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The Effect of Circuit Training on Increasing Endurance (VO2Max) in Persigar Garut Players

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Abstract

Study purpose. This study aims to examine the effectiveness of circuit training programmes on improving endurance (VO2Max) in Persigar Garut football players. Physical endurance is important for players to be able to last for 90 minutes of play.

Materials and methods. The method used was a quasi-experiment with a One Group Pretest-Posttest Design. The research sample consisted of 25 active Persigar Garut players, with measurements taken using the Multistage Fitness Test. The Circuit Training programme was administered for 4 weeks with a frequency of 3 times per week.

Results. The results showed a significant increase in average VO2Max, from 47.94 (Pretest) to 55.13 (Posttest), an increase of 15.00%. Paired t-test analysis showed a very significant difference (Sig. 2-tailed < 0.001).

Conclusion. The conclusion of this study is that Circuit Training has a significant and positive effect on increasing the endurance capacity (VO2Max) of Persigar Garut football players. This increase is due to the characteristics of Circuit Training, which stimulates the cardiorespiratory system intensely and repeatedly, as well as its effectiveness in maximising the body's ability to absorb and utilise oxygen.

Keywords: Circuit Training, Endurance, VO2Max, Football

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Introduction

Persigar (Persatuan Sepak Bola Indonesia Garut) is a legendary football club that is the pride of the people of Garut Regency, West Java. Persigar was founded on 28 September 1949. The team was known as Maung Sancang, but this nickname has now changed to Laskar Domba Garut. During the Perserikatan era, Persigar was one of the strongest teams in West Java, capable of competing with big teams such as Persib Bandung, Persikas Subang and Persika Karawang at the regional level. One of the most historic moments for the Persigar Garut team was when it reached the final of the Soeratin Cup in 1998 and was promoted to the National Division II in the 2000s. At that time, Garut produced many talented young players who were later scouted by major clubs.

Garut is known as a 'factory' for football players. Many players from Garut have successfully made it into the Persib Bandung squad or even the Indonesian national team, such as Zaenal Arif, Yandi Sofyan and Johan Juansyah. The development process in Garut is typically characterised by competitive inter-district tournaments, which serve as a screening process for selection into the Persigar squad. As the 2023-2025 season approaches, Persigar, currently competing in the Liga 4 Series 1 West Java, is undergoing a major transformation to prepare for promotion to the National Liga 4 in 2026. Management and the coaching staff are focusing development on the players' physical condition. The coaching staff is striving to ensure that the players have ideal endurance (VO2Max) to maintain intensity throughout the full 90 minutes of play. Aerobic endurance in football is measured through maximum oxygen uptake (VO2Max), which is the maximum volume of oxygen that the body can utilise during intensive training. A good VO2Max standard for professional footballers ranges from 55-65 mL/kg/minute. The higher the VO2Max value, the greater the player's ability to delay fatigue (Fitriyansyah et al., 2021).

Based on initial observations of Persigar Garut players, it was found that the average VO2Max value of players was still below the ideal standard for League 4 Series 1 competition, indicating the need for more effective training. One training method believed to be effective in increasing endurance is circuit training (Candra et al., 2024). Circuit training is a training method that uses several stations arranged with specific aims and objectives in a training situation. According to Sukardiyanto, circuit training can strengthen the respiratory muscles and has an impact on cardiovascular endurance, which is useful for maintaining heart and lung fitness (Alexander, 2021). The application of circuit training in football training programmes has various advantages. One of them is time efficiency, where players can train various aspects of fitness in one relatively short training session. In addition, circuit training also provides variety in the training programme, thereby reducing boredom and increasing players' motivation to train (Septiawan et al., 2025).

Circuit training is a training method that improves physical condition and fitness through a series of stations, where each station has a different activity (Kurniawan et al., 2024). Circuit training is an effective method for improving lung and heart endurance (VO2 max) because it uses several different stations, so that training does not become boring and increases motivation for athletes (Younus, 2025). Based on problems identified in the field by researchers, maximum endurance has not been achieved as desired by coaches, because many players experience fatigue during internal games. Furthermore, there is a lack of variety in endurance training, causing players to become bored and lose their enthusiasm for training (Al-sudani, 2025). The objective of this circuit training exercise is to improve the physical condition of Persigar Garut players, making them fitter, tougher, and more explosive, which will ultimately have a direct impact on the quality of their play and positive results on the pitch (Max et al., 2021).

Materials and Methods

Study participants

Populasi dalam penelitian ini adalah seluruh pemain aktif Persigar Garut Liga 4 Seri 1 Jawa Barat Tahun 2025 yang berjumlah 25 0rang dengan kriteria: (1) berusia antara 19–35 tahun, (2) dalam kondisi sehat dan bebas dari cedera, (3) rutin mengikuti latihan tim, dan (4) bersedia mengikuti seluruh rangkaian penelitian. Dalam penelitian ini peneliti menggunakan total sampling atau sampling jenuh, dimana pengambilan jumlah sampelnya sama dengan jumlah populasi. Alasan mengambil total sampling karena jumlah populasi yang kurang dari 100, maka seluruh populasi dijadikan sampel penelitian semuanya (Sugiyono, 2013).

Study organization

This study utilised a quasi-experimental method with a One Group Pretest-Posttest Design. This design was employed to determine the effect of circuit training on improving the aerobic endurance (VO_2max) of football players. In this design, there was only one group that received treatment, without a control group. Each research subject was given a pretest, then underwent a circuit training programme as treatment, and finally underwent a posttest to see the changes that occurred (Bausad & Musrifin, 2020). Sample determination, namely the researcher selected 25 active Persigar Garut players with the criteria of being 19-35 years old, in good health/not injured, also regularly participating in training and willing to participate in the entire series of research (Amar Ma'ruf et al., 2024).

The study was conducted at Jayaraga Stadium in Garut, which is the official training ground for the Persigar Garut football team. This location was chosen based on the availability of adequate training facilities and field conditions suitable for conducting the study. The instrument used to measure aerobic endurance was the Multistage Fitness Test, which is a test used to estimate VO_2max based on a 20-metre shuttle run. Before treatment was administered, all players underwent a pretest to measure their initial aerobic endurance levels (Suliarno et al., 2024).

The treatment consisted of a circuit training programme administered over 4 weeks at a frequency of 3 times per week. Each training session lasted approximately 60 minutes, consisting of a warm-up (10 minutes), core training (40 minutes), and cool-down (10 minutes). The core training was organised in a circuit format involving several stations such as sprints, jumps, shuttle runs, burpees, etc. Each station was performed at moderate to high intensity with a 1-minute rest period between stations (Kurniawan et al., 2024).

Statistical analysis

After the training programme was completed, all players underwent another Multistage Fitness Test (posttest) to measure the increase in VO_2max. The pretest and posttest data were then analysed using a paired sample t-test with a significance level of 0.05 to determine whether there was a significant difference between before and after the treatment (Khalifatullah et al., 2024). Through this design, it is hoped that a clear picture will be obtained regarding the effect of circuit training on improving endurance (VO_2max) in Persigar Garut players.

Results

This study involved 25 active players from Persigar Garut. VO2Max data was collected in two stages: pre-test (before treatment) and post-test (after treatment) circuit training for 4 weeks.

1. Descriptive Statistics

   The first step is to find the mean, standard deviation, and sample size (N) for both the pretest and posttest.

Formula Mean (*M*) :

$$\bar{X} = \frac{\Sigma X}{N}$$

Standard Deviation Formula:

$$SD = \sqrt{\frac{\Sigma(X - \bar{X})^2}{N - 1}}$$

Description:

- $\bar{X}$ = Average
- X = Individual scores
- N = Number of samples

Table 1. Descriptive Statistics Results

Statistics	Pretest (Initial VO2Max)	Post-test (Final VO2Max)
Mean ($\bar{X}$)	47.94	55.13
Standard Deviation (SD)	5.65	6.5
Minimum Value	35.7	41.06
Maximum Value	56.5	64.98
Number of Subjects (N)	25	25

Table 1 shows a significant increase in the average VO2Max of the treatment group. The average VO2Max increased from 47.94 during the pretest to 55.13 during the posttest. This average increase was 7.19, which is a 15.00% increase in percentage terms. This increase indicates that the circuit training programme has a positive effect on the aerobic endurance of Persigar Garut players.

2. Hypothesis Testing (Paired t-test)

   The paired t-test is used because measurements are taken twice on the same subject (pre-test and post-test).

   Paired t-test formula:

$$t = \frac{\bar{D}}{S_D / \sqrt{N}}$$

Description:

- $\bar{D}$ = Average difference between post-test and pre-test
- S_D = Standard deviation of the difference (D)
- N = Number of samples

Standard deviation formula (S^D)

$$S_D = \sqrt{\frac{\Sigma(D - \bar{D})^2}{N - 1}}$$

Description:

- D = Xpost – Xpre
- $\bar{D}$ = Average of all values D

Data Analysis Hypothesis Testing

Hypothesis testing uses the Paired Sample T-Test to compare the mean pretest and posttest results with a significance level of $\alpha = 0.05$.

Table 2. Hypothesis Testing

Couple 1	Mean	N	Std. Deviation	Std. Error Mean
Pretest (Initial VO2Max)	47.94	25	5.65	1.13
Post-test (Final VO2Max)	55.13	25	6.5	1.3

Table 2 the average VO2Max values achieved by Persigar Garut players were higher in the post-test (55.13) than in the pre-test (47.94), descriptively indicating an increase in endurance after treatment. The analysis results showed that there was a very significant difference between VO2MAX before and after treatment.

Discussion

The results of the paired T-test analysis show that there is a very significant difference in the mean VO2Max between the pre-test and post-test measurements of the circuit training programme, as indicated by a significance value (Sig. 2-tailed) < 0.001, which is much smaller than the significance level $\alpha = 0.05$. This decision rejects the Null Hypothesis (H0) and accepts the Alternative Hypothesis (Ha). Statistically, this means that Circuit Training has been proven to have a positive and significant effect on improving endurance (VO2Max) in Garut Persigar players. The average increase of 7.19 (or 15.00%) clearly demonstrates the effectiveness of the intervention provided (Trishandra & Rois, 2022). This improvement in aerobic endurance is due to the characteristics of circuit training, which is designed to stimulate the cardiorespiratory system intensely and repeatedly. A 40-minute core workout with moderate to high intensity and short rest periods between stations (1 minute) successfully improved the body's ability to absorb, transport and use oxygen, which is the key mechanism for increasing VO2Max. Exercises involving specific football movements such as sprints and shuttle runs in a circuit format also ensure specific adaptation to the endurance requirements of the game (Sukma et al., 2022).

The advantage of the circuit training method in this study also lies in the specificity of the exercises. The core exercises arranged in a circuit involve movements similar to those in football, such as sprints, shuttle runs, and burpees (Ardani et al., 2024). This pattern mimics the high intermittent energy demands of football, where players are required to perform repeated high-intensity activities. By combining aerobic (endurance) and anaerobic (short sprints) demands in a circuit format, this exercise ensures specific adaptation to the endurance requirements of the game (Christy et al., 2022). Therefore, circuit training has proven to be a highly effective method for not only improving aerobic fitness, but also for enhancing the field performance of Persigar Garut football players (Dhanireksa et al., 2023). These findings are consistent with various research literature stating that high-intensity exercise (such as High-Intensity Interval Training or intensive Circuit Training) is more effective at increasing VO2Max than continuous exercise at low-moderate intensity. The high intensity achieved in circuits (with short recovery periods) places maximum metabolic stress on the muscles and energy system, triggering a stronger adaptive response (Maulana et al., 2021).

The total duration of treatment over 4 weeks (12 training sessions) proved to be optimal for triggering significant physiological changes. The variety and complexity of movements in the circuit also helped maintain motivation and prevent boredom, which are important factors in adherence to the training programme (Shodiqin, 2025). In practical terms, the results of this

study provide strong recommendations to the Persigar Garut coaching team that circuit training should be integrated into their weekly training programme as a systematic effort to improve the players' physical condition, particularly their aerobic endurance (Samosir et al., 2022). This increase in VO2Max will have a positive impact on players' ability to maintain high game intensity until the end of the match, reduce early fatigue, and improve decision-making quality when under physical pressure. For further research, it is recommended to compare the effectiveness of circuit training with other endurance training methods, as well as to involve a control group to strengthen the external validity of the findings (Febriasyah, 2025).

Conclusion

This study aimed to examine the effectiveness of the Circuit Training programme on improving VO2Max aerobic endurance in Persigar Garut football players. Based on a comparison of the subjects' initial and final conditions, it can be concluded that Circuit Training has a significant and positive effect on improving the aerobic endurance capacity of Persigar Garut football players. The training programme implemented during the intervention period successfully promoted optimal physiological adaptation in the cardiorespiratory system.

This increase in endurance shows that training methods that combine high intensity with limited recovery time, such as those found in Circuit Training, are an effective approach to improving the body's ability to absorb and utilise oxygen to the maximum. The impact is the achievement of better fitness levels, which directly supports players' performance in meeting the physical demands of matches, particularly in maintaining work intensity throughout the duration of the game. Therefore, Circuit Training is recommended as a key component in physical training programmes for football athletes to achieve superior endurance in Persigar Garut players.

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