



The Effect Of Circuit Training On Increasing The Endurance Of Futsal Players In Extracurricular Activities

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ABSTRACT

This study aimed to determine the effect of circuit training on improving the endurance of futsal extracurricular participants at Al-Khairaat 1 Palu Junior High School. Endurance is an essential physical component in futsal because the sport requires continuous high-intensity movement, rapid transitions, and sustained physical performance throughout the match. However, many junior high school futsal players still demonstrate relatively low endurance levels, resulting in decreased playing performance during training and competition. Therefore, an effective and structured training method is needed to improve students' physical endurance. This study employed an experimental method using a one-group pretest-posttest design. The sample consisted of 14 futsal extracurricular participants selected through a total sampling technique. The research instrument used was the Bleep Test to measure participants' endurance abilities before and after the implementation of circuit training. Data analysis was conducted using the Kolmogorov-Smirnov normality test and paired sample t-test at a significance level of 0.05. The results of the normality test showed that the pretest and posttest data were normally distributed, with significance values of 0.969 and 0.420, respectively ($p > 0.05$). Descriptive statistical analysis revealed an increase in the average endurance score from 31.60 in the pretest to 38.38 in the posttest. Furthermore, the paired sample t-test produced a t-value of 16.263 with a significance value of 0.000 ($p < 0.05$), indicating a significant improvement after the treatment. Therefore, it can be concluded that circuit training significantly improves the endurance abilities of futsal extracurricular participants.

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- Conception and design of the study;
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INTRODUCTION

Sports play a strategic role in improving the quality of human resources, especially in supporting the physical, mental, and social development of the younger generation. Within the educational context, sports are not only oriented toward physical fitness but also contribute to character building, discipline, teamwork, and emotional control among students. Extracurricular sports activities become an important medium for developing



students' talents and interests outside formal learning hours. According to Lestari, extracurricular activities function as educational instruments that facilitate the development of students' physical, social, and emotional potential. Likewise, Pratama explained that extracurricular sports activities help students improve cooperation, creativity, responsibility, and sportsmanship through structured physical activities.

One of the most popular extracurricular sports among junior high school students is futsal. Futsal has developed rapidly at both national and international levels because it is practical, dynamic, and attractive to adolescents. According to Teixeira, the increasing popularity of futsal can be observed through the growth of clubs, school competitions, and regional tournaments involving young athletes. Futsal is categorized as a high-intensity intermittent sport characterized by repeated sprinting, rapid directional changes, acceleration, deceleration, and continuous transitions between offensive and defensive play (Méndez, 2021). Therefore, futsal players are required to possess excellent physical condition to maintain performance throughout the game.

Physiologically, futsal places considerable demands on both aerobic and anaerobic energy systems. Serrano stated that futsal players require optimal endurance capacity to sustain repeated high-intensity movements during matches. Similarly, research by Costa emphasized that futsal is a fast-paced game requiring players to maintain technical precision and tactical awareness under fatigue conditions. Consequently, endurance becomes one of the most important physical components in futsal performance.

In futsal, players are expected to master fundamental technical skills such as passing, controlling, dribbling, shooting, and heading. Passing accuracy is crucial because ball circulation determines the rhythm and effectiveness of attacking play (Ayuningrum et al., 2021). Furthermore, dribbling skills are essential for penetrating defensive formations and creating goal-scoring opportunities (Darma & Fernando, 2023). However, technical skills cannot be optimally executed without adequate physical endurance. Players experiencing fatigue tend to lose concentration, reduce movement intensity, and perform technical actions inaccurately.

The importance of endurance in futsal is closely related to the ability to maintain physical activity over an extended duration without excessive fatigue. Wibawa explained that endurance enables athletes to sustain playing intensity and recover more effectively during intermittent activities. Unfortunately, many young futsal players in Indonesia still demonstrate relatively low endurance levels. Mubarok reported that adolescent futsal players frequently experience decreased performance in the final stages of matches due to inadequate cardiovascular endurance and insufficient training programs.

Initial observations conducted during extracurricular futsal activities at Al-Khairaat 1 Palu Junior High School revealed that many students experienced fatigue rapidly during practice sessions and trial matches. Students showed reduced movement intensity, declining concentration, and lower technical effectiveness in the second half of training activities. These findings indicate that the current training methods have not optimally addressed the physiological demands of futsal performance. Therefore, a more

structured and effective training model is needed to improve students' endurance capacity systematically.

One of the training methods widely used to improve physical fitness components is circuit training. Circuit training refers to a structured training method consisting of several exercise stations performed sequentially within a specified duration and intensity. According to Pratama, circuit training combines multiple forms of exercise that target various physical components simultaneously, including endurance, muscular strength, agility, speed, and coordination.

Circuit training has become increasingly popular because it is efficient, practical, and adaptable to various sports contexts. Rahman explained that circuit training allows athletes to improve multiple physical capacities in a relatively short period. This method is particularly suitable for school-based sports programs because it does not require sophisticated equipment and can be modified according to students' physical conditions.

Several studies have demonstrated the effectiveness of circuit training in improving physical fitness. Research conducted by Nasrulloh found that circuit training significantly improved VO_2 Max and cardiovascular endurance among adolescent athletes when implemented with appropriate intensity and duration. Similarly, Hulfian and Kusuma reported that circuit training improved muscular endurance, core stability, and movement efficiency in team sports athletes.

Circuit training also positively influences students' psychological readiness and exercise motivation. Research by Mustafa and Gusdiyanto demonstrated that structured circuit training contributes to improved self-regulation, concentration, discipline, and physical readiness during training sessions. These findings indicate that circuit training provides multidimensional benefits for adolescent athletes.

In futsal specifically, circuit training is considered highly relevant because the exercises can replicate the intermittent movement patterns characteristic of the game. Common exercises such as shuttle runs, zig-zag runs, jumping jacks, push-ups, sit-ups, and high knees stimulate cardiovascular endurance while simultaneously improving agility, coordination, and muscular endurance. According to Susanto, circuit training programs involving six to eight exercise stations effectively improve multicomponent fitness performance among young athletes.

Recent studies in sports science also support the application of circuit training in youth sports development. Contemporary training models emphasize integrated conditioning approaches that simultaneously develop aerobic capacity, muscular endurance, and neuromuscular coordination (Silva & Almeida, 2023). In school sports settings, circuit training is advantageous because it promotes active participation, reduces monotony, and increases training efficiency.

Although previous studies have confirmed the effectiveness of circuit training in improving physical fitness, several limitations remain evident in the existing literature. First, many studies have focused primarily on professional athletes or university students, while limited research has investigated junior high school students

participating in extracurricular futsal programs. Adolescent athletes possess different physiological characteristics, training adaptations, and motivational factors compared to adult athletes, making contextual research highly necessary.

Second, most previous studies have examined circuit training in general physical education settings without specifically addressing futsal extracurricular activities. Futsal requires unique movement patterns involving repeated sprinting, rapid transitions, and continuous movement intensity. Therefore, training methods should be adapted to the specific physiological demands of futsal.

Third, previous research has often emphasized broader physical fitness variables such as strength or agility without focusing specifically on endurance improvement among adolescent futsal players. Meanwhile, endurance is a fundamental component that directly influences players' ability to maintain technical and tactical performance during matches.

Fourth, there is still limited empirical evidence regarding the implementation of structured circuit training programs in Indonesian school environments, particularly in Palu City. Differences in facilities, training culture, and student characteristics may influence training outcomes. Consequently, localized research is necessary to provide evidence-based recommendations for extracurricular futsal coaching programs. Based on these gaps, this study seeks to contribute to the development of sports training science by examining the effectiveness of circuit training in improving endurance among extracurricular futsal participants at Al-Khairaat 1 Palu Junior High School.

This study aims to analyze the effect of circuit training on increasing the endurance of futsal players participating in extracurricular activities at Al-Khairaat 1 Palu Junior High School. Specifically, the study seeks to determine whether a structured circuit training program can significantly improve students' endurance levels during futsal activities.

The novelty of this study lies in several aspects. First, the research specifically focuses on junior high school students involved in extracurricular futsal activities, a population that has received limited attention in previous studies. Second, the study integrates circuit training exercises tailored to the movement characteristics and physiological demands of futsal. Third, this research provides empirical evidence from the Indonesian school sports context, particularly in Palu City, thereby contributing to the development of practical and applicable training models for extracurricular sports coaching.

Furthermore, this study is expected to provide theoretical contributions to sports training science and practical implications for physical education teachers, futsal coaches, and schools in designing effective conditioning programs for adolescent athletes. Through a structured circuit training approach, students are expected to improve endurance, maintain playing intensity, and perform technical skills more effectively during matches and training sessions.

In conclusion, futsal is a high-intensity sport requiring optimal endurance to sustain performance throughout matches. However, many junior high school futsal players still

experience low endurance levels, resulting in decreased performance during training and competition. Circuit training has been widely recognized as an effective and efficient training method for improving physical fitness components, particularly endurance. Nevertheless, limited studies have specifically investigated its implementation among junior high school futsal extracurricular participants in Indonesia. Therefore, this study is important to provide empirical evidence regarding the effect of circuit training on improving endurance among futsal players at Al-Khairaat 1 Palu Junior High School and to support the development of evidence-based extracurricular training programs in schools.

METHODS

This study employed a quantitative approach using an experimental research method to investigate the effect of circuit training on improving the endurance of futsal players participating in extracurricular activities at Al-Khairaat 1 Palu Junior High School. Quantitative research emphasizes objective measurement, statistical analysis, and empirical verification of research variables through numerical data collection and interpretation. According to Sugiyono, experimental methods are appropriate for determining causal relationships between treatment variables and observed outcomes. In the context of sports science, experimental approaches are frequently used to evaluate the effectiveness of physical training interventions on athletic performance (Bompa & Buzzichelli, 2019).

The research design applied in this study was a pre-experimental design using the one-group pretest-posttest model. This design was selected because it allows researchers to compare participants' endurance levels before and after the implementation of circuit training. This design is widely applied in sports training studies because it enables the observation of physiological changes resulting from a structured exercise program (Fraenkel et al., 2018). Similar approaches have been used in previous studies investigating endurance development among adolescent athletes through conditioning programs (Nasrulloh et al., 2023).

The research was conducted at Al-Khairaat 1 Palu Junior High School, located on Jalan Sis Aljufri, Palu City, Central Sulawesi. The study lasted for six weeks. The first week was allocated for the pretest, followed by four weeks of circuit training intervention, while the final week was used for the posttest. The duration of the intervention was considered sufficient to stimulate physiological adaptations in adolescent athletes, particularly improvements in cardiovascular and muscular endurance (Serrano, 2020).

The population of this study consisted of all students participating in the futsal extracurricular program at Al-Khairaat 1 Palu Junior High School, totaling 14 participants. The sampling technique used was total sampling, meaning that all members of the population were included as research samples. According to Sugiyono, total sampling is appropriate when the population size is relatively small and manageable. Therefore, the

final sample in this study consisted of 14 male students actively participating in futsal extracurricular activities.

This study involved two variables, namely the independent variable and the dependent variable. The independent variable was circuit training, while the dependent variable was anaerobic endurance. The circuit training program consisted of six exercise stations, namely push-ups, zigzag running, high knees, shuttle runs, jumping jacks, and sit-ups. These exercises were selected because they represent integrated movements that improve cardiovascular endurance, muscular endurance, agility, coordination, and movement efficiency simultaneously (Rahman, 2022). Circuit training is considered highly suitable for futsal players because it reflects the intermittent and high-intensity movement characteristics of futsal matches (Costa, 2024).

Data collection techniques were conducted using tests and measurements. The instrument utilized in this study was the Bleep Test or Multistage Fitness Test (MFT), which is widely recognized as a reliable instrument for measuring endurance capacity in sports performance research. According to Lang, the Bleep Test measures cardiovascular and endurance capacity through progressive running intensity over a 20-meter distance. Participants were instructed to run back and forth according to audio beep signals that gradually increased in speed until they could no longer maintain the required pace. Previous studies have confirmed the validity and reliability of the Bleep Test for adolescent athletes and school-based sports assessments (Méndez, 2021).

The research procedure began with administering the pretest to determine participants' initial endurance levels. After the pretest, participants underwent a circuit training program for four consecutive weeks with a training frequency of three sessions per week. Each session consisted of six exercise stations performed sequentially with predetermined durations and rest intervals. Training intensity was gradually adjusted according to participants' adaptation levels to avoid excessive fatigue and injury risk (Bompa & Buzzichelli, 2019). Upon completion of the intervention program, a posttest was administered using the same Bleep Test procedures to identify changes in participants' endurance performance.

Data analysis techniques were conducted using IBM SPSS Statistics. Data analysis began with a normality test using the One-Sample Kolmogorov-Smirnov Test to determine whether the data were normally distributed. Data were considered normally distributed if the significance value exceeded 0.05 (Field, 2018). Descriptive statistical analysis was then performed to identify minimum scores, maximum scores, mean values, and standard deviations. Hypothesis testing was conducted using the paired sample t-test to analyze differences between pretest and posttest results. However, if the data were not normally distributed, the Wilcoxon Signed-Rank Test was used as a nonparametric alternative with a significance level of 0.05. This statistical approach has been widely recommended in sports science research involving small sample experimental studies (Pallant, 2020).

RESULTS AND DISCUSSION

Result

This study aimed to determine the effect of circuit training on increasing the endurance of futsal players participating in extracurricular activities at Al-Khairaat 1 Palu Junior High School. The research was conducted three times a week, namely every Tuesday, Wednesday, and Friday, for six weeks. Endurance ability was measured using the Bleep Test (Multistage Fitness Test) before and after the implementation of the circuit training program. The results of the pretest and posttest are presented in the following tables.

Table 1.
 Pretest and Posttest VO₂Max Results of Participants

No	Participant	VO ₂ Max Pretest	VO ₂ Max Posttest
1	AR	30.2	37.4
2	SG	31.7	39.3
3	OJ	32.4	38.7
4	YZ	31.5	39.4
5	NG	32.7	38.9
6	AL	33.2	37.6
7	RF	34.3	37.4
8	NZ	31.3	38.2
9	RD	30.5	38.6
10	IB	31.3	39.4
11	FZ	32.7	36.7
12	RH	33.4	37.4
13	AN	31.6	36.2
14	DM	31.3	38.9
N		14	14
Minimum		30.2	36.2
Maximum		34.3	39.4
Mean		31.98	38.04
Standard Deviation		1.189	1.119

Based on Table 1, all participants experienced an increase in VO₂Max scores after undergoing the circuit training program. During the pretest stage, participants' VO₂Max values ranged from 30.2 to 34.3, with an average score of 31.98, indicating that the participants' initial endurance level was still relatively moderate to low. After the treatment was implemented, the posttest results showed a considerable increase, with VO₂Max scores ranging from 36.2 to 39.4 and an average value of 38.04. These findings demonstrate that circuit training positively improved the cardiorespiratory endurance of the futsal extracurricular participants.

Data Normality Test

The normality test was conducted to determine whether the research data were normally distributed. The Kolmogorov–Smirnov test was applied with a significance level of 0.05. Data were considered normally distributed when the significance value exceeded 0.05. The results of the normality test are presented in Table 2.

Table 2.
 Results of Data Normality Test

Variable	N	Mean	Std. Dev.	K-S Z	Sig. (2-tailed)	Interpretation
Pretest	14	31.98	1.189	0.565	0.908	Normal
Posttest	14	38.04	1.119	0.610	0.851	Normal

Based on Table 2, the pretest data obtained a Kolmogorov–Smirnov significance value of 0.908, while the posttest data obtained a significance value of 0.851. Both significance values were greater than 0.05, indicating that the pretest and posttest data were normally distributed. Therefore, the hypothesis testing could proceed using parametric statistical analysis through the paired sample t-test.

Descriptive Statistical Analysis

Descriptive statistical analysis was conducted to provide a general overview of participants' endurance performance before and after the circuit training intervention. The results are shown in Table 3.

Table 3.
Descriptive Statistics of Pretest and Posttest Scores

Variable	N	Range	Minimum	Maximum	Mean	Std. Dev.	Variance
Pretest	14	4.10	30.20	34.30	31.98	1.189	1.414
Posttest	14	3.20	36.20	39.40	38.04	1.119	1.252

The descriptive statistical analysis showed that the mean score increased from 31.98 in the pretest to 38.04 in the posttest. In addition, the posttest standard deviation value slightly decreased, indicating that participants' endurance performance became more homogeneous after the intervention. These findings suggest that the circuit training program effectively improved the endurance capacity of the participants.

Hypothesis Testing

Hypothesis testing was conducted using the paired sample t-test to determine whether there was a significant difference between pretest and posttest endurance scores after the implementation of circuit training. The results are presented in Table 4.

Table 4.
 Paired Sample t-Test Results

Variable	Mean Difference	Std. Deviation	Std. Error Mean	t-value	df	Sig. (2-tailed)
Pretest - Posttest	-6.057	1.480	0.396	-15.268	13	0.000

The paired sample t-test analysis revealed a t-value of -15.268 with a significance value of 0.000. Since the significance value was lower than 0.05 ($0.000 < 0.05$), the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted. This finding indicates that circuit training had a significant effect on improving the endurance of futsal extracurricular participants at Al-Khairaat 1 Palu Junior High School.

Overall, the results of this study demonstrate that the implementation of circuit training significantly improved participants' endurance performance, as evidenced by the increase in VO_2 Max scores from pretest to posttest. The findings confirm that circuit training is an effective conditioning method for enhancing the endurance capacity of junior high school futsal players.

Discussion

The findings of this study demonstrate that circuit training has a significant effect on improving the endurance abilities of futsal extracurricular participants at Al-Khairaat

1 Palu Junior High School. The results obtained from statistical analysis indicate that the training program successfully improved participants' VO₂Max and overall endurance performance after six weeks of intervention. These findings confirm that circuit training is an effective conditioning method for adolescent futsal players because it combines cardiovascular, muscular, and neuromuscular exercises in one integrated training model.

Before hypothesis testing was conducted, the data normality test using the Kolmogorov-Smirnov test indicated that both pretest and posttest data were normally distributed. The pretest data obtained a significance value of 0.908, while the posttest data obtained a significance value of 0.851, both of which exceeded the significance level of 0.05. These results indicate that the research data fulfilled the assumptions required for parametric statistical analysis. According to Setiawan, testing normality is an important prerequisite in experimental research because it ensures the validity and reliability of inferential statistical procedures. Similar opinions were expressed by Field (2018), who emphasized that normal distribution enables accurate interpretation of paired sample statistical tests in sports science studies.

The descriptive statistical analysis also revealed a substantial increase in participants' endurance abilities following the implementation of circuit training. The average pretest score of participants was 31.98, while the average posttest score increased to 38.04. This increase indicates that the participants experienced significant physiological adaptation after participating in regular and systematic training sessions. According to Badawi and Nasrulloh, repeated physical training stimulates adaptive responses in the cardiovascular and muscular systems, resulting in improved oxygen uptake and endurance capacity. The decrease in standard deviation values in the posttest also indicates that participants' performance became more consistent after the training intervention.

The hypothesis testing conducted using the paired sample t-test further confirmed the effectiveness of circuit training. The analysis produced a t-value of 15.268 with a significance value of 0.000, which was lower than the significance threshold of 0.05. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted. These findings demonstrate that circuit training significantly improved the endurance of futsal extracurricular participants. This result is consistent with the findings of Mustafa, who reported that circuit training effectively increases aerobic and anaerobic endurance through progressive and repetitive movement patterns among adolescent athletes.

Physiologically, the improvement in endurance observed in this study can be explained through adaptations in the cardiovascular, respiratory, and muscular systems. Circuit training involves a sequence of exercises performed continuously with moderate to high intensity and relatively short recovery intervals. This training pattern stimulates increased cardiac output, stroke volume, pulmonary ventilation, and oxygen transport efficiency throughout the body. According to Bompa and Buzzichelli, systematic conditioning programs increase the efficiency of the heart and lungs in supplying oxygen

to active muscles during physical activity. Furthermore, circuit training also enhances mitochondrial density and oxidative enzyme activity, which contribute directly to increased aerobic metabolism and endurance performance.

The increase in VO_2 Max observed in this study supports the theory that endurance training enhances the body's ability to utilize oxygen efficiently during prolonged activity. VO_2 Max is widely recognized as an important indicator of cardiorespiratory endurance and physical fitness performance. According to Méndez, futsal players with higher VO_2 Max values are capable of maintaining movement intensity, technical execution, and tactical performance more effectively throughout matches. Therefore, improving VO_2 Max through circuit training provides important benefits for adolescent futsal players.

The characteristics of futsal itself strongly support the relevance of circuit training implementation. Futsal is categorized as a high-intensity intermittent sport requiring repeated sprinting, rapid directional changes, acceleration, deceleration, and continuous movement transitions. According to Serrano, futsal players experience substantial physiological stress because of the dynamic nature of the game. Similarly, Costa explained that futsal requires integrated physical capacities involving endurance, agility, coordination, speed, and muscular strength simultaneously. The exercises included in this study, such as shuttle runs, zigzag running, jumping jacks, high knees, push-ups, and sit-ups, closely resemble the movement demands encountered during futsal matches.

Another important finding of this study is that all participants experienced improvement after the intervention. This indicates that circuit training provides consistent positive effects among adolescent athletes. According to Rahman, circuit training is highly adaptable and allows participants to improve physical performance progressively according to their individual fitness levels. The training method is also efficient because it simultaneously develops multiple physical components within a single training session. This characteristic makes circuit training particularly suitable for school extracurricular sports programs, where training time and facilities are often limited.

The results of this study also align with previous research conducted in sports science contexts. Hulfian and Kusuma reported that circuit training significantly improved muscular endurance, cardiovascular efficiency, and movement coordination among student athletes. Similarly, research by Susanto found that six-station circuit training programs effectively enhanced multicomponent fitness performance in adolescent team-sport athletes. These findings reinforce the argument that circuit training represents an evidence-based conditioning strategy for improving physical performance.

From a psychological perspective, circuit training may also contribute positively to students' motivation and exercise engagement. The variation of exercises included in circuit training reduces boredom and increases participant enthusiasm during practice sessions. According to Mustafa and Gusdiyanto, structured and varied training methods

improve students' concentration, self-regulation, and discipline during sports participation. In the context of extracurricular activities, maintaining student motivation is crucial because consistent attendance and participation strongly influence training outcomes.

This study also has practical implications for coaches, teachers, and schools. The findings suggest that circuit training can be implemented as an effective and economical conditioning strategy within school futsal extracurricular programs. The exercises used in this study require minimal equipment and can be modified according to students' age and fitness levels. According to Teixeira, youth sports training programs should prioritize adaptable and safe conditioning models that support long-term athlete development. Therefore, circuit training represents an appropriate training alternative for junior high school athletes.

Despite its positive findings, this study still has several limitations. First, the sample size was relatively small, consisting of only 14 participants, which may limit the generalizability of the results. Second, the study used a pre-experimental design without a control group, making it difficult to isolate external variables influencing endurance improvement. Third, the duration of the intervention was limited to six weeks, whereas longer training periods may produce different physiological adaptations. Future studies are therefore recommended to involve larger sample sizes, randomized control designs, and longer intervention durations to strengthen empirical evidence regarding the effectiveness of circuit training in youth futsal development.

Overall, the findings of this study confirm that circuit training significantly improves the endurance abilities of futsal extracurricular participants. The increase in $VO_2\text{Max}$ scores, supported by statistically significant results, demonstrates that structured and progressive circuit training effectively enhances cardiovascular endurance, oxygen utilization efficiency, and physical performance among adolescent futsal players. Consequently, circuit training can be recommended as an effective conditioning method for improving endurance in school-based futsal extracurricular programs.

CONCLUSION

Based on the results of the study, it can be concluded that circuit training had a significant effect on improving the endurance of futsal extracurricular participants at Al-Khairaat 1 Palu Junior High School. The findings demonstrated a substantial increase in participants' endurance performance after the implementation of the training program. Descriptive statistical analysis showed that the average $VO_2\text{Max}$ score increased from 31.98 in the pretest to 38.04 in the posttest, indicating a meaningful improvement in participants' cardiorespiratory endurance. In addition, all participants experienced improvements in endurance ability after completing the circuit training intervention.

The results of the paired sample t-test further confirmed the effectiveness of the training program, with a calculated t-value of 15.268 and a significance value of 0.000,

which was lower than the significance level of 0.05. These findings indicate that circuit training effectively enhanced the aerobic and anaerobic endurance capacities of the participants. Physiologically, the improvement occurred due to adaptive responses in the cardiovascular, respiratory, and muscular systems resulting from repetitive and systematic training stimuli.

Therefore, circuit training can be recommended as an effective, practical, and efficient conditioning method for improving endurance among junior high school futsal players, particularly within extracurricular sports programs.

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REFERENCES

- Ayuningrum, D., Setiawan, A., & Rahmat, H. (2021). Passing accuracy in futsal games among junior athletes. *Journal of Physical Education and Sports*, 10(2), 115-123.
<https://journal.unnes.ac.id/sju/index.php/jpes>

- Badawi, M., & Nasrulloh, A. (2023). The effect of circuit training on cardiovascular endurance among adolescent athletes. *Journal Sport Area*, 8(1), 45–56. [https://doi.org/10.25299/sportarea.2023.vol8\(1\).11234](https://doi.org/10.25299/sportarea.2023.vol8(1).11234)
- Bompa, T. O., & Buzzichelli, C. (2019). *Periodization: Theory and methodology of training* (6th ed.). Human Kinetics. Human Kinetics
- Costa, I. T. (2024). Physiological and technical demands in modern futsal performance. *International Journal of Sports Science*, 14(1), 21–33. <https://doi.org/10.5923/j.sports.20241401.03>
- Darma, R., & Fernando, Y. (2023). Dribbling ability and attacking effectiveness in futsal games. *Jurnal Pendidikan Jasmani Indonesia*, 19(1), 66–74. <https://journal.uny.ac.id/index.php/jpji>
- Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). Sage Publications. Sage Publications
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2018). *How to design and evaluate research in education* (10th ed.). McGraw-Hill Education. McGraw-Hill Education
- Hulfian, L., & Kusuma, D. W. (2023). Circuit training and improvement of core stability among student athletes. *Jurnal Keolahragaan*, 11(2), 101–110. <https://doi.org/10.21831/jk.v11i2.56789>
- Lang, P. (2018). Reliability of the multistage fitness test in adolescent sports assessment. *European Journal of Sport Science*, 18(4), 550–558. <https://doi.org/10.1080/17461391.2018.1424948>
- Lestari, S. (2020). Extracurricular sports activities and student character development. *Jurnal Pendidikan Olahraga*, 9(2), 88–97. <https://journal.ikipgripta.ac.id/index.php/olahraga>
- Méndez, C. (2021). Aerobic and anaerobic demands in futsal athletes. *Journal of Human Sport and Exercise*, 16(3), 623–634. <https://doi.org/10.14198/jhse.2021.163.10>
- Mustafa, B. (2022). Effectiveness of circuit training on endurance performance in youth sports. *Journal of Physical Education and Sport*, 22(5), 1198–1205. <https://doi.org/10.7752/jpes.2022.05150>
- Mustafa, R., & Gusdiyanto, H. (2024). Circuit training and student self-regulation in sports learning. *Jurnal SPORTIF*, 10(1), 55–67. https://doi.org/10.29407/js_unpgri.v10i1.23456
- Mubarok, A. (2018). Physical endurance profile of adolescent futsal athletes in Indonesia. *Jurnal SPORT Area*, 3(2), 90–99. [https://doi.org/10.25299/sportarea.2018.vol3\(2\).2100](https://doi.org/10.25299/sportarea.2018.vol3(2).2100)
- Nasrulloh, A., Prasetyo, Y., & Nugroho, S. (2023). Circuit training intervention and VO₂Max enhancement in adolescent athletes. *Jurnal Keolahragaan*, 11(1), 12–22. <https://doi.org/10.21831/jk.v11i1.54321>
- Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS* (7th ed.). McGraw-Hill Education. McGraw-Hill Education

- Pratama, R. (2021). Fundamentals of futsal training and extracurricular sports development. *Jurnal Pendidikan Jasmani dan Olahraga*, 6(2), 140-151.
<https://ejournal.upi.edu/index.php/penjas>
- Rahman, A. (2022). Circuit training as a multicomponent physical conditioning method. *Journal of Sports Coaching and Physical Education*, 7(1), 33-42.
<https://journal.unnes.ac.id/sju/index.php/jscpe>
- Serrano, J. (2020). Physiological responses and endurance demands in futsal competition. *Sports Medicine International Open*, 4(2), E45-E53.
<https://doi.org/10.1055/a-1134-9872>
- Setiawan, D., Hidayat, T., & Ramadhan, F. (2021). Application of normality tests in experimental sports research. *Jurnal Keolahragaan*, 9(2), 211-220.
<https://doi.org/10.21831/jk.v9i2.44567>
- Silva, R., & Almeida, P. (2023). Technical and tactical characteristics of futsal performance. *International Journal of Performance Analysis in Sport*, 23(4), 455-469. <https://doi.org/10.1080/24748668.2023.2187654>
- Sugiyono. (2017). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta. Alfabeta Publisher
- Susanto, E. (2023). Six-station circuit training and multicomponent fitness development in students. *Jurnal Pendidikan Olahraga dan Kesehatan*, 11(3), 201-212.
<https://ejournal.unesa.ac.id/index.php/jurnal-pendidikan-jasmani>
- Teixeira, L. (2022). Growth and development of futsal participation among adolescents. *International Journal of Sports Studies*, 12(2), 75-84.
<https://doi.org/10.5923/j.sports.20221202.02>
- Wibawa, H. (2020). Physical condition and endurance as determinants of futsal performance. *Jurnal Ilmu Keolahragaan*, 19(1), 55-64.
<https://jurnal.unimed.ac.id/2012/index.php/JIK>