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The Effect of Small Side Games and Coordination Trainings on the Aerobic Endurance Ability of Male Futsal Athletes

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Abstract **Purpose:** This study aimed to investigate the effect of small-sided games (SSG) and coordination training (CT) on male futsal players. **Design/methodology/approach:** This was a quantitative study with a quasi-experimental design. The study population included 18 male futsal athletes determined by ordinal pairing. The sample was divided into two groups: the first group conducted the small-sided games and the second group conducted the coordination training. The research instrument applied in this study was the Yoyo Intermittent Recovery Level 1 to measure aerobic endurance (VO_2 max). The researchers conducted a paired t-test to determine whether the experimental group's pre- and post-test scored differently. **Results:** The results of the aerobic endurance ability analysis using the small-sided games method produced a t-count of 3.926 with a probability $p = 0.004 < 0.05$, indicating a significant result. While the coordination training method produced a t-count of 2.468 with a probability $p = 0.039 < 0.05$, also indicating a significant result. **Conclusion:** The small-sided games and coordination training methods could improve aerobic endurance. However, the small-sided games proved to be more effective and efficient in improving the aerobic endurance ability of male futsal players.

Keywords Small Side Games, Coordination, Training, *Futsal*, Male

1. Introduction

Futsal is a high-intensity, intermittent sport with an average length of 75-90 minutes, even though the official futsal game rule is only 2x20 minutes [1]. *Futsal* is currently in great demand by the Indonesian and has gained popularity worldwide. Thus, scientific research regarding this sport has increased exponentially in recent decades, which will be helpful for a better understanding of the characteristics and specificities of futsal players in team dynamics [2]–[4].

In general, futsal challenges players to perform quick, high-intensity activities in a short area, and forces a high level of physical prowess and tactical and technical expertise [5]. Throughout the game, futsal players are also expected to make quick decisions and do offensive (passing, dribbling, shooting) and defensive movements (marking, intercepting the ball) [6]. As a result of the futsal sport nature (which includes aspects such as the

dimensions of the playing field, the rules of the game, the length of the competition, and the abilities required), many factors influence someone's level of success in this sport. Consequently, it demands determination and precision for a coach to devise a game strategy during the matches.

The basic components of physical condition in futsal include strength, endurance, flexibility, speed, reaction time, flexibility, and coordination [7]. For improving physical condition, it is necessary to train the players under correct needs or principles. Coaching physical condition, when done with the proper training, will help athletes reach their maximum level of ability [8]. When it comes to achievement, physical ability is an essential part of the training process.

Physical exercise is described as the capacity of muscle groups and the cardiovascular system which are structured to improve physical condition [9]. Physical inactivity can diminish health quality, including muscle weakness and a decrease in cardiovascular, neurological, and endocrine levels [10]. Cardiorespiratory is a key part of an individual's fitness that is related to the endurance of the lungs and heart and the performance of blood vessels and capillaries in transporting oxygen throughout the body to produce energy.

Low aerobic endurance is one of the factors that causes futsal athletes to perform poorly. VO_2 max is one of the parameters for measuring someone's aerobic endurance or cardiorespiratory level. Professional futsal players in Indonesia have an average VO_2 max of 53.7 ml/kg/min [11]. At the same time, futsal players in the Brazilian 1st division have an average VO_2 max of 58.0 ml/kg/min [12]. This means that Indonesian professional players are still left behind compared to the average Brazilian futsal players. *Futsal* is a high-intensity sport that requires physical demands on aerobic and anaerobic capacities [13]. In this game, professional athletes' average VO_2 max value is 55 ml.kg-1 min-1, and each player sprints every 79 seconds on average during the game [14], which means futsal belongs to the category of a high-intensity sport that burdens the aerobic and anaerobic systems. From the data above, in terms of futsal performance, endurance is a crucial factor.

One of the efforts to increase aerobic endurance in futsal players is finding the best and most appropriate training model to motivate athletes. According to training principles, a training model can be designed methodically to enhance physical skills. Training programs and models can significantly impact the training process that is relevant to the objectives and the sport [15]. Endurance training requires physiological and psychological conditions by focusing on the training intensity so it can be done optimally [16]. The preparation should be progressive, starting with a three to five-minute warming up to boost heart rate and metabolic productivity [17].

In this study, the researchers compared the Small Side Groups (SSG) training model with the Coordination Training (CT). The *SSG* is a training model that resembles a futsal ball game [18]. In comparison, *Coordination Training* is more about combining eye, foot, and hand movements that generally use a tool to stimulate movement, such as agility ladder, rings, markers, cones, etc. According to its term, coordination is the capacity to properly integrate, not only motions into a unified movement pattern, but also one's level of focus.

The reason why the researchers used the SSG training model to improve aerobic endurance ability was that this training model is believed to increase VO_2 max. The SSG is known to improve the performance of sports athlete teams in their technical, tactical, or physical abilities [19]. This performance increase can be achieved depending on the SSG model [20]. In the model with a smaller field, the player movement will be faster and more agile to stimulate the development of their technical and tactical abilities [21]. Meanwhile, in the smaller SSG format or player number, this is often followed by an increase in the player's heart rate, which increases anaerobic abilities [21], [22]. Furthermore, an increase in the player number or the SSG format can increase aerobic capacity, as indicated by an increase in 80% to 86% of maximum heart rate [23]. In addition to the format and player number, the specific adaptation of the SSG training model can be influenced by the relationship between various aspects of the training model, such as the training regimen (duration, sets, and rest periods) [20], [24], rules of the game [25], and coach encouragement [26]. Thus, considering the various benefits of the SSG on players' physiological responses, the SSG model has become one of the most popular and important training menus in team sports.

In addition, the use of a coordination-based training model (CT) in this study was related to increasing aerobic endurance because this training model can build motor skills and movement variations. This model can also train players to swiftly adjust to fast movement changes to respond to sudden situations, such as futsal which requires players to move quickly and precisely in a limited space [27]. In addition, combining several moves will make players panting and followed by changes to perceived exertion. Therefore, exercise is needed to increase VO_2 max [28]. In other words, the CT model can improve aerobic endurance (VO_2 Max) if the CT model meets the stimuli that trigger physiological responses to aerobic ability. The CT training models can be arranged by considering the demands of motion or format, bouts, duration, rest, and field size. In summary, CT that fulfills the principles of aerobic exercise will affect changes in aerobic capacity. Research from [29] supports this, saying that physical fitness (VO_2 Max) can be improved with a short-term training based on aerobic, anaerobic, and coordination exercises.

Although the improvement of aerobic endurance based on the Small Side Games training is well-proven scientifically and already widely carried out by [5], [30], [31], the coordination training model in futsal had not been widely examined. Therefore, the objectives of this study

included 1) comparing internal proportions in both training models (SSG and CT) and 2) the effectiveness and efficiency of the SSG and CT on the aerobic endurance ability of male futsal athletes. We assumed that these two training models could improve the aerobic endurance ability of futsal players.

2. Materials and Methods

This study was an experimental study with a quasi-experimental design that included a control group. However, the group was not adequate for controlling the external factors that impacted the way in which the experiment was carried out [32].

Since this study applied a quasi-experimental design, the sample was selected using a purposive sampling technique with inclusion, exclusion, in-advance, and drop-out criteria. Samples that met the inclusion criteria could participate as the research samples. The criteria required the athletes should be 1) aged between 17 and 19 years, 2) male, 3) actively competing, 4) not having any injuries or post-surgery, and 5) willing to be the research samples. Meanwhile, samples that met the exclusion criteria could not participate as the research samples. The criteria involved 1) had an accident that caused serious bodily injury, 2) had not had an injury or fracture within the past year, and 3) unable or unwilling to provide the information the researchers needed. Meanwhile, the currently treated samples could be aborted if they meet the criteria, including 1) did not take part in the exercise three times in a row, 2) experienced an injury during the treatment, and 3) decided not to take part in the exercise anymore.

Moreover, at the beginning of the study, the experimental subjects were given a pretest with an aerobic endurance ability test. Following that, the two experimental groups received treatment in the form of Small Sided Games and Coordination Training respectively. A post-test was administered in the same format as the pre-test during the final stage.

The sample population in this study involved all male futsal players in Yogyakarta City who took part in the Training Center (TC) at the Regional Sports Week, with a total of 18 male athletes aged 18 ± 0.9 years old, height 168.7 ± 3.4 cm and weight 63 ± 3.4 kg. An ordinal pairing (AB-BA) from the pretest results was applied to determine the experimental group. This pairing system makes participants with findings identical to or nearly identical to the initial test matched with the AB-BA formula. These results came from the formation of two groups with the same number of experimental subjects: experimental group 1 (n = 9) and experimental group 2 (n = 9), both of which had a balanced ability level [33]. Each group underwent an appropriate training program (SSG and CT) with a training overview for the week, as shown in Table 1.

The SSG model in this study resembles a real futsal game which has undergone certain modifications that simultaneously determined the SSG intensity. Furthermore, the SSG intensity determination was based on the number of players [24], field format [21], [34], training regimen (duration, sets, and rest time) [20], [24], rules of the game [25], and the coach encouragement [26]. The details of the SSG exercises can be seen in Table 2.

The CT training model of this study adopted the training model in research by [35]. In this study, the CT used were five models of exercises or drills, namely *Agility Ladder Single Step with Passing and Control*, *Agility Ladder Steps Run Integration with Dribbling*, *Agility Ladder Lateral In and Out Run Integration with 1vs1*, *Two Foot Hops with Shooting*, and *Combination Training Using Circuit System*. It was known that these training models had a minimum standard Aiken's V validity value of 0.880, so the model could be considered valid when applied as a CT for junior futsal athletes [35]. Determination of CT intensity was based on the training regimen as described in Table 3.

Futsal is a sport that has intermittent high-intensity activities [1]. Therefore, VO_2 max data collection was carried out using Yoyo Intermittent Recovery (IR) to determine the ability to perform intense exercise and the potential ability to have speed recovery [36]. Furthermore, Yoyo IR level 1 is used to determine aerobic capacity [37].

Table 1. Training overview for the week

Week	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
1	MT 3x6min	MT 4x6min	Rest	LT 2x15min	HT 5x4min	MT 3x8min	Rest
2	MT 4x6 min	HT 5x4min	Rest	LT 2x15min	MT 4x6min	MT 3x8min	Rest
3	HT 6x4min	AT 6x30s	Rest	MT 3x10 min	HT 6x4min	MT 2x10min	Rest
4	HT 10x2min	AT 8x39s	Rest	MT 3x8min	AT 6x75s	HT 8x2min	Rest
5	HT 8x2min	AT 6x90s	Rest	LT 2x15min	AT 8x90s	HT 4x4min	Rest
6	HT 8x2min	AT 8x30s	Rest	LT 2x15min	MT 3x8min	AT 6x90s	Rest

*LT: Low-intensity aerobic training; MT: moderate- intensity aerobic training; HT: high-intensity aerobic training; AT: anaerobic training

Table 2. Training Protocol for Small Side Game

Intensity	Bouts	Duration	Rest	Small Side Games	
				Format	Field (m)
LT	2-3	>15 min	2 min	4 x 5	20 x 20
MT	2-4	6-10 min	2-3 min	4 x 5	30 x 20
HT	5-10	2-4 min	1-2 min	3 x 3	20 x 20
AT	4-8	30-90 s	30-90 s	2 x 2	20 x 15

Table 3. Protocol for Coordination Training

Intensity	Bouts	Duration	Rest	Coordination Training	
				Format	Field (m)
LT	2-3	>15 min	2 min	Agility Ladder Single Step with Passing and Control	20 x 20
MT	2-4	6-10 min	2-3 min	Agility Ladder Steps Run Integration with Dribbling	30 x 20
HT	5-10	2-4 min	1-2 min	Agility Ladder Lateral In and Out Run Integration with 1vs1	20 x 20
AT	4-8	30-90 s	30-90 s	Two-Foot Hops with Shooting	20 x 15
				Combination Training Using Circuit System	20 x 15

Errors in test execution must be avoided in order to obtain objective results. The test procedure can be seen as follows:

a) **Purpose**: The primary purpose of the YYIR test was to assess the capacity to repeatedly do intensive exercise, as well as the capacity to recover rapidly from such exercise.
b) **Tools required**: Marker/cones, measuring tape, audio.
c) **Procedures**: Participants ran for 40 m (2x20m), with an initial speed of 10km/h before gradually increased. Participants rested for 10 seconds every time they did 1 turn. Participants were given a warning when they cannot complete the feedback in the allotted time with a signal from the audio. Participants were considered failed when they could not complete the return the second time.
d) **Scoring Yo-Yo IR1 test**: VO_2 max (ml/min/kg) = IR1 distance (m) × 0.0084 + 36.4. The VO_2 max formula used in this research was adapted from Bangsbo et al [37].

The techniques employed for the data analysis process in this study involved (1) a normality test, the *Kolmogorov-Smirnov,* to see if the data were normally distributed and (2) the homogeneity test to determine whether the population number variations were the same. The variance similarity between the pre-and post-test experimental group data was determined using a variance homogeneity test. Furthermore, *Levene's Test* was utilized for the homogeneity test through the SPSS program to examine the variances' homogeneity. The homogeneity test was carried out to determine whether the two experimental groups' distribution of data (variance) was not heterogeneous, which meant it had balanced characteristics worth comparing [38]. The distribution of data (variance) of the two experimental groups was declared homogeneous when Levene's test results showed a significance value of p>0.05; (3) The *pre-test* and *post-test* results of the experimental group were compared using the t-test in order to see if there was a significant difference in any variables between the two. This t-test was performed to determine whether SSG and CT had a significant influence or difference on the aerobic endurance abilities of male futsal athletes. The data collected from the initial test (*pre-test*) and the final test (*post-test*) were evaluated statistically descriptively using the t-test provided by the SPSS version 26 program. The significance level was 5%, which was equal to 0.05. The results of the analysis stated that there was a difference because the significance value was less than 0.05 (P <0.05).

3. Result

3.1. Descriptive Pretest and Posttest Aerobic Durability Capabilities

Table 4 shows the results data of the aerobic endurance capacity test before and after the treatments. This aerobic endurance capability test (VO_2 Max) was conducted using Yoyo Intermittent Recovery Level 1. Table 4 below provides pretest and post-test data of the SSG and CT treatments.

Table 4. Descriptive Pretest and Post-test Results of Aerobic Endurance Capability (VO_2 max)

Group	No.	Level	Pretest VO_2 max (ml/Kg.bb/s)	Level	Post-test VO_2 max (ml/Kg.bb/s)
SSG	1	17.40	49.25	17.70	50.68
	2	17.30	49.00	17.50	50.26
	3	15.70	47.32	16.10	48.24
	4	15.50	44.72	15.80	46.56
	5	14.80	44.55	15.90	49.00
	6	14.70	44.63	15.80	45.64
	7	14.30	44.80	14.80	45.22
	8	14.20	42.28	14.80	43.96
	9	13.10	40.60	14.30	41.44
CT	10	17.40	49.00	17.50	49.25
	11	16.70	48.83	16.70	49.00
	12	16.50	47.91	16.50	47.91
	13	15.80	47.57	17.10	47.57
	14	15.60	43.96	17.10	44.97
	15	15.60	44.72	15.60	44.72
	16	15.30	43.12	15.30	43.54
	17	15.20	44.04	15.20	44.13
	18	14.10	40.68	14.10	41.44

Table 5 shows the descriptive pre-test and post-test results for each treatment group's aerobic capacity level and gain. The SSG and CT groups showed an increase in the mean value seen from the pre-and post-test results.

Table 5. Descriptive of Pre-Test and Post-Test YoYo IR level 1 Results in Each Group

Group	Test	Level	VO_2 max (ml/Kg.bb/s)
SSG	Pre-test	15.2 ± 1.4	45.24 ± 2.88
	Post-test	15.8 ± 1.1	46.78 ± 3.05
CT	Pre-test	15.8 ± 0.9	45.54 ± 2.90
	Post-test	16.1 ± 1.1	45.84 ± 2.70

Table 6. Aerobic Endurance Capability Pretest Frequency Distribution (VO_2 max)

No	Level	Absolute Frequency	Relative Frequency	Rating
1	17.3-18.6	3	16,67%	Good
2	15.7-17.2	4	22,22%	Average
3	14.2-15.6	9	50,00%	Below Average
4	< 14.2	2	11,11%	Very poor
Total		**18**	**100.0%**	

Table 6 displays the frequency distribution of the pre-test data. Based on the data in the table, it can be seen that among 18 futsal athletes, only three obtained good ratting on their aerobic endurance abilities, four were in the average class, nine were above average, and two were very poor athletes.

Table 7 presents the data after being given the treatment of Small Side Games and Coordination Training on improving aerobic endurance ability by post-test ratting. Based on table below, three athletes obtained good ratting, eight were in the average category, six were in the below average category, and one was in the very poor category.

Table 7. Post-test Frequency Distribution Aerobic Durability Capability (VO_2 max)

No	Level	Absolute Frequency	Relative Frequency	Rating
1	17.3-18.6	3	16,67%	Good
2	15.7-17.2	8	22,22%	Average
3	14.2-15.6	6	50,00%	Below Average
4	< 14.2	1	11,11%	Very poor
Total		**18**	**100.0%**	

3.2. Normality Test Results

The Kolmogorov-Smirnov test was used to examine the data distribution, producing a k-s coefficient of 0.227 and a probability of 0.199 for the *SSG pretest* group as shown in Table 8. When the $p > 0.05$, then the data are regularly distributed. Similarly, with the CT variable, $p > 0.05$ indicated normality. From the data above, it can be concluded that the variables were all normal.

Table 8. Normality Test Results Data

Group	Variables	pre	p	Post	p
		K-S		K-S	
	Small Side Games Score	0.227	0.199	0.129	0.200
	Coordination Score	0.203	0.200	0.184	0.200

3.3. Homogeneity Test Results

The F-test results that evaluated the similarity of the SSG variants from the two groups before the treatment obtained an F-count of 1.213, with a probability of 0.287 as shown in Table 9. The $p > 0.05$ indicated that their pulmonary intake capacity (group) was homogeneous. Likewise, for CT, in both homogeneous groups, the F-count was 0.051 with a probability of 0.823.

Table 9. Homogeneity Test Results Data

Variables	F Count	P
Small Side Games Score	1.213	0.287
Coordination Score	0.051	0.823

3.4. Hypothesis Test Results

The purpose of the t-test was to determine whether there was a difference in the VO_2 max skills of the group that participated in the Small Side Games and Coordination Training between the pre-test and the post-test. The study results indicated a difference when the significance value was less than 0.05 ($p < 0.05$). The significance of the difference was determined statistically using a t-test. The results of the t-test are presented in the following Table 10: Based on the t-test results, the Small Side Games and Coordination Training could improve aerobic endurance of male futsal athletes. The overall results can be seen in Table 9. The results of the cardiorespiratory ability analysis (VO_2 max) using the SSG method produced 3.926 with a $p = 0.004 < 0.05$, indicating significance. Hence, the outcomes of the pre-and post-tests were significantly different. Based on this analysis, the aerobic endurance ability of the two post-test groups was better than that of the pretest. Therefore, the research hypothesis that the Small Side Games and Coordination Training can improve aerobic endurance in male futsal ball athletes was accepted.

Meanwhile, based on Table 9, the average score of the VO_2 max group after being given Small Side Games training (46.778) was higher than that of the coordination training group (45.836). Thus, the research hypothesis stating that the Small Sides Games training was more effective for improving the aerobic endurance ability of male futsal athletes was accepted.

4. Discussion

Futsal is a fast and dynamic game played on a relatively compact field with almost no error tolerance [39]. Therefore, a component of physical condition, especially endurance, is needed as the dominant physical component of the players. Futsal players must have good aerobic endurance because it is a sport with short-paced and intense games with an average total game duration of 75-90 minutes, even though the rule of the futsal game states only 2x20 minutes [1].

This study showed that the aerobic endurance of 18 male futsal athletes had increased significantly. In other words, the Small Side Games and Coordination Training could improve their aerobic endurance. Nevertheless, the Small Side Games training method was proven to be more effective, as in the studies conducted by [5], [18], [40], which claim that the Small Side Games training could increase aerobic capacity in futsal athletes.

The Small Side Games is a training held by reducing the field and the number of players [41]. This method makes it seem like the player is in an actual game situation but with higher pressure due to the possibility of having more possession of the ball. The activeness of players who appear more often in small-sided games training allows players to practice with three aspects simultaneously: physicality, technique, and tactics [24], [42], [43]. Both coordination and SSG training programs increase futsal players' aerobic endurance in a significant manner. In addition, SSG programs also produce better technical performance. Therefore, it is an alternative to developing training to improve aerobics in futsal [20].

Research by [44] explains that the small-sided game training can increase maximal aerobic capacity. This is reinforced by the opinion of [45], which reveals that training using the small-sided games is a suitable to improve cardiovascular. Furthermore, [46] claims that the presence of a ball in small-sided games could enhance physical fitness. The three perspectives above are consistent with the results of a study conducted by [47], who also examined small-sided games training with formats (2 vs. 2) and (3 vs. 3), whose results could increase VO_2 max.

Table 10. Data on Test Results t Pretest against Post-Test

Aspect	Variables	Group	Small Side Games			Coordination		
			Mean	T	P	Mean	T	P
	V02maks	Post-test	46.7787	3.926	0.004	45.8367	2.468	0.039
		Pretests	45.2389			45.5367		

The coordination-based training method in this study was adopted from a research by [35]. Futsal players must move effectively and efficiently to win games [2]. Good coordination allows effective execution and efficient movements. The ability to win matches does not depend only on intrinsic talent, but the players must also train rigorously with a suitable training program. This method of coordination training is needed to improve aerobic endurance in futsal athletes. The results of previous studies have compared the Small Side Games with general training, for example, by running using intervals, long-distance runs, and many more.

The previous research on coordination exercises did not consider the effect on VO_2 max. The study was conducted by [48], who investigated the effects of a combined 10-week coordination and agility training program. The results of this study revealed that coordination training affected strength and agility but not long-distance speed performance. Another study on coordination training in school-aged children's executive functions reveals that short- and long-term endurance and coordination trainings could improve children's executive functions [49].

The gain in cardiorespiratory fitness is not simply attributable to the training method used. It is also essential that the determination of the training dose is carried out according to the training principle. Determining the correct training dose creates reasonable and targeted training compensation [50]. A study by [20] shows that the effect of the SSG model on performance can vary depending on how the structure of the SSG model is developed (e.g., format, field size, training regimen, coach encouragement, provisions for movement, rules of the game). Meanwhile, to achieve a good level of aerobic capacity, a program should be prepared and developed based on the needs of movement in each sport [15]. This can be seen in the characteristics of CT in this research model.

Therefore, this study emphasized that the SSG and CT exercises could increase aerobic capacity when the dose to train coordination and aerobics simultaneously was given appropriately. Furthermore, there are two contemporary endurance exercise theories: low-intensity exercise endurance (LIEE) and high-intensity exercise endurance (HIEE). Both can stimulate certain physiological changes in athletes, but the main goal is to achieve a better adaptation or aerobic capacity [51]. In the SSG and CT in this study, the increase in aerobic ability could be explained through training load compensation theory or training intensity. Exercise with a certain load is known to influence the adaptation of the energy system, while this energy system is the foundation for developing aerobic (endurance) and even anaerobic abilities [15]. Light-intensity exercise can adapt the oxidative energy system so that the glycolysis energy system (at a high intensity) becomes more effective and efficient. Not only that, adding the intensity of anaerobic training (as shown in Tables 2 and 3) can also increase aerobic capacity or endurance ability, even though the initial training objective is to adapt the phosphagen energy system (ATP-PC). This is reinforced by a study by [52] that stated that anaerobic exercise could help improve endurance ability. However, the effect of concurrent training in this study cannot be explained.

The authors suggest that the SSG and CT training can be done simultaneously with different proportions. For example, the SSG is 80% while the CT training is 20%, and vice versa depending on the match's needs and approach. Then gradually, the coach improves SSG training by adjusting it to the schedule so that the technical and tactical aspects suit the approach of the match.

Some limitations affected the results of this study. First, the control group of this study was unable to fully control the outside variables that affected the experiment's execution, such as athletes participating in matches during the treatments, having extreme fatigue due to the fact that the samples consisted of student-athletes and athletes who trained outside of the treatments given by the researchers. The researcher also could not control the athletes' rest, sleep, or eating patterns, which then affected athletes' performance. Second, our study could not explain the benefits of concurrent SSG and CT (SSG-CT) exercises because it was limited to only SSG and CT groups. Third, the low number of samples employed in this study was another limitation of this investigation. For future studies, it is recommended to have a bigger sample size to see whether the outcomes would be the same or different and to compare the effects of exercise in the SSG-CT, SSG, and CT groups.

5. Conclusions

On the basis of the study's findings, it can be stated that: (1) training using the small side games had a positive and significant effect on the aerobic endurance of futsal athletes; (2) the coordination training had a positive and significant effect on enhancing futsal participants' aerobic endurance; (3) the small side game training method had proven better to improve aerobic endurance ability

effectively and efficiently than coordination training. It is recommended that both training can be used to improve aerobic endurance, but the closer the match gets, the better it would be to use small-side games training.

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REFERENCES

[1] K. Spyrou, T. T. Freitas, E. Marín-Cascales, and P. E. Alcaraz, "Physical and Physiological Match-Play Demands and Player Characteristics in Futsal: A Systematic Review," *Front. Psychol.*, vol. 11, no. November, 2020, doi: 10.3389/fpsyg.2020.569897.

[2] Y. Miftachurochmah, Tomoliyus, S. Nahimana, E. R. Sukamti, A. Alim, and Fauzi, "Tactics analysis of attacking the pansa fc women's futsal team Yogyakarta, Indonesia," *Int. J. Hum. Mov. Sport. Sci.*, vol. 9, no. 2, pp. 356–362, 2021, doi: 10.13189/saj.2021.090225.

[3] H. Sarmento, P. Bradley, and B. Travassos, "The transition from match analysis to intervention: Optimising the coaching process in elite futsal," *Int. J. Perform. Anal. Sport*, vol. 15, no. 2, pp. 471–488, 2015, doi: 10.1080/24748668.2015.11868807.

[4] J. Almeida, H. Sarmento, S. Kelly, and B. Travassos, "Coach decision-making in Futsal: from preparation to competition," *Int. J. Perform. Anal. Sport*, vol. 19, no. 5, pp. 711–723, 2019, doi: 10.1080/24748668.2019.1648717.

[5] S. Amani-Shalamzari, E. Khoshghadam, A. Donyaei, A. Parnow, M. Bayati, and F. M. Clemente, "Generic vs. small-sided game training in futsal: Effects on aerobic capacity, anaerobic power and agility," *Physiol. Behav.*, vol. 204, pp. 347–354, 2019, doi: https://doi.org/10.1016/j.physbeh.2019.03.017.

[6] A. Mohammed, M. Shafizadeh, and G. K. Platt, "Effects of the level of expertise on the physical and technical demands in futsal," *Int. J. Perform. Anal. Sport*, 2014, doi: 10.1080/24748668.2014.11868736.

[7] I. Setiawan, M. F. Hidayatullah, and M. Doewes, "Anthropometry Factors and Physical Dominan Conditions in Futsal Playing Capabilities," *Int. J. Multicult. Multireligious Underst.*, 2019, doi: 10.18415/ijmmu.v6i1.889.

[8] R. S. Lloyd *et al.*, "National Strength and Conditioning Association position statement on long-term athletic development," *J. Strength Cond. Res.*, vol. 30, no. 6, pp. 1491–1509, 2016.

[9] A. Frederiksen, R. A. McLeman, and T. L. Elcombe, "Building backyard ice rinks in Canada: an exploratory study," *Leis. Loisir*, vol. 42, no. 1, pp. 47–68, 2018, doi: 10.1080/14927713.2017.1411822.

[10] E. Frias-Toral *et al.*, "Mediterranean Diet and Physical Activity for Successful Aging: An Update for Nutritionists and Endocrinologists," *Endocrines*, vol. 2, no. 4, pp. 366–383, 2021, doi: 10.3390/endocrines2040034.

[11] H. Sukmala, "Standardisasi Dan Gambaran Vo2max Atlet Futsal Putra Tingkat Profesional Di Indonesia." Universitas Pendidikan Indonesia, 2017.

[12] B. M. Baroni and E. C. P. Leal Junior, "Aerobic capacity of male professional futsal players," *J. Sports Med. Phys. Fitness*, vol. 50, no. 4, pp. 395–399, Dec. 2010.

[13] J. C. B. Alvarez, S. D'Ottavio, J. G. Vera, and C. Castagna, "Aerobic fitness in futsal players of different competitive level.," *J. strength Cond. Res.*, vol. 23, no. 7, pp. 2163–2166, Oct. 2009, doi: 10.1519/JSC.0b013e3181b7f8ad.

[14] C. Castagna, S. D'Ottavio, J. G. Vera, and J. C. B. Álvarez, "Match demands of professional Futsal: A case study," *J. Sci. Med. Sport*, vol. 12, no. 4, pp. 490–494, 2009, doi: 10.1016/j.jsams.2008.02.001.

[15] T. O. Bompa and C. Buzzichelli, *Periodization-: theory and methodology of training*. Human kinetics, 2019.

[16] F. J. Hettinga *et al.*, "Regulation of endurance performance: New frontiers," *Front. Physiol.*, vol. 8, no. SEP, pp. 1–4, 2017, doi: 10.3389/fphys.2017.00727.

[17] D. French and L. T. Ronda, *NSCA's Essentials of Sport Science*. Human Kinetics, 2021.

[18] K. Hulka and R. Weisser, "The influence of the number of players on workload during small-sided games among elite futsal players," *Montenegrin J. Sport. Sci. Med.*, vol. 6, no. 1, pp. 45–48, 2017.

[19] F. M. Clemente *et al.*, "Effects of Small-Sided Game Interventions on the Technical Execution and Tactical Behaviors of Young and Youth Team Sports Players: A Systematic Review and Meta-Analysis.," *Frontiers in psychology*, vol. 12. Switzerland, p. 667041, 2021. doi: 10.3389/fpsyg.2021.667041.

[20] F. M. Clemente, J. Afonso, and H. Sarmento, "Small-sided games: An umbrella review of systematic reviews and meta-analyses," *PLoS One*, vol. 16, no. 2, p. e0247067, 2021.

[21] D. Castillo *et al.*, "Influence of Different Small-Sided Game Formats on Physical and Physiological Demands and Physical Performance in Young Soccer Players.," *J. strength Cond. Res.*, vol. 35, no. 8, pp. 2287–2293, Aug. 2021, doi: 10.1519/JSC.0000000000003114.

[22] A. N. C. Rebelo, P. Silva, V. Rago, D. Barreira, and P. Krustrup, "Differences in strength and speed demands between 4v4 and 8v8 small-sided football games.," *J. Sports Sci.*, vol. 34, no. 24, pp. 2246–2254, Dec. 2016, doi: 10.1080/02640414.2016.1194527.

[23] T. Little, "Optimizing the use of soccer drills for physiological development," *Strength Cond. J.*, vol. 31, no. 3, pp. 67–74, 2009.

[24] H. Sarmento, F. M. Clemente, L. D. Harper, I. T. da Costa, A. Owen, and A. J. Figueiredo, "Small sided games in soccer–a systematic review," *Int. J. Perform. Anal. Sport*, vol. 18, no. 5, pp. 693–749, 2018.

[25] P. Bujalance-Moreno, P. Á. Latorre-Román, A. Martínez-Amat, and F. García-Pinillos, "Small-sided games in amateur players: rule modification with mini-goals to induce lower external load responses.," *Biol. Sport*, vol. 39, no. 2, pp. 367–377, Mar. 2022, doi: 10.5114/biolsport.2022.105336.

[26] J. Díaz-García, J. J. Pulido, J. C. Ponce-Bordón, C. Cano-Prado, M. Á. López-Gajardo, and T. García-Calvo, "Coach Encouragement During Soccer Practices Can Influence Players' Mental and Physical Loads.," *J. Hum. Kinet.*, vol. 79, pp. 277–288, Jul. 2021, doi: 10.2478/hukin-2021-0079.

[27] J. Dal Pupo, J. Barth, F. A. Moura, and D. Detanico, "Physical capacities related to running performance during simulated matches in young futsal players," *Sport Sci. Health*, 2020, doi: 10.1007/s11332-020-00639-1.

[28] J. M. Murias, S. Pogliaghi, and D. H. Paterson, "Measurement of a true V·O2max during a ramp incremental test is not confirmed by a verification phase," *Front. Physiol.*, vol. 9, no. FEB, pp. 1–8, 2018, doi: 10.3389/fphys.2018.00143.

[29] L. A. Enríquez-Del-castillo, A. Ornelas-López, L. G. De León, N. Cervantes-Hernández, E. Quintana-Mendias, and L. A. Flores, "Strength and VO_2 max Changes by Exercise Training According to Maturation State in Children," *Children*, vol. 9, no. 7, 2022, doi: 10.3390/children9070938.

[30] D. Pizarro, A. Práxedes, B. Travassos, F. del Villar, and A. Moreno, "The effects of a nonlinear pedagogy training program in the technical-tactical behaviour of youth futsal players," *Int. J. Sport. Sci. Coach.*, 2019, doi: 10.1177/1747954118812072.

[31] D. J. Paul, T. J. Gabbett, and G. P. Nassis, "Agility in Team Sports: Testing, Training and Factors Affecting Performance," *Sports Medicine*. 2016. doi: 10.1007/s40279-015-0428-2.

[32] M. A. Handley, C. Lyles, C. McCulloch, and A. Cattamanchi, "Selecting and improving quasi-experimental designs in effectiveness and implementation research," *Annu. Rev. Public Health*, vol. 39, p. 5, 2018.

[33] S. Wibowo *et al.*, "Endurance cardiovascular, core and leg strength development using AMRAP, EMOM and for time training program," *J. Phys. Educ. Sport*, vol. 22, no. 12, pp. 3168–3176, 2022, doi: 10.7752/jpes.2022.12402.

[34] M. Brandes, A. Heitmann, and L. Müller, "Physical responses of different small-sided game formats in elite youth soccer players.," *J. strength Cond. Res.*, vol. 26, no. 5, pp. 1353–1360, May 2012, doi: 10.1519/JSC.0b013e318231ab99.

[35] Y. Miftachurochmah and E. R. Sukamti, "Coordination Training Model Innovation for Junior Futsal Players: Aiken's Validity," in *Conference on Interdisciplinary Approach in Sports in conjunction with the 4th Yogyakarta International Seminar on Health, Physical Education, and Sport Science (COIS-YISHPESS 2021)*, 2022, pp. 181–187.

[36] P. Krustrup *et al.*, "The Yo-Yo intermittent recovery test: Physiological response, reliability, and validity," *Med. Sci. Sports Exerc.*, vol. 35, no. 4, pp. 697–705, 2003, doi: 10.1249/01.MSS.0000058441.94520.32.

[37] J. Bangsbo, F. M. Iaia, and P. Krustrup, "The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports," *Sport. Med.*, vol. 38, pp. 37–51, 2008.

[38] A. Petrovic, V. Koprivica, and B. Bokan, "Quantitative, qualitative and mixed research in sport science: a methodological report," *South African J. Res. Sport. Phys. Educ. Recreat.*, vol. 39, no. 2, pp. 181–197, 2017.

[39] V. Hermans and R. Engler, *Futsal: Technique, tactics, training*. Meyer & Meyer Verlag, 2010.

[40] D. Berdejo-del-Fresno, R. Moore, and M. W. Laupheimer, "VO₂max Changes in English Futsal Players after a 6-Week Period of Specific Small-Sided Games Training," *Am. J. Sport. Sci. Med.*, vol. 3, no. 2, pp. 28–34, 2015, doi: 10.12691/ajssm-3-2-1.

[41] D. Pizarro, A. Práxedes, B. Travassos, B. Gonçalves, and A. Moreno, "How the number of players and floaters' positioning changes the offensive performance during futsal small-sided and conditioned games," *Int. J. Environ. Res. Public Health*, vol. 18, no. 14, pp. 1–10, 2021, doi: 10.3390/ijerph18147557.

[42] Y. Koklu and A. Asci, "Comparison of the Physiological Responses to Different Small-Sided Games in Elite Young," *Strength Cond.*, vol. 25, no. 6, pp. 1522–8, 2011.

[43] M. Karahan, "Effect of skill-based training vs. small-sided games on physical performance improvement in young soccer players," *Biol. Sport*, vol. 37, no. 3, pp. 305–312, 2020.

[44] J. Moran *et al.*, "Effects of Small-Sided Games vs. Conventional Endurance Training on Endurance Performance in Male Youth Soccer Players: A Meta-Analytical Comparison," *Sport. Med.*, no. 0123456789, 2019, doi: 10.1007/s40279-019-01086-w.

[45] S. Amani-Shalamzari *et al.*, "Occlusion training during specific futsal training improves aspects of physiological and physical performance," *J. Sport. Sci. Med.*, vol. 19, no. 2, pp. 374–382, 2020.

[46] A. L. Owen, M. Newton, A. Shovlin, and S. Malone, "The Use of Small-Sided Games as an Aerobic Fitness Assessment Supplement within Elite Level Professional Soccer," *J. Hum. Kinet.*, vol. 71, no. 1, pp. 243–253, 2020, doi: 10.2478/hukin-2019-0086.

[47] A. Dellal, K. Chamari, A. L. Owen, D. P. Wong, C. Lago-Penas, and S. Hill-Haas, "Influence of technical instructions on the physiological and physical demands of small-sided soccer games," *Eur. J. Sport Sci.*, vol. 11, no. 5, pp. 341–346, 2011.

[48] F. T. González-Fernández, H. Sarmento, A. Castillo-Rodríguez, R. Silva, and F. M. Clemente, "Effects of a 10-week combined coordination and agility training program on young male soccer players," *Int. J. Environ. Res. Public Health*, vol. 18, no. 19, 2021, doi: 10.3390/ijerph181910125.

[49] A. Drozdowska, G. Jendrusch, P. Platen, T. Lücke, M. Kersting, and K. Sinningen, "Dose-Related Effects of Endurance, Strength and Coordination Training on Executive Functions in School-Aged Children: A Systematic Review," *Children*, vol. 9, no. 11, 2022, doi: 10.3390/children9111651.

[50] H. Permana, E. R. Sukamti, Suhadi, and Y. Miftachurochmah, "The Impacts of Plyometric Circuit Training before and after Technical Training on Cardiorespiratory and Power Abilities of Junior Male Volleyball Athletes," *Int. J. Hum. Mov. Sport. Sci.*, vol. 10, no. 4, pp. 823–831, 2022, doi: 10.13189/saj.2022.100423.

[51] M. H. Stone *et al.*, "Maximum Strength and Strength Training---A Relationship to Endurance?," *Strength Cond. J.*, vol. 28, no. 3, 2006.

[52] H. Sözen, "The effects of aerobic and anaerobic training on aerobic and anaerobic capacity," *J Int Anatolia Sport Sci Vol*, vol. 3, no. 3, 2018, doi: 10.5505/jiasscience.2018.68077.