pair 1	Pre-test SSG	35.8940	1.96545
	Post- test SSG	34.7353	1.30882
Pair 2	Pre-test HIIT	35.3880	1.90705
	Post- test HIIT	34.8460	1.61980

Note: Results between pretest-posttest small-sided games (SSG) 0.004 and high-intensity interval training (HIIT) 0.278, showing significance <0.05, which means there is a difference in results between the pretest and posttest.

1 shows the average values of SSG vs. HIIT pretest and posttest results.

The results of the SSG and HIIT pretest-posttest normality test on anaerobic endurance are shown in

Table 3.

The data were normally distributed with a significance value greater than 0.05. Table 4 presents the paired sample t-test results to evaluate the effect

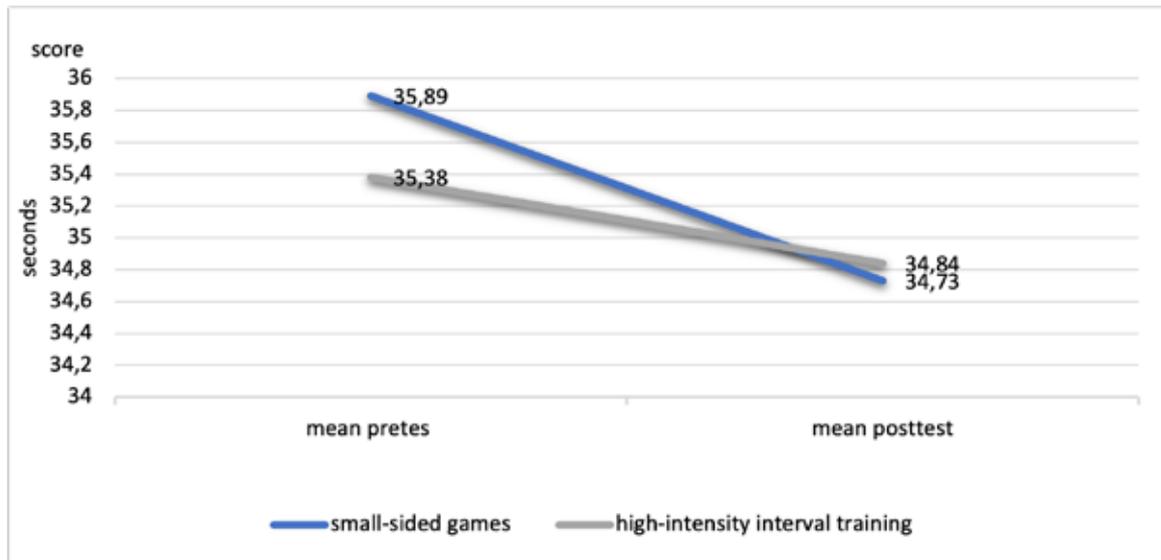


Figure 1. Descriptive data mean pretest-posttest small-sided games and high-intensity interval training

Table 5. Independent samples t-test between small-sided games and high-intensity interval training

Variable	Equality of Variances		t-test for equality of Means			
	f	Sig.	t	df	Sig. (2-tailed)	Mean difference
Anaerobic	0.403	0.501	-0.206	28	0.838	-0.11067

Note: Independent sample t-test significance value <0.05. The results showed no significant difference between small-sided games vs. high-intensity interval training with a 2-tailed significance value of 0.838.

of the SSG and HIIT programs, showing significance values greater than 0.05, indicating an increase between pretest and posttest results. Furthermore, Table 5 compares the effectiveness of the SSG vs. HIIT programs using an independent t-test, with a significance value less than 0.05, indicating no significant difference between SSG and HIIT.

Discussion

The study’s main objective was to evaluate the effects of small-sided games (SSG) and high-intensity interval training (HIIT) and to determine the effectiveness of SSG vs. HIIT training for adolescent football players. The study’s novelty focused on modifying the area, duration, and frequency of SSG and HIIT methods and comparing the effectiveness of the two methods in football training.

The findings support the first hypothesis, showing a significant increase (sig. < 0.05) in anaerobic endurance performance (Table 4). This indicates that the designed methods successfully improve anaerobic endurance. The findings align with previous research, suggesting that the SSG method is suitable and beneficial for early-stage physical, technical, and change-of-direction training in football [20]. Additionally, other studies suggest that the HIIT method improves young players’ Vo2max, aerobic, and anaerobic performance [21].

Then, the results related to the effectiveness of SSG vs. HIIT showed no significant difference

(sig. > 0.05), indicating that both methods have the same level of effectiveness in improving anaerobic endurance performance and do not show a dominant difference in results. Similar research also highlighted that SSG and HIIT methods are equally effective in maintaining the physical fitness of youth football players over several weeks [14]. Furthermore, Arslan [13] confirmed that SSG and HIIT methods were equally effective in improving body composition, aerobic fitness, and anaerobic fitness in youth football players.

Specifically, this study was designed to test SSG vs. HIIT methods on anaerobic endurance performance. However, neither method showed dominant results in either group. This may be due to the fact that both methods are running-based exercises. SSG involves running-based exercises using a game dynamic that includes intervention from opponents [24], with durations ranging from 45 seconds [25] to four minutes [26] and several repetitions from two to ten. It also uses a smaller area format to provide high-intensity running demands, such as sprints [27,28] with rapid excitatory changes [29,30]. In comparison, HIIT consists of repeated short-interval sprints, long intervals, and sprint intervals [31], with a work-to-rest ratio of 1:1 [25]. Thus, comparing the effects of these two methods is challenging. Based on a meta-analysis review, the performance of HIIT is similar to SSG principles, involving frequent direction changes, acceleration, and deceleration [32].

The SSG and HIIT methods showed improved anaerobic endurance performance after receiving their respective treatments. Therefore, the study's final results are expected to be valid and provide valuable guidance for coaches and athletes, especially in the field of football.

The limitation of this research is the small sample size of adolescent male athletes, which does not accommodate more comprehensive results regarding gender, competition level, or different age groups. Future studies are recommended to use a broader range of subjects and to apply SSG and HIIT methods that consider player profiles, including gender and competition levels.

Conclusions

Based on the research findings, both SSG and HIIT showed significant results (significance > 0.05) for the training program effect and insignificant results (significance < 0.05) for the effectiveness between

SSG and HIIT. This means that both methods are equally effective in improving anaerobic endurance performance in adolescent football players. Therefore, these findings can be considered by coaches in developing various training programs, as they can improve anaerobic endurance performance in youth football. Additionally, the findings of this study provide an essential foundation for future research to encourage more comprehensive studies exploring various populations and genders.

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