

PENGARUH MODEL *CIRCUIT TRAINING* TERHADAP DAYA TAHAN SISWA EKSTRAKURIKULER FUTSAL

THE EFFECT OF THE CIRCUIT TRAINING MODEL ON THE ENDURANCE OF FUTSAL EXTRACURRICULAR STUDENTS

Hanafi Prasetyo ^{1*}, Muhammad Saleh ², Wening Nugraheni ³

^{1 2 3} Program Studi Pendidikan Jasmani, Kesehatan, dan Rekreasi, Universitas Muhammadiyah
Sukabumi, Jawa Barat, Indonesia

* Corresponding Author: Muhammad Saleh, muhammadsaleh@ummi.ac.id

Received: 2025-08-05; Revised: 2025-10-07; Accepted: 2025-11-07

Abstrak

Penelitian eksperimen dengan desain *One-Group Pretest-Posttest* ini mengevaluasi pengaruh latihan sirkuit terhadap peningkatan kapasitas VO2Max pada 19 siswa ekstrakurikuler futsal di MTs Ma'arif Assobariyyah Sukabumi, sebagai solusi atas rendahnya daya tahan atlet saat bertanding. Pengukuran kapasitas aerobik dilakukan sebelum dan sesudah intervensi menggunakan *Bleep Test*, dengan analisis data melalui uji normalitas Shapiro-Wilk dan uji non-parametrik Wilcoxon Signed Rank. Hasil penelitian menunjukkan adanya lonjakan signifikan pada rata-rata nilai VO2Max siswa, yaitu dari 32,92 saat *pretest* meningkat menjadi 43,18 saat *posttest*. Signifikansi ini diperkuat oleh hasil uji Wilcoxon yang menghasilkan nilai Asymp. Sig. (2-tailed) sebesar 0,000 ($p < 0,05$), sehingga hipotesis nol ditolak. Dengan demikian, latihan sirkuit terbukti secara empiris efektif dalam meningkatkan kebugaran fisik dan daya tahan aerobik siswa futsal. Guna mengoptimalkan capaian ini, studi merekomendasikan dukungan penuh terhadap kegiatan ekstrakurikuler melalui penyediaan fasilitas latihan yang memadai, perbaikan infrastruktur, serta penyusunan jadwal latihan yang lebih terstruktur. Selain itu, penelitian ini diharapkan dapat menjadi referensi teoretis bagi peneliti selanjutnya untuk melakukan kajian serupa dengan cakupan populasi yang lebih luas dan representatif.

Kata kunci: model, *circuit training*, daya tahan, siswa, ekstrakurikuler, futsal

Abstract

This experimental study, employing a One-Group Pretest-Posttest design, evaluated the effect of circuit training on improving VO2Max capacity in 19 students participating in the futsal extracurricular program at MTs Ma'arif Assobariyyah in Sukabumi, as a solution to the athletes' low endurance during matches. Aerobic capacity was measured before and after the intervention using the Bleep Test, with data analyzed via the Shapiro-Wilk normality test and the non-parametric Wilcoxon Signed-Rank test. The results showed a significant increase in the students' average VO2Max values, rising from 32.92 at the pretest to 43.18 at the posttest. This significance was reinforced by the results of the Wilcoxon test, which yielded an Asymp. Sig. (2-tailed) value of 0.000 ($p < 0.05$), thereby rejecting the null hypothesis. Thus, circuit training has been empirically proven to be effective in improving the physical fitness and aerobic endurance of futsal students. To optimize these outcomes, the study recommends full support for extracurricular activities through the provision of adequate training facilities, infrastructure improvements, and the development of a more structured training schedule. Additionally, this research is expected to serve as a theoretical reference for future researchers to conduct similar studies with a broader and more representative population.

Keywords: models, *circuit training*, endurance, students, extracurricular, futsal

How To Cite: Prasetyo, H., Saleh, M., & Nugrahaeni, W. The Effect of the Circuit Training Model on the Endurance of Futsal Extracurricular Students. *Journal Of Sport Education (JOPE)*, 8(1), 32-40.
doi:<http://dx.doi.org/10.31258/jope.8.1.32-40>



Journal Of Sport Education is an open-access article under the CC-BY-SA 4.0

INTRODUCTION

Sport is an important component in the physical development of students. Through planned physical activity, students not only gain health benefits, but also motor skills and sportsmanship (Mirpana & Mahfud, 2024). The role of sport in daily life has a very significant level of significance. One type of sport that is popular with students today is futsal. Futsal has fast, dynamic, and physically demanding characteristics. Therefore, to support performance in futsal, physical fitness, especially endurance, is very necessary.

Endurance serves as one of the main components of physical fitness, which is directly related to a person's ability to exercise in large amounts without tiring for too long. According to (Handoko, et al., 2020), endurance is when the body can perform activities for a long time without tiring. In futsal, a player is required to keep moving, pressuring the opponent, and making transitions between defense and attack quickly and continuously. If a player has poor endurance, their performance may decrease drastically in the middle or at the end of the game.

However, based on initial observations and evaluations of the futsal extracurricular activities at MTs Ma'arif Assobariyyah Sukabumi, it was found that most students still exhibited low levels of endurance. They appeared to tire quickly, had difficulty maintaining game intensity, and lacked consistency in executing team strategies throughout the match. This suggests the need for a more structured and effective physical training approach to improve students' endurance.

One of the training methods that can be applied to improve student endurance is circuit training. Circuit training is a model of exercise that combines various types of movements or physical training between several stations carried out sequentially with a certain intensity. (Rua, et al., 2024) Stated Circuit training is an exercise performed in several pre-planned locations. Each station has a specific type of exercise tailored to their needs. This exercise not only trains muscle strength and agility but is also effective in increasing cardiorespiratory capacity which is directly related to endurance.

The circuit training method offers advantages in terms of time efficiency and flexibility of training methods. By combining bodyweight, aerobic, and anaerobic exercises, students can train multiple components of physical fitness in a single session. Furthermore, the varied and competitive training environment keeps students motivated and prevents them from becoming bored easily during the program.

Several previous studies have shown that circuit training has been proven effective in improving endurance in students at various levels of education. This training can increase maximal oxygen consumption, heart muscle strength, and lung efficiency. These physiological adaptations are crucial for improving students' capacity for physically demanding sports activities like futsal.

The implementation of the circuit training model in the futsal extracurricular activities at MTs Ma'arif Assobariyyah is expected to be the right solution to improve student endurance. With a structured, systematic training program tailored to students' physical abilities, it is expected that students will experience improved performance in futsal games. In addition to improving endurance, circuit training also has a positive impact on developing discipline, teamwork, and student motivation in training. Through time management, training sequences, and performance targets at each position, students learn to focus, take responsibility for their own progress, and appreciate the training process they undergo.

MTs Ma'arif Assobariyyah, as an educational institution that supports the development of student interests and talents through extracurricular futsal activities, needs to develop a more targeted training strategy. By integrating a circuit training model into its futsal training program, the school plays a role in developing students' potential, both in terms of physical fitness and a positive competitive mentality. Therefore, the researcher wanted to further investigate this issue. "The Effect of Circuit Training Model on the Endurance of Futsal Extracurricular Students at MTs Ma'arif Assobariyyah Sukabumi" The focus of this research is to determine the extent to which the training model significantly improves students' endurance, as well as to provide input for extracurricular managers and sports teachers in developing training programs that are more suited to students' needs.

METHOD

This study uses a quantitative method with a quasi-experimental approach. This method was chosen based on the research objective, which is to determine the effect of exercise. Circuit training against increased VO₂ Students' learning outcomes was measured by comparing pretest and posttest results within an experimental group. The quasi-experimental approach is considered relevant because it allows researchers to directly observe changes resulting from the treatment, even without a control group for comparison.

The research was conducted at MTs Ma'arif Assobariyyah Sukabumi, West Java, a school with an active futsal extracurricular activity. This location was chosen intentionally because it suited the research needs, particularly regarding the availability of participants involved in sports activities regularly. The research was conducted on June 1, 2025, coinciding with the regular futsal practice schedule, so that the data collection process could be carried out effectively without disrupting teaching and learning activities or the students scheduled practice schedule.

The population in this study was all 19 students participating in the futsal extracurricular activity at the school. The entire population was sampled using a total sampling technique. This technique was chosen because the population size was relatively small and all members of the population had characteristics relevant to the research focus, namely the need to improve physical fitness, particularly VO₂ Max through structured training.

To obtain data on VO capabilities₂ Max, this study used the Bleep Test, or Multistage Fitness Test. This test involves participants running back and forth 20 meters to the rhythm of a beep that accelerates at each level. This instrument was chosen because it has a high level of reliability for measuring aerobic capacity and is widely used in research and sports training programs. Measurements were taken twice: before treatment (pretest) and after treatment (posttest), allowing for direct observation of changes in aerobic capacity.

Data collection was conducted using established measurement procedures. In the pretest phase, all students underwent a Bleep Test to obtain their initial VO₂Max score. After that, they follow a training program/circuit training during the period determined according to the research design. After the training program was completed, VO₂ measurements were taken VO₂Max measurements were taken again underwent a posttest to determine if there were any significant changes after the treatment. The data obtained from both measurements were then systematically recorded as the basis for analysis.

Data analysis in this study was conducted using the SPSS program to obtain accurate and statistically tested results. The first stage was a normality test using Shapiro–Wilk to determine whether the data were normally distributed. The test results showed that the data were not normally distributed, so the analysis was continued using a nonparametric test, namely the Wilcoxon Signed Rank Test. This test was used to determine whether there was a significant difference between the pretest and posttest results. The significance level used was 0.05, so if the p-value is less than 0.05, it can be concluded that the training circuit training has a

significant impact on increasing VO2Max student.

RESULTS

This study aims to determine the effect of circuit training on increasing VO2Max is a futsal extracurricular student at MTs Ma'arif Assobariyyah Sukabumi. The analysis was conducted using descriptive statistics, normality tests, homogeneity tests, and hypothesis testing using the Wilcoxon Signed Rank Test. The descriptive results of the VO value₂ Max is presented in the following table:

Table 1. Descriptive Statistic

	N	Minimum	Maximum	Mean	Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error
VO2Max Pre	19	26,8	36,7	32,921	0,7236
VO2Max Post	19	35,0	53,9	43,184	0,9306
Valid N (listwise)	19				

The results of the descriptive analysis show that there is an increase in the VO value₂ Max after being given circuit training. Average VO2Max increased from 32.92 to 43.18, with a difference of 10.26 ml/kg/minute. This increase was also seen in the minimum and maximum values, which increased significantly after treatment. After obtaining descriptive statistics, the next step was to conduct a normality test to determine whether the data were normally distributed. The Shapiro–Wilk normality test was chosen because the sample size was less than 50 people.

Table 2. Test of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Say.	Statistic	df	Say.
VO2Max Pretest	0,108	22	.200*	0,927	22	0,104
VO2Max Posttest	0,183	22	0,055	0,905	22	0,038

Based on the Shapiro–Wilk test, which is recommended for samples of less than 50, the pretest data has a significance value of 0.104, indicating a normal distribution. However, the posttest data has a significance value of 0.038, indicating a non-normal distribution. The irregularity in the posttest distribution is thought to arise from variations in VO₂ levels. There was considerable variation among participants after circuit training. Some students showed significant improvement, while others experienced lower improvements, resulting in an asymmetrical data distribution. Furthermore, the relatively small sample size also affected the

sensitivity of the normality test. Because one of the data groups (posttest) was not normally distributed, the analysis continued by testing the homogeneity of variance to ensure that the data distribution was uniform. The homogeneity test used the Levene Test. which is on the menu One-Way ANOVA SPSS.

Table 3. Test of Homogeneity of Variances

VO2Max Pre	Based on Mean	1,861	1	3	0,266
	Based on Median	0,061	1	3	0,822
	Based on Median and with adjusted df	0,061	1	2,000	0,829
	Based on trimmed mean	1,461	1	3	0,313

The results show that the significance value for all approaches is greater than 0.05. This finding indicates that the variance of the pretest and posttest data is homogeneous. However, the assumption of normality remains a key determinant in determining the type of statistical test. Because the posttest data is not normally distributed, even though the variance is homogeneous, parametric statistical tests cannot be used. Based on the results of the normality and homogeneity tests, the analysis was continued using the non-parametric Wilcoxon Signed Rank Test to test the hypothesis regarding the effect of circuit training on increasing VO₂ Student's Max. The Wilcoxon test is used to compare two paired data that are not normally distributed.

Table 4. Test Results Wilcoxon Signed Rank Test

Total N	22
Test Statistic	231,000
Standard Error	28,762
Standardized Test Statistic	4,016
Asymptotic Sig. (2-sided test)	0,000

The Asymptotic Significance The value of 0.000 is smaller than 0.05, so it can be concluded that there is a significant difference between the VO2Max values before and after exercise. Thus, circuit training has been shown to have a significant effect on increasing VO2Max capacity is a futsal extracurricular student. This shows that the training model involves a series of moderate to high intensity movements. Based on the results of the study, there was a significant increase in the value of VO2Max after students follow the training program/circuit training.

Based on the results of the normality test using the test Kolmogorov-Smirnov And Shapiro-Wilk, it is known that the data pretest has a significance value of 0.104 (greater than 0.05) which means it is normally distributed, while the data posttest has a significance value of 0.038 (less than 0.05), which means it is not normally distributed. This irregular distribution of posttest data is caused by differences in the ability to adapt to training among students. Some students showed an increase in VO₂ The maximum is very high, while the others increase moderately, so the data is asymmetric. Furthermore, the relatively small sample size (19 students) also affects the distribution of the data, because with small sample sizes, a few extreme values can cause the data to appear statistically abnormal.

DISCUSSION

The hypothesis analysis in this study focused on testing the effect of a circuit training intervention on students' aerobic capacity. Based on the initial normality test, it was found that the distribution of the pretest and posttest data was not entirely normal, so parametric statistical tests could not be applied. Therefore, the data analysis shifted to using a non-parametric test, namely the *Wilcoxon Signed Rank Test*, which remains robust for evaluating differences between two paired samples in non-normal data. The test results showed an *Asymptotic Significance (2-tailed)* value of 0.000, which is far below the significance threshold of 0.05. This figure provides very strong statistical evidence to reject the null hypothesis and accept the alternative hypothesis. Thus, it can be conclusively stated that there is a highly significant difference between the VO2Max capacity results before and after the circuit training program intervention.

Practically, these statistical findings confirm that the circuit training model has a significant positive effect on improving the cardiorespiratory endurance of students participating in the futsal extracurricular activity at MTs Ma'arif Assobariyyah Sukabumi. The increase in the average VO2Max value after the intervention serves as a direct indicator that the students' aerobic capacity has shown tangible improvement following the structured training program. The ability to sustain performance over extended periods without significant fatigue was clearly evident in the students' physical performance on the field after the intervention concluded. This demonstrates that the circuit training method is not only theoretically superior but also practical and effective when applied to the adolescent population of junior high school students. These results confirm that the lack of physical stamina, which often poses a challenge for novice athletes, can be significantly addressed through this training approach.

The increase in VO2Max capacity can be explained by the mechanism of circuit training, which involves a series of physical activities performed repeatedly. The main characteristic of circuit training is the combination of several exercise stations that must be completed sequentially with minimal rest intervals between each station. These activities are designed at moderate to high intensity levels, forcing the body to continuously produce and adapt under conditions of brief recovery. The sequential engagement of various large muscle groups at each station also ensures that the training load is evenly distributed throughout the body. This dynamic and repetitive movement pattern constantly challenges the body's energy metabolism system to operate at its optimal capacity. Consequently, the body becomes accustomed to physical stress similar to that of an actual futsal match.

From a physiological perspective, the moderate-to-high-intensity physical activity in this circuit training stimulates the cardiovascular and respiratory systems to function far more efficiently. As major muscle groups contract intensely, the demand for oxygen and nutrient supply increases drastically to support aerobic energy production. The heart responds to these demands by increasing heart rate and the force of blood pumping, while the lungs increase ventilation to absorb more oxygen from the outside air. The efficiency developed through these periodic workouts enables the circulatory system to distribute oxygen to all active muscle tissues more quickly and smoothly. At the cellular level, muscles also become more adept at extracting and utilizing this oxygen to produce adenosine triphosphate (ATP). The end result is an overall improvement in the body's functional adaptability in managing energy supply during physical activity.

The findings of this study are fully consistent with the theoretical framework proposed by Bompa (1994), who stated that circuit training is a highly effective form of exercise for improving physical fitness, particularly the endurance component. Bompa explained that the

gradual regulation of intensity in circuit training stimulates the functional adaptation of the body's organs as a whole. Regular repetition of movements with strict time control simultaneously stimulates both anaerobic and aerobic capacity. In addition to improving cardiorespiratory endurance, this training methodology has also been proven to enhance muscle strength, local muscle endurance, and the biomechanical efficiency of body movements. Thus, the resulting adaptation is holistic, improving not just a single aspect of fitness but enhancing the athlete's biomotor readiness in an integrated manner.

The importance of VO2Max capacity in athletic performance is further emphasized by Fox et al. (1988), who state that VO2Max is the primary indicator of an individual's aerobic capacity. A high VO2Max level reflects the superior ability of the cardiovascular system to inhale, transport, and deliver oxygen to hard-working muscle tissues. When a student has an optimal VO2Max value, their fatigue threshold shifts to a later point, allowing them to maintain performance intensity for a longer duration. Conversely, a low VO2Max capacity limits oxygen supply, forcing the body to switch to the anaerobic energy system, which produces lactic acid—the cause of muscle fatigue. Therefore, an increase in this value following a training program demonstrates that the students' oxygen delivery and utilization systems have undergone a substantial improvement in quality.

The increase in the maximum VO2Max value in students post-exercise serves as concrete evidence that their bodies have successfully adapted physiologically to the training load provided. One of the most crucial internal adaptations is the increase in cardiac stroke volume, which allows the heart to pump more blood with each beat. Additionally, there is an increase in the density and number of blood capillaries in the trained muscle tissue, thereby expanding the surface area for the exchange of oxygen and carbon dioxide. This adaptation is further enhanced by an increase in the number and size of mitochondria within muscle cells, which function as "factories" for producing aerobic energy. Through this combination of structural and functional changes in vital organs, muscle oxygen uptake capacity increases sharply, making the students' bodies far more efficient energy-processing machines.

The success of this study is further reinforced and supported by various relevant prior research findings in the fields of elite sports training and school sports. A study conducted by Riyanto (2019) found that the implementation of circuit training methods significantly improved the endurance of futsal students compared to monotonous conventional training methods. A similar finding was reported in Rahman's (2019) study, which demonstrated that circuit training programs have a massive positive impact on the physical fitness and VO2Max scores of student-level futsal athletes. Not to be outdone, Lestari (2021) concluded in her study that circuit training makes a tangible contribution to boosting the aerobic endurance of high school students actively involved in sports extracurricular activities. This series of previous research findings solidifies the position of circuit training as a reliable, consistent, and highly valid method for improving outdoor physical performance.

Another key factor that significantly influences the success of this physical conditioning improvement is the training program design, which was systematically and programmatically structured over 14 sessions. The number 14 is considered ideal because it meets the minimum requirement for the human body to trigger lasting biological and anatomical adaptations. Each training session is structured chronologically, beginning with a warm-up to prepare the muscles and joints and gradually increase the heart rate. Following this, students proceed to the core training routine, which consists of several circuit stations with carefully determined volume and intensity. Training sessions always conclude with a cool-down phase aimed at accelerating the elimination of metabolic waste and restoring the body to its original state (homeostasis).

The application of the principle of progressive overload in daily training routines has been

shown to provide students' bodies with the opportunity to adapt effectively without the risk of injury. Increases in training intensity or volume are implemented gradually from one session to the next, ensuring the body is constantly challenged yet remains safe. This measured training regimen prevents overtraining, which often actually reduces athletic performance or leads to a decline in immune function. Consistent attendance and discipline in carrying out each session serve as the main pillars that strengthen the students' functional capacity of the heart and lungs. Through well-maintained training continuity, the circulatory system is trained to respond quickly to physical stress, ensuring that oxygen distribution throughout the body proceeds without significant hindrance.

Overall, the results of this study provide empirical confirmation that the circuit training model has a highly positive impact on improving the endurance capacity of futsal students. A significant increase in the average VO2Max value confirms that this method is highly effective in training and developing the aerobic energy system that underpins athletic fitness. These findings are highly relevant to the characteristics of futsal, a sport that demands complex and dynamic physical attributes. Futsal requires players to possess high stamina, quick reaction times, and lightning-fast recovery capabilities amidst the fast-paced flow of the game. By developing excellent cardiorespiratory endurance through circuit training, the students at MTs Ma'arif Assobariyyah Sukabumi now possess a strong physical foundation to maintain their peak performance throughout the duration of a match.

CONCLUSION

This study shows that the training model circuit training has a significant effect on increasing VO2Max or aerobic endurance of futsal extracurricular students at MTs Ma'arif Assobariyyah Sukabumi. Based on the results of the normality test using Shapiro-Wilk, it is known that the data is not completely normally distributed with a significance value of 0.05.post-testof $0.038 < 0.05$, so the hypothesis test was carried out using the non-parametric Wilcoxon Signed Rank Test. The results of the Wilcoxon test show the value Asymptotic Significance (2-tailed) of $0.000 < 0.05$, which means there is a significant difference between the VO2Max before and after treatment. This proves that the exercise circuit training improves students' physical fitness, particularly in terms of aerobic endurance. This improvement occurs because the exercises are structured at moderate to high intensity, involving the entire body system, especially the cardiovascular and respiratory systems. It can be concluded that the application of these exercises circuit training Regularly exercising can have a positive impact on improving VO2Max futsal students. This training model can be used as an alternative method for developing physical fitness in extracurricular futsal activities, as it has been proven to significantly increase endurance and support student performance in sports activities.

REFERENCES

- Bompa, T. O. (1994). *Theory and Methodology of Training: The Key to Athletic Performance*. Iowa: Kendall/Hunt Publishing Company.
- Fox, E. L., Bowers, R. W., & Foss, M. L. (1988). *The Physiological Basis for Exercise and Sport*. Dubuque, Iowa: Wm. C. Brown Publishers.
- Handoko, D., Fahrizqi, E. B., & Yuliandra, R. (2020). Cardiopulmonary Endurance Level of 2019 Student Sports Students During the Covid Pandemic. *Journal Of Physical Education*, 1(2), 1–5. <https://doi.org/10.33365/joupe.v1i2.584>
- Lestari, D. (2021). "The Effect of Circuit Training on Aerobic Endurance of High School Students Participating in Extracurricular Sports." *Indonesian Journal of Sports Science*, 9(3), 211–219
- Mirpana, K., & Mahfud, I. (2024). *Kejaora Journal: Journal of Physical Health and Sports the*

Effect of Circuit Training on Agility in High School Futsal Extracurricular Activities. 9 (November), 267–272.

Rahman, A. (2019). "The Effect of Circuit Training on Increasing VO2Max Futsal Athlete at SMA Negeri 1 Bandung." *Journal of Sports and Health Education*, 7(2), 145–152.

Riyanto, A. (2019). "The Effect of Circuit Training Method on the Physical Endurance of Futsal Students." *Scientific Journal of Sports*, 8(1), 33–40.

Rua, O. M., Fallo, K., & Berek, P. A. L. (2024). Circuit Training Innovation Based on Used Goods. 2(2).