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MIXED SMALL-SIDED GAMES TRAINING: A STRATEGY FOR IMPROVING ALACTIC ANAEROBIC CAPACITY

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Abstract

This study aimed to examine the effect of mixed-method Small-Sided Games (SSG) training on the improvement of alactic anaerobic capacity among adolescent football players. Utilising a pre-test and post-test experimental design, thirty-eight participants aged 12 to 18 years from the Persib Academy underwent a six-week mixed SSG training protocol, three times per week. The intervention systematically varied intensity, duration, and game scenarios to maximise physiological adaptation. Alactic anaerobic capacity was assessed using the Running-based Anaerobic Sprint Test (RAST). Descriptive and inferential analyses revealed statistically significant increases in maximal power, mean power, and fatigue index after the intervention ($p < 0.001$), with very large effect sizes. These findings highlight the effectiveness of structured mixed SSG training for improving anaerobic performance in youth footballers. The study recommends incorporating mixed SSG approaches in regular training regimens to optimise physical development and support evidence-based coaching practices. These results demonstrate the substantial benefits of mixed-method SSG training for enhancing anaerobic capacity. Nevertheless, future studies are recommended to incorporate a control group and examine long-term effects across diverse youth populations.

Keywords: ***Small-Sided Games, Anaerobic Capacity, Football, Youth Athletes, Physical Conditioning***

INTRODUCTION

Football is a team sport that demands not only technical skills and tactical understanding but also optimal physical capacity from each player. Modern football matches are characterised by high-intensity transitions and frequent explosive movements, necessitating both aerobic and anaerobic energy systems. Of particular importance is the alactic anaerobic capacity, which enables players to perform repeated short sprints, rapid directional changes, and powerful actions such as shooting or duelling for the ball (Plakias & Karakitsiou, 2024; Leo et al., 2022). Adolescent football players, particularly those in the under-17 and under-18 age groups, are in a crucial stage of physiological development. During this period, they are highly responsive to appropriately structured training interventions, which lay the foundation for future professional performance (Byrne et al., 2022; Wu et al., 2021). Consequently, the design of training programmes that effectively enhance both the technical-tactical and physical aspects of the game is of significant interest to coaches and sports scientists (Halouani et al., 2014).

One of the most widely adopted methods for integrated football training is the Small-Sided Games (SSG) approach. SSG involves reducing the number of players and the size of the pitch, thereby increasing the frequency and intensity of technical actions and physical exertion (Riboli et al., 2022; Clemente et al. 2021). This format closely replicates the demands of actual matches but with greater physiological load, making it particularly effective for improving both fitness and game-related skills (Fadchurrohman, 2016; Hidayat et al., 2019). To further optimise the benefits of SSG, a mixed-method training approach can be implemented. This method incorporates variations in intensity, duration, and game scenarios, thus providing diverse training stimuli while maintaining player motivation and minimising the risk of overtraining (Arslan et al., 2021). While the theoretical advantages of mixed-method SSG training have been widely discussed, empirical evidence specifically addressing its impact on alactic anaerobic capacity in adolescent football players remains limited (Beato et al., 2023). Given this context, the present study seeks to examine the effect of mixed-method Small-Sided Games training on the enhancement of alactic anaerobic capacity among youth football players at the Persib Academy (Hammami et al., 2018). The findings are expected to

offer practical recommendations for coaches, sports academies, and the broader field of football training, particularly regarding evidence-based approaches for physical conditioning in youth athletes (Hill-Haas et al., 2012). Therefore, this study aims to examine the effect of mixed-method Small-Sided Games (SSG) training on the improvement of alactic anaerobic capacity among adolescent football players. This research seeks to address the gap in previous studies regarding the impact of varied SSG protocols on anaerobic performance in the context of Indonesian youth football.

LITERATURE REVIEW

Football is a highly complex team sport that integrates physical, technical, tactical, and psychological elements. The increasing demands of modern football require players to possess high levels of speed, explosive power, and sustained physical fitness throughout matches (Pratama et al., 2022; Leo et al., 2022). To meet these demands, coaches must develop training programmes that specifically enhance players' physical capacities in alignment with the unique physiological requirements of football (Lacome et al., 2018). A key physiological component in football performance is alactic anaerobic capacity. This refers to the body's ability to rapidly produce energy without oxygen—primarily using intramuscular ATP-PCr stores—during high-intensity, short-duration actions such as sprinting, duelling, and shooting (Plakias & Karakitsiou, 2024; Byrne et al., 2022). Enhancement of this capacity is particularly important given the repetitive nature of explosive activities in contemporary football matches. High-intensity interval training, including sprints, plyometrics, and fast-paced game-based drills, has been demonstrated to effectively improve alactic anaerobic capacity (Leo et al., 2022; Moran et al., 2019).

Small-Sided Games (SSG) have emerged as a prominent training method, offering a format that reduces the number of players and the size of the pitch to increase the frequency and intensity of technical and tactical actions (Clemente et al., 2021). SSG provides players with more touches, frequent explosive movements, and rapid decision-making opportunities under pressure. This format not only enhances physiological load but also facilitates simultaneous development of technical, tactical, and physical attributes (Riboli et al., 2022; Nobari et al., 2022). The mixed-method approach in physical training involves systematic variation of intensity, duration, format, and objectives within training sessions (Zaharia et al., 2023). This approach is designed to prevent monotony, stimulate diverse energy systems, and optimise physiological adaptation (Hidayat et al., 2019). In the context of football, combining SSG with mixed-method training offers a dynamic stimulus that develops speed, strength, and endurance, while maintaining a strong technical and tactical emphasis. Moreover, such variation is crucial for sustaining athlete motivation and reducing the risk of overtraining (Wu et al., 2021).

Several previous studies have highlighted the effectiveness of SSG-based training in improving the physical performance of youth football players. For instance, Clemente et al. (2021) reported significant improvements in VO_2max, sprint speed, and anaerobic endurance following a six-week SSG programme. Plakias and Karakitsiou (2024) found that combining SSG with variable intensity produced significant gains in alactic anaerobic capacity among U-17 players. Nonetheless, there remains a paucity of research specifically addressing the impact of mixed-method SSG on alactic anaerobic capacity, particularly within the context of youth football academies (Mendham et al., 2014).

Table 1. Summary of Previous Studies on Small-Sided Games (SSG) Training and Anaerobic Capacity

Author(s) & Year	Sample	Design	Intervention	Main Findings
Clemente et al., 2021	U-17 players	Experimental	SSG (6 weeks, 3x/week)	↑ Anaerobic power, ↑ Sprint ability
Plakias & Karakitsiou, 2024	U-18 players	Experimental	Mixed SSG (8 weeks)	↑ Alactic capacity, ↑ Power output
This Study	U-12–18	Experimental	Mixed-method SSG (6 weeks)	↑ Alactic capacity, ↑ Power, ↑ Fatigue index

Sources: Author's own work adapted from literature review

Table 1 summarises previous research on SSG interventions and their effects on anaerobic performance. As can be seen, there remains a gap in the literature concerning mixed-method SSG in the Indonesian youth context. Given this gap in the literature, the present study aims to investigate the effect of mixed-method Small-Sided Games training on alactic anaerobic capacity in adolescent football players. This research seeks to provide empirical evidence supporting the integration of varied, game-based training methods as an effective strategy for enhancing the physiological foundations necessary for elite football performance (Mikalonytė et al., 2022). Despite the

widespread use of SSG in football training, limited research has specifically addressed its impact on alactic anaerobic capacity, especially within Indonesian youth football academies. The present study offers new empirical evidence by implementing a structured mixed-method SSG protocol, thus contributing to the existing literature and providing practical guidance for coaches and practitioners.

METHOD

This study employed a quantitative experimental approach using a one-group pre-test and post-test design without a control group. The main objective was to investigate the effect of mixed-method Small-Sided Games (SSG) training on the improvement of alactic anaerobic capacity among adolescent football players. This design facilitated a direct comparison of physiological performance measures before and after the intervention to evaluate its effectiveness.

Participants

A total of 38 adolescent football players, aged 12 to 18 years, from the Persib Academy participated in this study. All participants were actively involved in the academy's regular training programme. Purposive sampling was used to select participants who were physically healthy, free from injury, and willing to complete the full intervention period.

Setting and Duration

The intervention was conducted at the official Persib Academy training facility over a period of four to six weeks. The training programme included three sessions per week, with each session lasting approximately 60–90 minutes.

Intervention Procedure

Participants underwent a mixed-method SSG training protocol three times weekly for four to six weeks. Each session consisted of two sets, each with three repetitions, incorporating various game formats (e.g., 3v3, 5v5) and scenario-based drills such as overloading and area-specific exercises. The mixed-method approach systematically varied intensity, duration, and game situations to maximise both physiological and technical adaptation.

Data Collection

The primary measurement tool for assessing alactic anaerobic capacity was the Running-based Anaerobic Sprint Test (RAST). The procedure for the RAST is as follows:

- Each participant performed six maximal sprints over a distance of 35 metres, with a 10-second rest interval between sprints.
- The time for each sprint was recorded using a stopwatch or electronic timing system.
- Body weight was measured prior to the test.

Based on the collected data, the following calculations were performed for each sprint:

- Speed (m/s): Distance divided by time for each sprint.
- Acceleration (m/s^2): Speed divided by time for each sprint.
- Force (N): Body weight multiplied by acceleration.
- Power (W): Force multiplied by speed.

From these calculations:

- Maximum Power: Highest power value from the six sprints.
- Minimum Power: Lowest power value from the six sprints.
- Fatigue Index: Calculated using the formula

$$\text{Fatigue Index} = \frac{\text{Maximum Power} - \text{Minimum Power}}{\text{Total Time for Six Sprints}}$$

This index quantifies the decline in performance across repeated sprints, reflecting anaerobic capacity and resistance to fatigue.

Data Analysis

Descriptive statistics (mean, standard deviation) were calculated for all key variables. The normality of the data was verified using the Shapiro-Wilk test. To determine the effectiveness of the intervention, a paired sample t-test was applied to compare pre-test and post-test results of RAST-derived variables (maximum power, minimum power, and fatigue index). Effect size was also calculated to assess the magnitude of change. All statistical analyses were performed using IBM SPSS (latest version).

Ethical Considerations

Informed consent was obtained from all participants and their parents or guardians before data collection commenced. The research protocol complied with ethical standards for research involving minors.

RESULTS AND DISCUSSION

Results

Descriptive analysis of the key performance parameters, as presented in Table 2, shows that there was a substantial increase in all measured variables following the intervention. The mean maximal power improved from 552.95 ± 98.63 W in the pre-test to 1079.99 ± 192.63 W in the post-test, and mean power increased from 422.48 ± 61.25 W to 825.16 ± 119.64 W. The fatigue index also showed a notable rise from 6.77 ± 2.70 to 16.54 ± 6.58 after the training programme. These results indicate that the mixed-method Small-Sided Games intervention had a substantial impact on anaerobic power and fatigue resistance, in line with previous findings by Clemente et al. (2021) and Plakias & Karakitsiou (2024), who also reported significant improvements in anaerobic capacity through game-based training protocols.

Table 2. Descriptive Statistics of RAST Parameters (Pre- and Post-Test)

Parameter	Pre-test Mean ± SD	Post-test Mean ± SD
Power Max (W)	552.95 ± 98.63	1079.99 ± 192.63
Power Min (W)	319.60 ± 63.20	624.21 ± 123.43
Mean Power (W)	422.48 ± 61.25	825.16 ± 119.64
Fatigue Index	6.77 ± 2.70	16.54 ± 6.58

Sources: Author's own work

Normality tests (Shapiro-Wilk) confirmed that all data were normally distributed ($p > 0.05$). Paired sample t-tests revealed highly significant differences between pre-test and post-test for all major parameters ($p < 0.001$; see Table 3). Cohen's d values indicated very large effect sizes.

Table 3. Results of Paired t-Test and Effect Size (Cohen's d)

Parameter	t	p-value	Cohen's d	Interpretation
Power Max	-34,5603636	9,12874E-30	3,444029565	Very large
Mean Power	-42,51659393	5,14463E-33	4,236888482	Very large
Fatigue Index	-15,49154857	9,34419E-18	1,941714271	Large

Sources: Author's own work

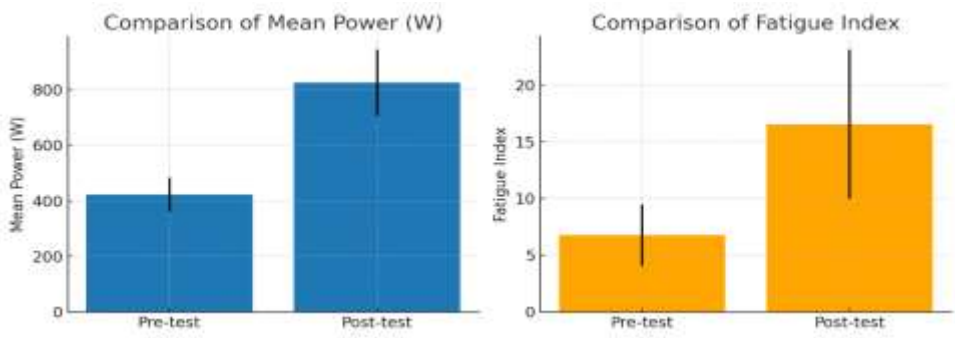

Figure 1. Mean Power & Fatigue Index
Sources: Author's own work

Figure 1 illustrates the improvements in mean power and fatigue index from pre-test to post-test.

Discussion

The findings of this study demonstrate that the mixed-method Small-Sided Games (SSG) training protocol produced highly significant improvements in alactic anaerobic performance among adolescent football players. Both maximal and mean power values increased substantially following the intervention, and the fatigue index also showed a pronounced rise. All effect sizes were classified as large or very large, indicating that the intervention was not only statistically significant but also practically meaningful. The marked increases in power output and fatigue index align with previous studies (e.g., Clemente et al., 2021; Plakias & Karakitsiou, 2024) that have highlighted the efficacy of SSG-based training for enhancing anaerobic capacity and repeated sprint ability in youth footballers. The robust improvement observed in this research underscores the critical role of optimally designed, high-intensity, and variable game-based training protocols.

Limitations and Practical Implications

Although the findings provide strong evidence of the effectiveness of mixed-method SSG training, this study is limited by the absence of a control group, potential variability in participant adherence, and the specific focus on one academy setting. Future research should include a control group, explore different durations and intensities of SSG protocols, and involve larger, more diverse samples to enhance generalisability. Practically, the results suggest that structured and varied SSG training can be implemented as a routine part of youth football conditioning programmes to maximise anaerobic development and performance.

CONCLUSION

In conclusion, mixed-method Small-Sided Games training produced significant improvements in alactic anaerobic capacity, as demonstrated by increases in maximal power, mean power, and fatigue index among adolescent football players. These findings underscore the value of structured, varied SSG protocols in youth football training and offer practical recommendations for coaches and practitioners seeking to optimise anaerobic development. Further research is encouraged to confirm these results in different settings and populations.

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