



Comparison of The Effectiveness of Interval Training and Circuit Training in Increasing The Endurance in Futsal Extracurricular

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Abstract

Endurance is an important component in physical fitness which is needed in futsal, because this game requires repetitive activities with varying intensities so that players must be able to maintain optimal performance. However, there are still many futsal extracurricular students who experience rapid fatigue and decreased performance, so effective training methods are needed to increase endurance. This study aims to analyze the influence and difference in the effectiveness of interval training and circuit training in increasing the endurance of futsal extracurricular students at the junior high school level. The method used is quantitative with a quasi-experimental design through a two-group pretest-posttest approach, which involves two groups. The participants amounted to 22 male students aged 13-15 years from State Junior High School 1 Conggeang who were divided into two groups, each given interval training and circuit training for 12 meetings. The instrument used is a multistage fitness test (bleep test) to measure VO_{2max} as an indicator of cardiovascular endurance. Data analysis was carried out using the help of SPSS 27 through descriptive tests, normality tests, homogeneity tests, and t tests. The results showed that there was an increase in the average value of endurance in both groups, where the circuit training group increased from 35,845 to 38,645, while the interval training group increased from 36,082 to 39,000. The paired sample t-test showed that both exercise methods had a significant effect on increasing endurance ($p < 0.05$). However, the results of the independent samples t-test showed no significant difference between the two methods ($p = 0.671 > 0.05$). Thus, it can be concluded that interval training and circuit training are both effective in increasing endurance, but do not show significant differences in effectiveness. This study provides the implication that both training methods can be used flexibly in fostering students' physical fitness, especially in futsal extracurricular activities.

How to Cite

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INTRODUCTION

Endurance is one of the components of physical fitness that is very important, related to the ability of individuals to perform physical activities for a certain period of time without feeling excessive fatigue. According to Radovanovic (2013), endurance reflects the capacity of the cardiovascular and respiratory systems to supply oxygen to the muscles during activity. In general, endurance is divided into two types, namely aerobic endurance and anaerobic endurance. Aerobic endurance is the body's ability to perform activities with moderate to moderate intensity for a relatively long duration of time by utilizing oxygen as the main source of energy, while anaerobic endurance is the ability to perform high-intensity activities in a short period of time without direct dependence on oxygen (Noordhof et al., 2013). Aerobic activity means physical activity to improve or maintain cardiorespiratory fitness or aerobic capacity, while anaerobic activity refers to high-intensity activity that exceeds the cardiovascular capacity to provide oxygen. (Lengkana & Muhtar, 2021). In the context of futsal, both types of endurance are needed because this game demands repetitive activities with varying intensities, ranging from light running to fast sprints, so players must have adequate physical capacity to maintain consistent performance throughout the game.

Interval training is a method of physical exercise that is carried out by combining periods of work (activities) and periods of rest or recovery alternately in one training session. According to Gibala (2021), interval training is designed to increase the body's working capacity through systematic regulation of intensity, duration, and rest time. The main characteristic of interval training lies in the repetition of activities of a certain intensity interspersed with active and passive rest periods. In addition, these exercises can be varied in the form of low to high intensity, including high-intensity interval training (HIIT) which is widely used to improve cardiovascular fitness (Liu & Li, 2024). The principle of interval training implementation includes regulating exercise components such as intensity, volume, duration, frequency, and work-rest ratios tailored to individual training goals and conditions (MacInnis & Gibala, 2017). With the application of these principles, interval training becomes a flexible and effective method for different fitness levels.

Circuit training is a method of physical training by combining various forms of exercise

in a series or station that is carried out sequentially with predetermined work and rest times. According to Sidik & Rosdiana, (2023), circuit training is designed to train various components of physical condition simultaneously through a variety of movements involving the entire body. The form of training in circuit training can be in the form of a combination of strength, muscle endurance, agility, and cardiovascular training, such as push-ups, sit-ups, squats, skipping, and shuttle runs arranged in several training posts. The main characteristic of this method is that there is a continuous variety of exercises with a certain intensity, thus providing a thorough stimulus to the body's systems. In addition, circuit training can be adjusted to the individual's ability level, both in terms of the number of posts, duration of training, and intensity, so that it is flexible to be applied to various age groups, including school students (Fitrian & Asmara, 2024).

Futsal game activities require players to move quickly, make sudden changes in direction, and maintain the intensity of the game for a certain duration, so that endurance is a very important physical component, especially for students who participate in extracurricular activities at the junior high school level. (Imanudin & Sultoni, 2017). However, in its implementation, there are still many problems in the form of students who quickly experience fatigue, lack of consistency in movement, and show decreased physical performance both during practice and matches. This condition shows that the level of students' endurance has not developed optimally. The impact of these problems not only affects the decline in the quality of the game, but can also hinder the process of developing technical and tactical skills, and potentially reduce students' motivation in participating in futsal activities. A person will have a good quality of play if he has an improved physique (Silalahi, 2024). Therefore, it is necessary to apply a suitable and structured training model, such as interval-based endurance training or circuit training, which is designed according to the characteristics and needs of students (Ningrum et al., 2025). The urgency of this problem lies in the importance of increasing endurance as the main foundation in supporting the performance of futsal games, so that students are able to play optimally, consistently, and sustainably and support the achievement of achievements in extracurricular activities.

Research on interval and circuit training in increasing endurance has been widely conducted with a focus on futsal players and similar sports. Taufik et al., (2021) examined the effect of

circuit and interval training on the VO₂max of futsal players and found that both were effective, but circuit training provided a more significant improvement. Bahtra et al., (2025) also compared circuit and interval training in young soccer players and concluded that circuit training was more effective in increasing endurance. On the other hand, Bossmann et al., (2022) examined different types of HIIT in children and adolescents and found that interval training effectively increases aerobic capacity and strength in a short period of time. while Badawi & Nasrulloh, (2023) show that the combination of circuit and interval effectively increases VO₂max and agility.

Based on the problems and findings of previous research, the novelty in this study lies in the specific assessment of the effectiveness of interval training and circuit training applied to futsal extracurricular students at the junior high school level, taking into account the characteristics of age, fitness level, and the context of coaching in the school environment. In contrast to previous studies that generally focused on athletes or players with a certain level of performance, this study emphasizes the school student population as part of physical education oriented towards basic coaching. In addition, this research also contributes to supporting the achievement of the Sustainable Development Goals (SDGs), especially SDGs 3, namely Good Health and Well-being, through efforts to improve students' physical fitness from an early age, and SDGs 4, namely quality education by presenting effective training models in extracurricular activities. Thus, this research is expected to provide direct benefits for teachers and coaches in planning training programs that are suitable for increasing the endurance of adolescent futsal athletes. From this description, the research question arises: is there an effect of interval training and circuit training in increasing the endurance of junior high school futsal extracurricular students? Is there a difference in influence between the two experiments in increasing the endurance of junior high school futsal extracurricular students.

METHOD

This study used a quantitative method with a quasi-experimental design with a two-group pretest-posttest approach, which involves two groups each of which are given different treatments in the form of interval training and circuit training, and measurements are taken before treatment and then measurements are taken again after treatment. This design was chosen by the researcher

because it makes it easier for researchers to directly compare the effectiveness of two exercise methods in increasing students' endurance, even though a full randomization of the study subjects was not carried out. According to Cham et al., (2024), quasi-experimental designs are suitable for use in educational research due to limitations in controlling external variables and randomizing group divisions. With this design, researchers can find out the changes that occur due to the treatment given through the difference in pretest and posttest results. The selection of this design was based on the purpose of a research that wanted to test the difference in the influence between the two training methods on increasing the endurance of junior high school futsal extracurricular students, so that the results obtained were more relevant to the real conditions on the field.

This research procedure is carried out in several systematic stages to achieve the research objectives. The first stage is preparation, at this stage it includes the preparation of instruments, sample determination, and coordination with related schools. The second stage is the implementation of a pretest to measure the initial ability of the student's endurance using a multistage fitness test (bleep test). The third stage is the provision of treatment. The first treatment is interval training with 6 different exercise patterns in the first group. The principle of interval training implementation includes the regulation of exercise components such as intensity, volume, duration, frequency, and work-rest ratios adjusted to the training goals and individual conditions (MacInnis & Gibala, 2017). The second treatment is circuit training with 6 different training patterns in the second group over a period of time. Circuit training is a training method that is carried out by combining several forms of training in a series or stations that are carried out sequentially with predetermined work and rest times. According to Syrotynska & Chekhovska, (2023), circuit training is designed to train various components of physical condition simultaneously through a variety of movements involving the entire body. The treatment was carried out for 12 meetings with 2 repetitions of the exercise pattern in each group. The fourth stage was the implementation of a posttest to determine the increase in endurance after treatment. The last stage is data processing and analysis to draw conclusions.

Participants in this study were 22 futsal extracurricular students from a total population of 40 male students. The sampling technique in this study is purposive. This technique was chosen because the sample selected must be in ac-

cordance with the research criteria. Participants were selected with an age range of 13–15 years which is the category of early adolescents with rapid physical development. All participants are male, come from the Conggeang area, Sumedang Regency, and are active students in grades VII, VIII, and IX. The selection of these participants is based on active involvement in futsal extra-curricular activities so that they have a relatively homogeneous training experience. According to Gabriel & Gyax, (2023), the determination of clear participant characteristics is important to improve the validity of the study and facilitate the generalization of results. In addition, the number of participants used has met the requirements of a simple experimental research in the field of physical education.

In this study, participants were divided into two treatment groups, namely the interval training group and the circuit training group, each consisting of 11 students. The interval training group was treated as an exercise program with alternating work and rest patterns, which included six variations of exercise with systematic adjustment of intensity, duration, and work-rest ratio. The variations of the exercise include: Tabata exercise type of exercise in the form of 40 seconds of intense activity (Sprint Running) + 20 seconds of rest for 8 reps (Winarta et al., 2021). The next exercise is a sprint as far as 20 meters and then recovery jogging to the original place, the exercise is carried out for 8 minutes. Another exercise is futsal court interval run (running across the futsal sprint field while on the long part of the jogging field when on the width of the field) the exercise is carried out for 8 minutes. Four Corners Relay Drill is a form of group running practice that is carried out in four corners of the field, where each corner is occupied by one group. The exercise begins with one group running towards one of the corners (clockwise or counterclockwise), then after arriving, the group stops/rests at the intended corner. Simultaneously, the next group moves to the next corner, so that a rotation pattern occurs like a relay between corners. The next exercise is combined with a real futsal game, Drill Sprint Chase Paired with Dribbling is an exercise that is done in pairs, where one student plays the role of a dribbler who sprints while controlling the ball along the track, while his partner serves as a chase. The student who dribbles must keep the direction of running according to the predetermined trajectory, while the pursuer tries to catch up and touch the drigger's back. The last variation is the 2 VS 1 defensive exercise. The rules in this exercise are dynamic. If two attackers

fail to score, then one of the attackers (usually the last one to control the ball or make a mistake) will take turns as a defender. On the other hand, if the attacker manages to score, then the defender remains in his position and there is no change of role. Thus, the defender will continue to be under pressure if he continues to concede.

Meanwhile, the circuit training group was given treatment in the form of a series of exercises in 4 stations consisting of six different training variations, such as strength, muscle endurance, and cardiovascular training, which were carried out sequentially with certain working time and rest. The first variation exercise is Post 1: Push-Up, Post 2: Sit-Up, Post 3: Lunges, Post 4: Squat. The second variation is Post 1: Jumping Jack, Post 2: Squat Thrushs, Post 3: High Knee Raises, Post 4: Jump Squat. The third variation is Post 1: Running in place, Post 2: Mountain Climbers, Post 3: Jump in place, Post 4: Cross Elbow to Knees. The fourth variation is Post 1: Plank, Post 2: wall sit, Post 3 Burpee, Post 4 Heel Taps. The fifth variation is combined with a real futsal game, Post 1: Zig-zag dribbling with a ball, Post 2: 10-meter sprint, Post 3: Deer jump, Post 4: Bear Crawl. The Last Variation Post 1: 10-meter ball juggling, Post 2: Squat Walk, Post 3: Skipping Rope, Post 4: Jump forward with 2 feet. Each post has a total duration of 2 minutes. The execution at each post is divided into 2 sets, each lasting 1 minute, with a short break between sets. After completing two sets (2 minutes in total), participants move to the next post until all posts are completed. Both treatments were carried out for 12 meetings with a frequency adjusted to the extracurricular schedule. With these characteristics, participants are expected to be able to provide representative data related to the effect of interval training and circuit training on the endurance of junior high school students.

The instrument used is a bleep test, because this test is able to provide an objective picture of students' VO_{2max} levels as an indicator of cardiovascular endurance. The data collection procedure was carried out twice, namely at the pretest stage before treatment was given, and at the posttest stage after the treatment was completed. The data collected in this study was carried out for approximately 3 months with the frequency of training adjusted to the futsal extracurricular schedule at school. Data was obtained through a multistage fitness test (bleep test) with a distance of 20 meters which was carried out twice during the pretest and during the pretest. This test is used to measure a student's level of aerobic endurance expressed in VO_{2max} . According to

Bagchi et al (2019), the bleep test is a valid and reliable instrument for measuring cardiovascular endurance in adolescence. During the data collection process, the researcher ensures that the environmental conditions, implementation time, and instructions given to students remain consistent to maintain the accuracy of the data. In addition, students are given warm-ups before the test and post-test cool-down to avoid injury. With a structured data collection duration, it is hoped that the results obtained can objectively describe.

Data analysis in this study was carried out to determine the influence of experiments conducted from the two groups as well as the difference in the influence between interval training and circuit training on students' endurance. The data analyzed included the results of the pretest and posttest of the two groups, which were then calculated using SPSS 27. The analysis techniques used include a description test, a normality test to determine the distribution of data, a homogeneity test to see the similarity of variance, and a t test to test the influence and average difference between two groups. According to Thukral et al., (2023), the t-test is used in experimental research to determine the significance of differences in treatment outcomes. In addition, gain score analysis is also used to see the magnitude of the increase that occurs in each group. The results of the analysis are then interpreted to answer the formulation of the research problem. By using the right analysis techniques, it is hoped that valid conclusions can be obtained regarding the effectiveness of interval training and circuit training in increasing the endurance of junior high school futsal extracurricular students.

RESULTS AND DISCUSSION

Based on the results of the research that has been obtained in the field, the description of the research data provides an overview of the pretest and posttest values in each experimental group.

Table 1. Description test Interval Training and Circuit Training

Variabel	N	Mean	Standard Deviation
Pretest interval training	11	35.845	4.5247
Posttest interval training		38.645	4.2425
Pretest circuit training		35.845	4.5247
Posttest circuit training		38.645	4.2425

Based on the results of the descriptive analysis, there was a change in the mean value which showed an increase in endurance after treatment was given

The description of the pretest results in the group experiment series showed that the number of samples (N) was 11 students, with a mean score of 35.845 with a standard deviation of 4.5247. This shows that the initial ability of the students' endurance in the circuit group is in a relatively moderate category with a not too large level of data variation.

Furthermore, the results of the posttest in the circuit training group showed an improvement. With the same number of samples (N = 11), the average value range increased to 38.645 with a standard deviation of 4.2425. This increase in average scores shows that circuit training has a positive influence on increasing students' endurance.

In the interval training group, the results of the pretest showed a total of 11 students with an average score range of 36.082 with a standard deviation of 5.6884. This suggests that the initial state of students' endurance at group intervals was also at a relatively comparable level to that of the group set, although it had a slightly greater variation in the data.

Meanwhile, the posttest results in the interval experimental group showed a fairly clear improvement. With the same number of samples, a range of values of 18.8, a minimum value of 31.4, and a maximum of 50.2 were obtained. The average value increased to 39,000 with a standard deviation of 5.6079. This increase shows that interval training exercises also have a positive effect on increasing students' endurance.

Based on the overall description of the data, it can be concluded that both the circuit group and the interval experienced an increase in average values from pretest to posttest. This suggests that both training methods have contributed to increase endurance, but it needs to be further tested whether the difference in the increase is significant or not.

Before the hypothesis test is carried out, a normality test is first carried out to find out whether the data is normally distributed as a condition for using the parametric test. The normality test in this study used the Kolmogorov-Smirnov and Shapiro-Wilk methods.

The results of the normality test in the circuit training group pretest series showed significance values of 0.071 (Kolmogorov-Smirnov) and 0.368 (Shapiro-Wilk). Both values are greater than 0.05, so it can be concluded that the data is

normally distributed. In the circuit training group posttest series, significance values of 0.200 (Kolmogorov-Smirnov) and 0.877 (Shapiro-Wilk) were obtained. This value is also greater than 0.05, so the data is declared to be normally distributed.

Furthermore, in the pretest of the interval training group, significance values of 0.200 (Kolmogorov-Smirnov) and 0.803 (Shapiro-Wilk) were obtained. These results show that the data is normally distributed because the significance value is greater than 0.05. In the interval group posttest, the significance values were 0.200 (Kolmogorov-Smirnov) and 0.683 (Shapiro-Wilk). The value is also greater than 0.05, so the data is declared to be normally distributed. From all the results of the normality test, it can be concluded that all data, both pretest and posttest in both groups, are distributed normally. Thus, this study is qualified to use parametric statistical tests in testing hypotheses.

Table 2. Paired sample t-test circuit training

Variabel	Sig (2 tailed)
Pretest posttest circuit training	< 0,001

Based on the results of the parametric statistical test with the paired sample t-test, it was obtained that the significance value (Sig. 2-tailed) obtained was < 0.001, which means it is smaller than 0.05. Thus, it can be concluded that there is a significant difference between the pretest and posttest values in the circuit training experimental group series. These results show that circuit training has a significant influence on increasing students' endurance. This increase can be seen from the change in average values from pretest to posttest, which shows an increase in endurance ability after being given an exercise program.

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Table 3. Paired sample t-test interval training

Variabel	Sig (2 tailed)
Pretest posttest interval training	0,001

Based on the results of the analysis for the interval training group, a significance value (Sig. 2-tailed) was obtained of 0.001 which means it is smaller than 0.05. Thus, it can be concluded that there is a significant difference between the

pretest and posttest values at the interval of the experimental group.

These results show that interval training exercises have a significant influence on increasing students' endurance. This increase can be seen from an increase in the average score after treatment compared to before treatment, which indicates a physiological adaptation to the exercise program given.

Table 4. Paired sample t-test difference test between groups

Variabel	Sig (2 tailed)
Gain circuit training & interval training	0,671

The results of the difference test between the circuit training experimental group and interval training based on the results of the t-test obtained a tcal value of -0.431 with a degree of freedom (df) = 19 and a significance value (Sig. 2-tailed) of 0.671.

The significance value is greater than 0.05, so it can be concluded that there is no significant difference between the training circuit group and the training interval. Based on these results, H1 was rejected and H0 was accepted, which means that there was no difference in the effect between circuit training and interval training in increasing students' endurance.

The results of the study showed that both interval training and circuit training had a considerable influence on increasing the endurance of junior high school futsal extracurricular students. These findings are in line with the theory that increased endurance is strongly influenced by planned exercise stimuli either through interval patterns that emphasize variations in intensity and circuit training that combines different forms of exercise in sequence (Dickhuth et al., 2012). The increase in the average value in both groups indicates that the body undergoes physiological adaptations, especially in the cardiovascular and respiratory systems, so that the ability to supply oxygen to the muscles becomes more efficient.

However, the results of this study show that there is no significant difference between the effectiveness of interval training and circuit training. These findings are different from some previous studies that stated that one method is superior to another. This difference in results is likely due to several factors, such as the relatively equal duration and intensity of exercise between the two groups, the limited number of samples, and the homogeneous characteristics of the subjects. Subjects with relatively homogeneous cha-

characteristics tended to show not much different exercise responses, so differences in outcomes between groups became less noticeable (Arwandi et al., 2023). In addition, the control of external variables such as rest patterns, nutritional intake, and students' motivation levels during exercise has not been fully optimal, so it can affect the results of the study.

Another drawback in this study is the use of a quasi-experimental design without full randomization, which has the potential to cause bias in group divisions. Limited samples can allow for imperceptible changes, so extensive sample size planning is essential for determining outcomes for a population (Vozzi et al., 2021). In addition, the relatively short duration of the study and the limited frequency of exercise may not be enough to show a more significant difference between the two exercise methods. The instruments used also only focus on VO_2max measurements, so they do not cover other aspects of endurance such as anaerobic endurance more specifically.

Based on these findings, the researchers suggest that future studies use larger sample sizes and more rigorous experimental designs, such as randomized controlled trials, to improve the validity of the results. In addition, there needs to be better control over external variables such as diet, rest time, and participant attendance levels during training. Further research is also recommended to combine the two training methods or test different variations of intensity to see more optimal effectiveness. Individual differences such as genetics and lifestyle are very influential in seeing more optimal benefits so a variety of exercises is needed to overcome these differences (Sandbakk et al., 2026). For practitioners, both PE teachers and trainers, these two training methods can be used flexibly according to the needs and conditions of students, while still paying attention to the principles of training so that increased endurance can be achieved to the maximum.

CONCLUSION

This study aims to compare the effectiveness of interval training and circuit training in increasing endurance in futsal extracurricular students at State Junior High School 1 Conggeang. Based on the overall results of the analysis that has been carried out, it was found that both training methods, both interval training and circuit training, are both able to increase students' endurance. This can be seen from the increase in the average value of physical ability after being given treatment to each group.

However, the results of the comparison between the two methods show that the resulting improvement does not show a substantially difference between the two. In other words, both interval training and circuit training have relatively equivalent levels of effectiveness in the context of increasing students' endurance. These findings confirm that differences in training approaches either through interval patterns with varying intensities or through a series of movements in circuit training ultimately have a physiological adaptation impact that is in line with the cardiovascular system.

From the point of view of the research objectives, these results have answered that no method is dominantly superior, so that the selection of the form of exercise can be adjusted to the needs, conditions, and variations of the training program desired by the trainer or teacher. This flexibility becomes important in the practice of learning and coaching sports in schools, as it allows for a variety of exercises without compromising the main goal of increasing endurance.

The novelty in this study lies in the empirical proof that two different training methods conceptually can produce commensurate achievements in the context of junior high school students, especially in futsal extracurricular activities. In addition, this study makes a practical contribution by showing that the variety of practice methods does not always have to be focused on finding a "superior" method, but rather on how the method can be applied consistently and in accordance with the characteristics of the learner.

Thus, this study confirms that the increase in endurance is not only determined by the type of exercise method used, but also by the consistency of implementation, the suitability of the program, and the active involvement of participants in the training process.

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