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RESEARCH ARTICLE

Effectiveness of Circuit and Fartlek Exercises to Increase Aerobic Endurance in Adolescent Futsal Players

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Abstract

Aerobic endurance is an important component in futsal sports games, so it requires an exercise that can increase aerobic endurance. This study aims to evaluate the effectiveness of circuit training with fartlek exercises to increase aerobic endurance futsal players Bina Darma. The research method used was an experiment with the design of the control group pre-test post-test. The study population of 40 Bina Darma futsal players was divided evenly into two groups, namely the circuit training group and the fartlek training group consisting of 20 samples. Each group performed the exercises for 8 weeks with a frequency of 3 times a week. Aerobic endurance measurements were taken before and after the exercise program using the Bleep Test. Analysis Data obtained from VO2 max test will be analyzed using statistical software SPSS 23. Statistical analysis that will be used is an Paired Samples Test to compare the increase in aerobic endurance between circuit training group and fartlek exercise group. The results showed a significant increase in aerobic endurance in all groups after the exercise programme. The results of this study showed that the circuit training group was more significant than the fartlek training group with very high statistical significance ($p < .001$), showing that the difference between circuit training and fartlek training in improving aerobic endurance was significant. In conclusion, circuit training is a more effective option for improving aerobic endurance in Bina Darma futsal players. Choosing the right type of sport can increase the aerobic endurance of futsal players.

Keywords
Circuit Training, Fartlek, Aerobic Endurance, Futsal

INTRODUCTION

The aerobic endurance of futsal players is crucial to support modern futsal matches that require players to be physically active throughout the match (Travassos et al., 2018). This is important because futsal players with good aerobic endurance have a significant competitive advantage (Nabo et al., 2021). Increased aerobic endurance can help players perform better on the pitch, reduce the risk of injury and increase their productivity during matches (Endrawan & Aliriad, 2023). A better understanding of the most effective training methods is a must in the effort to improve the performance of futsal players (Satria et al., 2023). Improved aerobic endurance is a key aspect of futsal players' training that can have a significant

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impact on their performance on the pitch (Figueiredo Machado et al., 2023).

Maintaining aerobic endurance is crucial for optimal performance in futsal games due to the high intensity and fast movements required in a limited space (Helgerud et al., 2023; Mosteoru et al., 2023). Futsal matches are short, which demands optimal aerobic energy levels. However, players often struggle to adjust to the high intensity, short duration, and limited recovery time between matches (Li et al., 2023; Ziyaiyan et al., 2023). Futsal players with good aerobic endurance can maintain high performance levels throughout matches, with effective defence and consistent attack, as well as quick recovery. Research indicates that incorporating specific exercises to improve aerobic endurance can provide significant benefits, such as better fitness, quick recovery, and consistent performance (Vibarel-Rebot et al., 2023; Volterrani et al., 2023). However, there is still uncertainty about the most effective training method to achieve maximum improvement in aerobic endurance (Rahman, 2018). Increasing aerobic endurance is an important factor in the training of futsal players, given the nature of the game, which relies heavily on prolonged physical activity (Lago-Fuentes et al., 2021).

Circuit training and fartlek training are two training methods that have great potential for improving aerobic endurance in futsal players (Festiawan et al., 2020; Muryadi et al., 2021). Circuit training involves a series of different physical exercises, from strength to cardiovascular, performed sequentially with little or no rest in between (Festiawan et al., 2021). This approach allows players to work at high intensity for relatively short periods of time, increasing their aerobic and anaerobic capacity (Kharisma & Mubarok, 2020). Fartlek exercises emphasise variations in intensity and speed during training, reflecting the nature of futsal matches, which often involve alternating periods of high and low intensity (Hermanzoni, 2019; Pratama & Kushartanti, 2018). This training allows players to develop the ability to adapt to sudden changes in the tempo of the game, which is an important skill in the modern world of futsal (Karatrantou et al., 2023; Molinaro et al., 2023).

The main difference between this study and the previous one is the focus on two training methods that have the potential to increase aerobic endurance in futsal players (Satria, 2018), namely circuit training and fartlek training. Focus on general problems encountered in futsal matches, whereas this study is more specific in explaining the two training methods. The difference of this study may be the emphasis on the effectiveness of circuit training and fartlek training in improving the aerobic and anaerobic capacity of futsal players.

As sport science has developed, several previous studies have provided valuable insights into training methods that can improve aerobic endurance in futsal players (Atakan et al., 2019; Matias et al., 2023). Several studies have shown that circuit training and fartlek exercises have the potential to significantly improve aerobic endurance. The main problem to be solved in this study is to determine the most effective training methods to improve aerobic endurance in Bina Darma futsal players (Bahtra et al., 2020; Saputra et al., 2022). As part of this problem, we will also compare the effectiveness of circuit training exercises and fartlek exercises.

Recent evidence from the world of sport has identified circuit training and fartlek exercises as potential methods to improve aerobic endurance. Several recent studies in the exercise and fitness literature have supported the benefits of both types of exercise in improving aerobic endurance (Astuti et al., 2022). Research (Almy & Sukadiyanto, 2014) showed a significant increase in aerobic endurance in participants who underwent an 8-week circuit training programme. Research by (Rahman, 2018) showed an equally significant increase in aerobic endurance in participants who undertook fartlek training over the same period. There is a need to relate this knowledge specifically to the context of futsal players. In addition, a direct comparison betweenn these two types of training in Bina Darma futsal players has not been carried out in detail. Previous studies Implement regular circuit training sessions that focus on a combination of cardiovascular, strength and endurance exercises. The improvement of aerobic endurance in futsal players has a strong theoretical basis (Apriantono et al., 2023), but no research has explicitly compared the effectiveness of circuit training and fartlek training in futsal players. Therefore, there are gaps in knowledge that need to be filled, particularly in assessing the most effective training methods in this context.

Circuit training and fartlek exercises have their respective advantages and potential, and this study will provide insight into the most effective

training methods for improving aerobic endurance in futsal bina darma players. The main objective of this study was to investigate and compare the effectiveness of circuit training and fartlek exercises in improving aerobic endurance in Futsal Bina Darma players. This study aims to provide a deeper understanding of the most effective training methods for improving aerobic endurance in futsal players, particularly in the Bina Darma environment. The benefit of this research is the application of training methods that have been shown to be effective in specific contexts, in the hope of providing more accurate guidance to futsal coaches and players to maximise their training and improve their performance on the field.

MATERIALS AND METHODS

This study adopts an experimental research design with a post-test pre-test control group design (Andriani et al., 2017). The population of this study is all futsal players who are members of Bina Darma futsal team, totaling 40 players. Ethics Committee approval required This article was approved by the Ethics Committee of Health Research Islamic Hospital Malang, Malang City, East Java, Indonesia with number (No.26/ KEPK/RSI-U/V/2024). Participants provide informed consent with a volunteer form that includes details about the research, risks, benefits, confidentiality and rights of participants. The study will strictly adhere to all the principles contained in the WHO Ethical Guidelines 2011 and CIOMS 2016, prioritising the rights and well-being of participants in the design, procedures and confidentiality measures.

The study sample was randomly selected from a total of 20 players aged 18-20 years, who were included in the category of junior players with 2 years of futsal experience. Participants were randomly assigned to a circuit training group, and fartlek exercise group. The details of the study participants are shown in Table 1.

Table 1. Research participants

Sample	Gender	Age (Years)	Height (Cm)	Weight (Kg)	IMT
1	Male	18	170	68	23.5
2	Male	18	172	70	23.7
3	Male	18	168	66	23.4
4	Male	18	175	75	24.5
5	Male	18	167	65	23.3
6	Male	20	176	78	25.2
7	Male	20	169	67	23.5
8	Male	18	177	74	23.6
9	Male	20	173	72	24.1
10	Male	19	171	69	23.6
11	Male	19	174	73	24.1
12	Male	20	178	77	24.3
13	Male	19	172	68	23.0
14	Male	18	167	66	23.7
15	Male	20	175	76	24.8
16	Male	18	170	67	23.2
17	Male	19	176	75	24.2
18	Male	20	169	65	22.8
19	Male	18	173	72	24.1
20	Male	18	171	70	23.9

Furthermore, the sample was divided into 2 groups, the circuit training group and the fartlek group, each with 10 players. The data collection tool used in this study is the bleep test to measure the aerobic endurance of futsal players. Measurements were taken before and after the training programme to obtain VO2 max data. The pre-test was carried out before the start of the training programme to measure the baseline aerobic endurance of each player using the bleep test. After an 8-week training programme at a frequency of 3 times per week, a post-test was carried out using the

same Bleep test to measure improvements in aerobic endurance. The data obtained from the pre- and post-test results were analysed using SPSS 23 statistical software with paired sample t-tests to compare the results between the circuit training group and the fartlek training group. The details of 8-week training programme are shown in table 2 and table 3.

Table 2. Circuit training exercise program for 8 weeks

Week	Day	Exercise 1 (30 sec)	Exercise 2 (30 sec)	Exercise 3 (30 sec)	Exercise 4 (30 sec)	Exercise 5 (30 sec)	Rest (1 minute)	Total Sessions
1	Monday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	3 round
	Wednesday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	3 round
	Friday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	3 round
2	Monday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	3 round
	Wednesday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	4 round
	Friday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	4 round
3	Monday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	4 round
	Wednesday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	4 round
	Friday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	4 round
4	Monday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	4 round
	Wednesday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	5 round
	Friday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	5 round
5	Monday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	6 round
	Wednesday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	5 round
	Friday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	5 round
Week	**Day**	**Exercise 1 (45 sec)**	**Exercise 2 (45 sec)**	**Exercise 3 (45 sec)**	**Exercise 4 (45 sec)**	**Exercise 5 (45 sec)**	**Rest (45 minute)**	**Total Sessions**
6	Monday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	6 round
	Wednesday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	6 round
	Friday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	6 round
7	Monday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	6 round
	Wednesday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	6 round
	Friday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	6 round
8	Monday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	6 round
	Wednesday	Burpees	Lunges	Bicycle Crunches	High Knees	Tricep Dips	Rest	6 round
	Friday	Jumping Jacks	Push-ups	Squats	Plank	Mountain Climbers	Rest	6 round

Table 3. Fartlek training exercise program for 8 weeks

Week	Day	Light Running	Sprint	Light Running	Walk	Total Sessions	Total Duration
1	Tuesday	5 minutes	1 minutes	2 minutes	1 minutes	3 round	27 minutes
	Thursday	10 minutes	1 minutes	2 minutes	1 minutes	2 round	28 minutes
	Saturday	5 minutes	30 Second	2 minutes	1 minutes	4 round	34 minutes
2	Tuesday	5 minutes	1 minutes	2 minutes	1 minutes	4 round	36 minutes
	Thursday	10 minutes	1 minutes	2 minutes	1 minutes	3 round	42 minutes
	Saturday	5 minutes	1 minutes	2 minutes	1 minutes	5 round	45 minutes
3	Tuesday	5 minutes	1 minutes	2 minutes	1 minutes	3 round	27 minutes
	Thursday	10 minutes	1 minutes	2 minutes	1 minutes	2 round	28 minutes
	Saturday	5 minutes	30 Second	2 minutes	1 minutes	4 round	34 minutes
4	Tuesday	5 minutes	1 minutes	2 minutes	1 minutes	4 round	36 minutes
	Thursday	10 minutes	1 minutes	2 minutes	1 minutes	3 round	42 minutes
	Saturday	5 minutes	30 Second	2 minutes	1 minutes	5 round	45 minutes
5	Tuesday	10 minutes	1 minutes	2 minutes	1 minutes	4 round	56 minutes
	Thursday	15 minutes	1 minutes	2 minutes	1 minutes	3 round	57 minutes
	Saturday	10 minutes	30 Second	2 minutes	1 minutes	4 round	54 minutes
6	Tuesday	10 minutes	1,5 minutes	2 minutes	1 minutes	4 round	58 minutes
	Thursday	15 minutes	1,5 minutes	2 minutes	1 minutes	4 round	78 minutes
	Saturday	10 minutes	1,5 minutes	2 minutes	1 minutes	4 round	58 minutes
7	Tuesday	10 minutes	1,5 minutes	2 minutes	1 minutes	4 round	58 minutes
	Thursday	15 minutes	1,5 minutes	2 minutes	1 minutes	4 round	78 minutes
	Saturday	10 minutes	1,5 minutes	2 minutes	1 minutes	4 round	58 minutes
8	Tuesday	10 minutes	1,5 minutes	2 minutes	1 minutes	4 round	58 minutes
	Thursday	15 minutes	1,5 minutes	2 minutes	1 minutes	4 round	78 minutes
	Saturday	10 minutes	1,5 minutes	2 minutes	1 minutes	4 round	58 minutes

RESULTS

The Data collected consisted of two tests, namely a Bleep test to measure the aerobic endurance of athletes in each circuit training exercise and fartlek exercise. Data collection was conducted in two stages, namely before treatment (pre-test) and after treatment (post-test). The purpose of the post-test is to compare the results of the pre-test and post-test. Thus, the data obtained include two tests, namely aerobic endurance athletes and stamina athletes, both in the pre-test and post-test. The study reported the pre- and post-test endurance results for the circuit training exercises in Table 4, where the participants were divided into aerobic system categories from "very good" to "less than once". Before the exercise, the majority of participants were in the "less than once" category with 70% of cases, followed by the "less" category with 10% of cases, while none were in the "very good" or "good" categories. After the exercise, the distribution of categories changed, with the majority of participants in the "moderate" category (50%), followed by the "less" category (40%), while none were in the "very good" or "good" category.

Table 4. Results of pre-test and post-test aerobic endurance in circuit training

Category	Pre-test	Pre-test	Post-test	Post-test
Very Good	0	0%	0	0%
Good	0	0%	0	0%
Moderate	2	20%	5	50%
Less	1	10%	4	40%
Less Than Once	7	70%	1	10%

Table 5 presents a descriptive analysis of pre- and post-test stamina in ten different samples using the bleep test method. The table shows that the mean pre-test score was 32.08, while the post-test score increased to 35.45, indicating an increase in the participants' endurance after training. The standard deviation of the pre-test was 2.89 and the post-test was 3.04, indicating a slightly greater variation in performance after training. The maximum score on the post-test was 39.20, an increase from 36.60 on the pre-test, while the minimum score increased from 27 to 31.20. Overall, the results of the analysis showed that the circuit training exercise programme resulted in a significant increase in the participants' endurance. Average post-test performance was higher than pre-test, with most samples showing improvement. A slightly higher standard deviation on the post-test showed greater variation in post-test results, which could be due to variations in individual responses to exercise.

One-sample test results for circuit training exercises in Table 3 In a one-sample t-test for circuit training, a statistical t-value of 35,162 with 9 degrees of freedom showed a very high statistical significance ($p < .001$) in the pre-test, indicating that the mean aerobic endurance prior to the exercise programme was significantly different from zero. Similarly, in the post-test, a statistical t-value of 36,820 with 9 degrees of freedom showed very high statistical significance ($p < .001$), indicating that the average aerobic endurance after the exercise programme was also significantly different from zero. The mean increase in aerobic endurance from pretest to post-test was 35.45, with a 95% confidence interval between 33.2720 and 37.6280.

Table 5. Descriptive analysis of pre-test and post-test aerobic endurance before and after circuit training exercises**.**

Name	Bleep Test (Pre-test)	Bleep Test (Post-test)	Difference
Sample 1	27	31.2	6.2
Sample 2	30.8	35.3	4.6
Sample 3	33.9	38.5	3.7
Sample 4	32	32.8	0.8
Sample 5	33.4	35.3	2
Sample 6	28.6	32.4	3.9
Sample 7	36.6	38.5	2
Sample 8	30.5	32.8	2.4
Sample 9	34	38.5	3.7
Sample 10	34	39.2	5.5
Average	32.0800	35.4500	3.48
Std Dev.	2.88513	3.04458	-0.14108
Max	36.60	39.20	3.7
Min	27	31.20	5.4

The study presented the results of the pre- and post-test endurance of the fartlek exercises in Table 6, which grouped the participants by aerobic system category from "very good" to "less than once". Before the exercise, the majority of participants were in the "less than once" category with 90% of cases, followed by the "less" category with 10% of cases, while none were in the "very good" or "good" categories. After the exercise, the distribution of categories changed, with the majority of participants being in the "moderate" category (50%), followed by the "less" category (30%), while none were in the "very good" or "good" categories.

Table 6. Results One-Sample Test circuit training exercises

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	P-Value	Mean Difference	Lower	Upper
Pre-test	35.162	9	.000	32.08000	30.0161	34.1439
Post-test	36.820	9	.000	35.45000	33.2720	37.6280

Table 7 shows that the mean pre-test score was 30.27, while the post-test score increased to 33.75, indicating an increase in the participants' endurance after training. The standard deviation of the pre-test was 3.08 and the post-test was 2.94, indicating relatively similar variations in performance before and after exercise. The maximum score on the post-test was 38.20, up from 34.50 on the pre-test, while the minimum score increased from 25 to 30.40. The results of the analysis showed that the fartlek exercise programme was also successful in increasing the endurance of the participants. Average post-test performance was higher than pre-test, with most samples showing improvement. Nearly equal standard deviations showed similar variation in pre-test and post-test results.

Table 7. Results of pre-test and post-test aerobic endurance in fartlek training

Category	Pre-test	Pre-test	Post-test	Post-test
Very Good	0	0%	0	0%
Good	0	0%	0	0%
Moderate	0	0%	5	50%
Less	1	10%	3	30%
Less Than Once	9	90%	2	20%

Table 8 shows the results of the one-sample t-test for fartlek training. The results showed that in the pre-test, the statistical t-value of 31.024 with 9 degrees of freedom showed a very high statistical significance ($p < .001$), indicating a significant difference between the mean aerobic endurance before the exercise programme and the zero value. Meanwhile, in the post-test, the statistical t-value of 36,773 with 9 degrees of freedom also showed a very high statistical significance ($p < .001$), indicating a significant difference between the average aerobic endurance after the exercise programme and the baseline value. The mean increase in aerobic endurance from pre-test to post-test was 33.77, with a 95% confidence interval between 31.6926 and 35.8474. It can therefore be concluded that the fartlek exercise programme was effective in improving aerobic endurance in the study subjects.

Table 8. Descriptive analysis of pre-test and post-test aerobic endurance before and after fartlek training

Name	Bleep Test (Pre-test)	Bleep Test (Post-test)	Difference
Sample 1	25	31.3	4.3
Sample 2	28.7	33.2	4.4
Sample 3	32.8	36.5	3.6
Sample 4	30	30.9	0.9
Sample 5	31.3	33.2	1.8
Sample 6	26.5	30.5	3.9
Sample 7	34.5	36.5	1.9
Sample 8	28.4	30.9	2.4
Sample 9	32.8	36.5	4.5
Sample 10	32.7	38.2	5.2
Average	30.2700	33.7500	3.37
Std. Deviation	3.08547	2.94439	0.15945
Max	34.50	38.20	2.6
Min	25.00	30.40	4.2

Table 9 shows the results of the paired t test for differences between circuit training and fartlek training. The mean difference between the two types of exercise is 1.68, with a standard deviation of 0.70206 and a standard error of 0.22201. The 95% confidence interval for the difference is between 1.17778 and 2.18222. A statistical t-value of 7.567 with 9 degrees of freedom indicates a very high statistical significance ($p <.001$), showing that the difference between circuit training and fartlek

training in improving aerobic endurance was significant.

Based on the pretest data, the average bleep test score for circuit training is 35.45 and 33.75 for fartlek training. The standard deviation is 3.04 for the circuit training and 2.94 for the fartlek training. In general, bleep test results are slightly higher on average in circuit training. The almost equal standard deviation indicates that the variation in the results is also relatively similar. Based on the results of the post-test bleep test, both exercises showed similar effectiveness in increasing aerobic endurance. The paired t-test results in Table 10 showed that the difference between circuit training and fartlek training in increasing aerobic endurance was significant. It can therefore be concluded that there is a significant difference in the effectiveness of circuit training and fartlek training in improving aerobic endurance in the study subjects. Based on the results of the paired difference test between circuit training and fartlek training, it can be concluded that there are significant differences between the two types of exercise in improving aerobic endurance in the study subjects. The mean difference between circuit training and fartlek training was 1.68, indicating that circuit training has a higher mean increase in aerobic endurance compared to fartlek training. In addition, a high t-statistic (7.567) with a very high statistical significance (p<.001) confirms that this difference did not occur by chance. Therefore, based on these results, it is likely that circuit training is more effective in improving aerobic endurance than fartlek training in the study subjects. The difference between the two is not very great in terms of average results. Therefore, the choice between these two types of exercise should be based on the preferences and needs of each individua

Table 9. Results One-Sample fartlek training

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	P-Value	Mean Difference	Lower	Upper
Pre-test	31.024	9	.000	30.27000	28.0628	32.4772
Post-test	36.773	9	.000	33.77000	31.6926	35.8474

Table 10. Results Paired Samples Test Post test Circuit training and Post test Fartlek training

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	P-Value
Pair 1	Circuit training - Fartlek training	1.68000	.70206	.22201	1.17778	2.18222	7.567	9	.000

DISCUSSION

The results of this study showed that circuit training and fartlek exercises significantly increased the participants' endurance, as reflected in the pre- and post-test results. In particular, in the circuit training exercise, the majority of participants moved from the "less than once" to "moderate" category. In the case of the fartlek exercise, the majority of participants moved from the "less than once" to "moderate" category. These results indicate the effectiveness of both types of exercise in increasing aerobic endurance. It is important to note that these findings can be linked to a number of previous theories and studies. Have highlighted the importance of interval training, such as fartlek, in improving aerobic capacity (Scheer et al., 2021). Study indicated that circuit training exercise can increase the aerobic endurance of Bina Darma University soccer players. The t test showed that t_ (count) = 6,564> t_ (table) = 1,740 so that the accepted Ha is significant. This study confirms the importance of interval training in improving aerobic endurance and provides empirical support, particularly in sports such as football. Our results

support their findings by showing a significant improvement in post-test scores. Furthermore, circuit training exercises, which combine elements of resistance exercise with cardiovascular exercise, have been supported by previous research (Nobari et al., 2023). Our results confirm that this approach can be effective in increasing endurance. What is new is the direct comparison between these two types of training in the context of increasing endurance (Bae & Kasser, 2023; Ma et al., 2023). Previous research has tended to focus on the effects of each type of training separately (Edwarsyah et al., 2017). Our results suggest that both can provide significant benefits, but there may be individual factors that influence the choice of exercise that is more effective for an individual.

The concept of aerobic endurance, as defined by the principles of cardiorespiratory exercise (Dwi Juniarsyah et al., 2021), encompasses various elements such as exercise intensity, duration, and frequency (Chen et al., 2022; Mancha-Triguero et al., 2022). The aim is to improve the efficiency of the heart and lungs, as well as the body's capacity to transport and utilize oxygen. Regular and measured exercise at an appropriate intensity level gradually increases the body's ability to supply oxygen to muscles, increase blood flow, and strengthen the lungs (Belli et al., 2022; Scoubeau et al., 2022). This leads to increased efficiency of the cardiovascular system and oxygen capacity in the body (Sinurat, 2019).

Have highlighted the importance of interval training, such as fartlek, in improving aerobic capacity (Scheer et al., 2021). Our results support their findings by showing a significant improvement in post-test scores. Furthermore, circuit training exercises, which combine elements of resistance exercise with cardiovascular exercise, have been supported by previous research (Ambroży et al., 2022; Rodrigues et al., 2022). Our results confirm that this approach can be effective in increasing endurance (Edwards et al., 2023; Pechstein et al., 2022). What is new is the direct comparison between these two types of training in the context of increasing endurance. Implement regular circuit training sessions that focus on a combination of cardiovascular, strength and endurance exercises.

However, it is important to recognise that an exercise program must be tailored to individual needs and conditions (Maurer et al., 2019; Van de Velde et al., 2019). In the context of this study, it is important to note that the pre- and post-test results provide a brief overview of changes in the participants' endurance. The limitation of this study lies in the nature of the exercise, which only uses circuit training and fatlek training, the types of samples used are not diverse and the number is small, so in the future it is necessary to increase the number of exercises and other types of exercises that compare the effect between exercise methods and exercise model development. Future studies could consider additional measures or further observations to improve understanding of the effects of these exercises on broader aspects of health and performance. It is also important to consider the motivation and commitment of participants to the exercise programme. Further research can deepen the analysis of psychological aspects that may affect the effectiveness of exercise in the long term.

From the pretest data, it was seen that the average Bleep test score for circuit training was slightly higher (35.45) compared to fartlek training (33.75), although the difference was not statistically significant. The score variability between the two groups was also relatively similar, indicated by almost the same standard deviation (3.04 for circuit training and 2.94 for fartlek training). However, post-test results showed that both exercises had the same effectiveness in increasing aerobic endurance. Statistical analysis using paired t-tests showed a significant difference between circuit training and fartlek training in increased aerobic endurance. Circuit training showed a higher average improvement (1.68) compared to fartlek training, and this difference did not occur by chance with high t-statistical values (7.567) and very high statistical significance ($p < .001$). These results are consistent with the findings of other studies that

also observed a greater increase in aerobic endurance with circuit training compared to fartlek training. Although the difference between the two types of exercises is not very large in terms of average results, it is quite statistically significant.

Interval and circuit training are proven effective approaches to improving aerobic capacity, particularly in the context of improving athletic performance (Boraczyński et al., 2021; Menz et al., 2021). This approach involves a period of high intensity followed by a lighter recovery period, forcing the heart and lungs to work harder in a short period . Increased aerobic capacity allows the body to use oxygen more efficiently, which has a direct impact on the increased volume and strength of the heart and lungs (Gavanda et al., 2022; Selland et al., 2022; Yue et al., 2022). Interval training in particular provides an intense challenge to the cardiorespiratory system, which in turn significantly increases aerobic capacity (Arslan et al., 2022; Hendker & Eils, 2021; Son et al., 2022). This technique is particularly relevant in the context of futsal, where players are often required to go through a period of intense activity followed by a short period of recovery.

Circuit training, on the other hand, involves a series of resistance or cardiovascular exercises performed sequentially with little or no rest between each exercise (Anderson et al., 2021; Lee et al., 2021; Satria, Ramadhan, et al., 2023). This approach, combined with interval training, can be very beneficial in increasing aerobic endurance (Aliriad et al., 2023, 2024; S Adi et al., 2023). In the context of physical preparation for futsal, where the intensity of the game is high and the duration of the match relatively long, an increase in aerobic endurance is particularly important. Although circuit training and interval training in general can improve aerobic endurance, it is important to consider more specific futsal exercises. The principles of cardiorespiratory exercise and the concept of aerobic endurance have direct implications for improving the performance of futsal players. By developing an appropriate training program that includes interval training, circuit training, and futsal-specific exercises, players can maximize their potential on the pitch.

Tailoring training programs to individual needs is essential for the effective preparation of futsal players. An individual and personalized approach to the design of a training program, taking into account individual strengths, weaknesses, fitness levels, and goals, will enable players to achieve their best performance on the futsal pitch. Therefore, the integration of interval and circuit training into training programs, together with an individualized approach, will play a crucial role in improving the aerobic capacity and performance of futsal players.

In practice, the choice between circuit training and fartlek training should preferably be based on the preferences and needs of each individual. Factors such as personal preferences, training goals and physical condition can influence the choice of suitable exercises. In addition, setting up an effective exercise program also takes into account variations in the type of exercise and its intensity o achieve optimal results in increased aerobic endurance.

Conclusions

The conclusion of this study is that both circuit training and fartlek training significantly increased aerobic endurance in the participants. Although the pre-test results showed a slight advantage in the Bleep test scores for circuit training, this difference was not statistically significant. The score variability between the two groups was also relatively similar. However, the post-test results showed that the effectiveness of both types of exercise in improving aerobic endurance was equally significant. Statistical analysis using paired t-tests showed that circuit training resulted in a greater average increase in aerobic endurance compared to fartlek training. This difference does not occur by chance and is statistically significant. This is consistent with the results of previous studies, which also found a greater increase in aerobic endurance with circuit training. In practice, the choice between circuit training and fartlek training should be based on an individual's preferences, training goals and physical condition. In addition, it is important to design an effective exercise programme that takes into

account the variety of exercise types and their intensity. In conclusion, the results of this study make an important contribution to the understanding of the effectiveness of circuit training and fartlek in improving aerobic endurance. A suggestion for future research is to expand the sample to include different genders and a larger number of participants. Research can also explore the effect of participants' motivation and commitment to exercise programmes. In addition, studies could consider additional measures or further observations to better understand the effects of these exercises on broader aspects of health and performance.

Conflict of interest

The authors declare no conflict of interest.

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Ethics Statement

Ethical clearance (No.26/KEPK/RSI-U/V/2024). for this research was obtained from the Research Ethics of Health Research Ethics Committee of Malang Islamic hospital, Malang City, East Java, Indonesia

Author Contributions

Study Design, MHS; Data Collection, MHS, JJ ; Statistical Analysis, MHS, JJ, MD and LMYI; Data Interpretation, MHS, JJ and MD; Manuscript Preparation, MD, LMYI, KA and KD; Literature Search, KA and KD. All authors have read and agreed to the published version of the manuscript

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