Original Article

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Effectiveness of extracurricular futsal training using small-sided games in improving aerobic capacity (vo^2max) of students.

Annizar Gunawan Yunus[1ABCD], Irwan Hermawan[2B], Z. Arifin[3CD], Ani Kurniawati[4A]

[1,2,3,4] Physical Education, Universitas Garut, Indonesia

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Abstract: Small-sided games (SSG) are one of the training methods used by coaches to stimulate the technical, tactical, and physical components of futsal players. This study aims to determine the effect of small-sided games (SSG) training with high-intensity interval training (HIIT) on improving VO2 Max among futsal extracurricular students at SMAN 15 Garut. The issue addressed in this study is the suboptimal endurance level of many students involved in the futsal extracurricular program. The research used an experimental method with a one-group pre-test and post-test design. The sample consisted of 20 students. VO2Max measurements were conducted using the Bleep Test, a standard method for assessing aerobic capacity. Before the training program commenced, all participants underwent the Bleep Test to obtain baseline VO2Max values (pretest). The small-sided games training program was implemented over 14 sessions, with training frequency set at three times a week. Data analysis involved normality, homogeneity, and t-test, yielding a significant value of ($p = 0.000$) < 0.05, indicating a significant increase in VO2 Max with an average post-test value of 39.720. These findings confirm that SSG training with HIIT can effectively improve cardiovascular endurance in high school futsal players. The high-intensity small-sided games training method had a significant effect on improving VO2Max in these students.

Keywords: Small-sided games; VO2 Max; Physical Education.

Corresponding author: Irwan Hermawan, email: irwan.hermawan@uniga.ac.id

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INTRODUCTION

Optimal physical condition serves as the foundation for athletes to perform effectively at a competitive level. Without adequate physical fitness, athletes may struggle to meet the technical and tactical demands of the sport. Each sport, including futsal, requires a combination of physical attributes such as endurance, muscle strength, speed, and agility. Therefore, training programs must be structured and tailored to meet the specific physical requirements of the sport (Hasanah et al., 2021). One of the most essential components of physical fitness is endurance, which plays a vital role in sustaining performance throughout a match. In futsal, players must remain active in a fast-paced environment, constantly switching between offensive and defensive roles with minimal rest. Both aerobic and anaerobic endurance are crucial in allowing players to resist fatigue and maintain optimal decision-making and motor control under pressure (Pranata, 2022). In addition to endurance, lower-body explosive power and agility are also critical physical attributes. Explosive power is necessary for quick movements such as kicking, jumping, or pushing off the ground, while agility allows players to change direction rapidly and efficiently (Cosma et al., 2021). These physical traits not only enhance individual performance but also contribute to effective teamwork and tactical execution on the field.

Thus, improving overall physical condition is a key investment in developing high-performing athletes (Arif Luqman Hakim et al., 2023).In the realm of competitive sports, athletes must possess good physical condition, as it significantly influences athletic performance. Physical fitness components include strength, endurance, muscular power, speed, flexibility, reaction, balance, accuracy, coordination, lower-body explosive power, and agility (Farley et al., 2020).In futsal, endurance is the dominant physical component. Endurance refers to an individual's capacity to use their cardiovascular, respiratory, and circulatory systems efficiently and effectively over an extended period (Kharisma & Mubarok, 2020). A futsal athlete with good physical condition can perform better; however, achieving such fitness requires several supporting elements, including technical and psychological aspects. Physical condition is closely related to physical well-being, which allows athletes to maintain performance throughout prolonged matches. Therefore, endurance is crucial for futsal players. Emphasize, futsal matches are lengthy and highly intense, hence requiring superior endurance capabilities (Zulheri Is & Septi Hariansyah, 2020)

Endurance is a crucial component in futsal, as the sport demands peak performance over extended periods and at high intensity. Futsal is played at a rapid pace, requiring players to perform continuous movements, explosive sprints, and sudden directional changes in a confined space (Aljabar & Purnomo, 2023). These demands place a significant load on both the cardiovascular and muscular systems, making endurance a vital determinant of athletic performance in this sport. Players must sustain their physical output for up to 40 minutes of intense play, often with minimal rest. In such a demanding environment, high endurance allows players to maintain speed, strength, and coordination while minimizing the onset of fatigue. This is critical, as fatigue can compromise not only physical performance but also technical skills and decision-making abilities, especially during the final minutes of a match (Pranata, 2022).To address these demands, High-Intensity Interval Training (HIIT) has become an effective method for improving endurance in futsal. HIIT involves alternating periods of intense anaerobic exercise with brief recovery periods, mimicking the stop-and-go nature of futsal games (Rohman et al., 2021). This training approach improves both aerobic and anaerobic capacities, increases VO2 max, and enhances the body's ability to recover quickly between high-effort bursts, making it particularly suitable for futsal athletes.

Therefore, integrating HIIT into endurance-focused training programs is essential for players aiming to reach peak performance and maximize their competitiveness. Not only does it boost stamina and recovery, but it also prepares players for the real physical demands of competition. By developing endurance through targeted training methods like HIIT, futsal players can sustain high performance throughout the match and contribute consistently to their team's success (Imanudin, 2025)

Small-sided games (SSG) are one of the training methods used by coaches to stimulate the technical, tactical, and physical components of futsal players. This method incorporates all key elements of the game, such as passing, dribbling, shooting, and scoring (Firdaus Soffan Hadi, 2016). The rules of SSG can be modified according to specific training goals. Several studies have analyzed how variations in SSG formats—such as player numbers and field size—impact players' technical, tactical, and physical performance (Fahrudin et al., 2024). Small-sided games (SSG) are an efficient and effective method for enhancing both the skills and physical fitness of players within a shorter period of training. Many coaches utilize SSG to improve the technical and tactical abilities of futsal players by designing game-like situations that mirror real match conditions. Research and practical evidence support the effectiveness of SSG in developing overall player performance, making it a widely accepted training approach in modern futsal

(Hermawan, Faturohman & Permadi, 2024). Coaches can also tailor SSG formats to suit specific objectives or replicate various in-game scenarios, thereby increasing relevance and engagement.One key advantage of small-sided games is their capacity to be implemented at high intensity, particularly for improving maximal oxygen uptake (VO_2 max). VO_2 max refers to the body's ability to absorb, transport, and utilize oxygen during physical activity—an essential aspect of endurance. In small-sided games, players are required to move continuously and with intensity within a confined space, which results in elevated physical exertion in a shorter duration. This structure not only encourages sustained engagement but also stimulates the physiological adaptations necessary for improved endurance (Chandra et al., 2025).

The primary aim of high-intensity SSG training is to enhance cardiovascular efficiency. This type of play significantly increases heart rate and blood circulation, compelling the heart and lungs to adapt and function more effectively in delivering oxygen to working muscles. Repeated exposure to high-intensity activity stimulates improvements in aerobic capacity, allowing athletes to perform for longer durations with reduced fatigue. Moreover, a higher VO_2 max enhances post-training or post-match recovery by improving the body's ability to transport and utilize oxygen efficiently (Yunita & Darmawan, 2024). With consistent implementation, high-intensity small-sided game training improves both aerobic and anaerobic endurance—both of which are vital in a high-intensity sport like futsal. Players who undergo regular SSG-based training demonstrate better stamina, quicker recovery times, and greater overall physical resilience during competition. As futsal demands continuous bursts of movement, rapid transitions, and sustained performance, training methods like SSG provide a comprehensive approach to meeting these physical demands effectively (Kurniawati, 2024).

MATERIAL AND METHODS

This study employed an experimental method with a one-group pretest-posttest design. The sample consisted of 20 students participating in the futsal extracurricular program at SMAN 15 Garut, selected through purposive sampling based on specific criteria, such as participation level in training and initial physical condition. VO2Max measurements were conducted using the Bleep Test, a standard method for assessing aerobic capacity. Before the training program commenced, all participants underwent the Bleep Test to obtain baseline VO2Max values (pretest). The small-sided games training program was implemented over 14 sessions, with training frequency set at three times a week. Each training session lasted 60

minutes, targeting an intensity of 80–90% of the participants' maximum heart rate (Z. Arifin, Rifan, 2023).

The training included various small-sided games designed to enhance technical skills and tactical gameplay while improving aerobic endurance. Each session comprised a warm-up, core training (small-sided games), and a cool-down period. After the training program concluded, participants underwent the Bleep Test again to measure changes in VO2Max (posttest). Data obtained from VO2Max measurements were analyzed using the Shapiro-Wilk normality test to ensure data distribution, homogeneity test to check variance equality, and parametric t-test to determine the significance of differences between pretest and posttest values at a significance level of 0.05.

RESULTS

The results of the data analysis are presented in several tables and descriptions below:

Tabel 1. Pre-test Results on Endurance

Statistik	Hasil *Pretest*
Mean	35,595
median	38,5
Mode	40,5
std dev	4,509811
Min	29,9
Max	46,5

The pre-test passing data of futsal extracurricular students at SMAN 15 Garut showed a minimum score of 29.9, a maximum score of 46.5, a mean of 35.595, a median of 38.5, a mode of 40.5, and a standard deviation of 4.509.

Tabel.2 Results of the Post-test on Endurance

Statistik	Hasil *Posttest*
Mean	35,910
Median	40,05
Mode	36,8
std dev	4,235141
Min	29,9
Max	46,8

The pre-test passing data of futsal extracurricular students at SMAN 15 Garut showed a minimum score of 29.9, a maximum score of 46.8, a mean of 35.91, a median of 40.05, a mode of 36.8, and a standard deviation of 4.235.

Tabel.3 Description of Normality Test Data Results

Hasil Data	Probabilitas	Sig.	Ket
Pretest	0,713	0,05	Normal
Posttest	0,771	0,05	Normal

From the table data above, it can be observed that the endurance test results of the futsal extracurricular students at SMAN 15 Garut show P-values (0.713 and 0.771) greater than 0.05. Therefore, it can be concluded that the data for this variable are normally distributed, and further data analysis can be conducted.

Tabel 4. Description of Homogeneity Test Data Results

Hasil Data	df1	df2	Sig.
Pretest-Posttest	1	38	0,646

From the table above, the data obtained from futsal extracurricular students at SMAN 15 Garut show a significance value of P = 0.646, which is greater than 0.05. Therefore, it can be concluded that the research data are homogeneous.

Tabel 4. Results of the T-Test

Hasil Data	t-test						
	Df	t-hitung	t-tabel	Sig.	Rata-rata	Selisih	%
Pre-test	19	2,073	1,729	0,000	38,795	0,925	1%
Post-test					39,720		

Based on the t-test results above, the calculated t-value (2.073) is greater than the table t-value (1.729), and the significance value (0.000) is less than 0.05. These results indicate a statistically significant effect. This can be seen from the post-test mean score of 39.720 points, which is higher than the pre-test mean score of 38.795 points.

DISCUSSION

Based on the results of the data analysis, it was found that there was a significant effect, indicated by a 1% level. The t-test analysis in this study showed that the calculated t-value (2.073) was greater than the table t-value (1.729), and the significance value (0.000) was less than 0.05. These results indicate that there is a significant effect of small-sided games training variations on endurance (VO2max) among futsal extracurricular students at SMAN 15 Garut.

This suggests that endurance strength training using small-sided games variations can be continuously implemented for futsal extracurricular students at SMAN 15 Garut in order to improve training effectiveness and maximize VO2max/endurance capacity in futsal performance.

CONCLUSION

Based on the overall research findings and the discussion presented, it can be concluded that the futsal extracurricular students at SMAN 15 Garut obtained a calculated t-value (2.073) greater than the table t-value (1.729), and a significance value (0.000) less than 0.05 (5%). Furthermore, there was an increase in endurance training effect, with a percentage improvement of 0.925 (1%) among the futsal extracurricular students at SMAN 15 Garut. The high-intensity small-sided games training method had a significant effect on improving VO2Max in these students. This is evident from the increase in the mean score, where the pre-test average was 38.795 and the post-test average was 39.720, resulting in a mean difference of 0.925. This indicates a positive change of approximately 1% following the implementation of small-sided games training.

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Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this study.

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