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Aerobic training as an approach to increasing VO₂max in amateur football athletes

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ABSTRACT

Background Problems: Lack of variety in aerobic exercise can cause boredom and reduce motivation to increase VO₂max. **Research Objectives:** This study aims to assess how much influence aerobic exercise has on increasing VO₂max in amateur football athletes. This involves regularly monitoring and measuring changes in VO₂max levels over time. **Methods:** This research used a pre-experimental method; the design used was a one-group pretest and posttest design. The study used total sampling to select a population and sample of 30 amateur athletes. The instrument used was the 15-minute balke test to determine the athlete's VO₂max capacity. The method used aerobic training with a 400-metre run. The data analysis technique used descriptive statistical tests, and prerequisite tests were normality, homogeneity, and hypothesis testing using the t-test with the SPSS version 26 program. **Findings and Results:** The analysis of the data reveals a notable improvement in VO₂max following aerobic exercise. The average VO₂max value increased from 55.38 during the pretest to 70.70 in the posttest phase. This increase was substantiated by the t-test results, where the calculated t-value was 10.36. Consequently, this indicates a significant enhancement in VO₂max post-exercise. **Conclusion:** Aerobic exercise has a crucial role in increasing VO₂max in amateur football athletes. Good cardiorespiratory conditioning can help improve their endurance, performance, and recovery during training and competition.

Keywords: VO₂max; aerobics; football



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Authors' Contribution: a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection

INTRODUCTION

Aerobic training for football athletes encompasses not only the enhancement of physical condition but also the prioritisation of tactical aspects, including playing positions, ball movement, and technical skills necessary for achieving success (Tamozhanskaya & Shkola, 2016; Ribeiro et al., 2021). Integrating aerobic exercise into regular football training programmes helps to create a well-balanced approach, considering each participant's specific abilities, fitness levels, and the need to improve VO₂max (Sampaio et al., 2024). This tailored training approach results in more focused and effective programs. Michaelides et al. (2021) include a variety of aerobic exercises to maintain motivation and engagement. Enhancing VO₂max provides teams with a significant competitive advantage, as it not only boosts performance but also supports heart and lung health, crucial for

overall well-being (Bari et al., 2023; Santisteban et al., 2022). With an increasing understanding of aerobic capacity's role in sports, optimal aerobic training has become essential for improving football performance (Bonafiglia et al., 2022). Therefore, developing aerobic abilities through customised training offers substantial benefits for football athletes, both in terms of performance and health maintenance.

Amateur football athletes often have varying fitness levels. Aerobic training can help equalise these differences, providing the team with a better collective advantage during matches (Kusuma, 2018). Good cardiorespiratory conditioning enhances responses to exercise, including strength and technique training (Ramos-Campo et al., 2021). By increasing their aerobic capacity, athletes can be more effective in various aspects of football training (Nohrizal & Kahri, 2020). Regular aerobic exercise boosts blood flow to the brain, improves oxygenation, and stimulates neurotransmitter production that supports cognitive function (Ferrer-Uris et al., 2022). This improved cognitive function helps athletes stay focused and concentrated during practice and matches (Vardakis et al., 2022). Effective aerobic exercise provides solid physical preparation for a football season or competition (Anderson et al., 2022). It ensures participants have the fitness to handle busy schedules and intense gaming challenges (Mackała et al., 2020). Increasing VO₂max through aerobic exercise is a long-term investment in an athlete's health and performance, enhancing cardiorespiratory ability, which benefits various aspects of life and physical activity (Wang & Zhou, 2021). Therefore, implementing an effective and tailored aerobic exercise programme for amateur football athletes is crucial for achieving desired performance improvements (Lee & Zhang, 2021).

Monotonous and unvaried aerobic exercise can lead to athlete boredom and decreased motivation, reducing their commitment to the training programme and affecting results (Hirsch et al., 2021). If the exercise intensity does not match the athlete's initial fitness level, it may feel either too easy or too difficult, diminishing its effectiveness in increasing VO₂max (Parpa & Michaelides, 2020; Kada et al., 2023). The lack of systematic monitoring and evaluation of progress exacerbates this issue, making it difficult to gauge the success of the training programme (Guerrero-Calderón, 2022). Scheduling aerobic training wisely alongside regular football sessions is crucial to prevent fatigue and overtraining, which can hinder development and increase injury risk (Costache et al., 2021). To significantly increase VO₂max, it is essential to choose the right type of aerobic exercise and determine the appropriate intensity based on individual capacity and the required training volume (Yunus & Raharjo, 2022). Participants may feel less motivated or reluctant to engage in additional aerobic exercises outside of the main football training, affecting engagement and program success. Each participant's different initial fitness levels must be considered; otherwise, the programme may not challenge everyone adequately. Furthermore, if coaches do not fully understand the importance of proper aerobic training for football and its integration with other exercises, planning and implementation issues can arise (Cuthbert, 2022).

A holistic approach to training programmes is essential, taking into account various aspects that influence the effectiveness of aerobic training in increasing VO₂max in football. This can be achieved by a fitness expert or trainer with a deep understanding of the sport's needs and the individuals involved (McHaffie et al., 2022). In football training, if the aerobic exercises chosen do not reflect the movements and intensity required in a football game, athletes will not benefit optimally (Bok & Foster, 2021). Effective aerobic training should pay attention to game aspects such as fast running, acceleration, sideways movements, and sudden changes in direction (Dasa et al., 2022). Interval training, which involves alternating periods of high intensity and recovery, can be very effective in increasing VO₂max by mimicking the varying intensities of football (Marzouki et al., 2023). Aerobic exercise alone may not effectively increase participants' anaerobic capacity, which is also crucial for football. Therefore, problems may arise if the exercise programme does not include appropriate anaerobic exercises (Frytz et al., 2023). Innovations in aerobic training to increase VO₂max in amateur football athletes can achieve better and more efficient results by combining interval training with movements similar to football games, such as short sprints or sudden accelerations. This approach simulates game situations and helps improve the player's ability to respond to changes in intensity (Sopyan et al., 2023).

Recent research emphasises the necessity of tailoring interval training to suit athletes' profiles, taking into account factors such as intensity, duration, and type (Harper et al., 2019). Studies confirm the effectiveness of methods like small games and interval training, with environmental considerations reinforcing the need for customisation (Hadiana et al., 2019; Bahtra et al., 2023). Nevertheless, athletes with low initial fitness levels may encounter obstacles, necessitating gradual intensity increments to prevent injury and enhance performance (Ruzmatovich & G'ayratjon, 2023). Maintaining consistent aerobic exercise is crucial for improving VO2max, though athletes often struggle with continuity (Arslan et al., 2020). This study aims to bridge the gap in effectively integrating aerobic exercise into football athletes' routines to enhance VO2max. By exploring innovative approaches and considering individual requirements, the study seeks to offer valuable insights for optimising aerobic exercise and fostering long-term athlete development and well-being. The goal of aerobic training in amateur football is to increase aerobic capacity, aiding endurance and oxygen utilization efficiency. Although immediate increases in VO2max may not occur, enhanced oxygen utilisation leads to long-term performance improvements. Athletes with higher VO2max tend to recover faster after intense activity, facilitating a quicker return to peak performance levels. Therefore, incorporating aerobic exercise into training programs is critical for improving VO2max in amateur football athletes, enhancing performance, and reducing injury risks.

METHOD

Types of Research

This study used a pre-experimental or non-design method for the design used, namely one group pretest and posttest design, where there was only one experimental research group without a comparison group, namely to see the pretest value before there was treatment and the posttest value after there was treatment (Kusumawati, 2015).

Table 1. Pretest and Posttest Design with One Group

Pre-Experimental Design	Design			Information
One group pretest and posttest design	O ₁	X	O ₂	O ₁ : Pretest scores X : Treatment O ₂ : Posttest scores

Research Subject

The population involved in carrying out the research was 30 amateur football athletes, while the sampling technique used total sampling, where the entire population could be sampled, so that the sample in the study was 30 people.

Research Procedure

The instrument used was the balke test for 15 minutes to find out the athlete's VO2max capacity (Saiful, 2021). The method used aerobic exercise by running 400 metres, which is carried out for 6 weeks every week, three times. So that the athlete's maximum ability is 90 seconds for one round and accumulated based on the load, namely 60% (light), 70% (moderate), and 80% (heavy).

Data Analysis

The data analysis technique used a statistical descriptive test then continued with the analysis prerequisite test, namely the normality test and homogeneity test, and continued using the t-test, with SPSS Version 26. Based on the results of the analysis test, it was found that the validity test was 0.89 and the reliability test was 0.94, so it can be concluded that the data is valid and reliable.

RESULTS AND DISCUSSION

Using minimum, maximum, mean, and standard deviation values, we break down the descriptive data on the aerobic exercise variable to increase VO2max in amateur football athletes into different types. Table 1 presents these various types of analyses.

Table 2. Descriptive of Pretest and Posttest Implementation on Increasing VO2max

Data Statistic	Test VO2max Pretest	Test VO2max Posttest
Number of Samples	30	30
Minimum	42.08	47.24
Maksimum	64.04	69.24
Improvement of Means	55.38	60.70
Standard Deviation	6.00	5.97

Based on the results of statistical analysis on increasing VO2max with aerobic exercise, there was an increase from the pretest to the posttest. The data obtained during the pretest carried a minimum result of 42.08, followed by a maximum result of 64.08, with a mean of 56.28 and a standard deviation of 5.97. The descriptive data results can be contained in the following diagram:

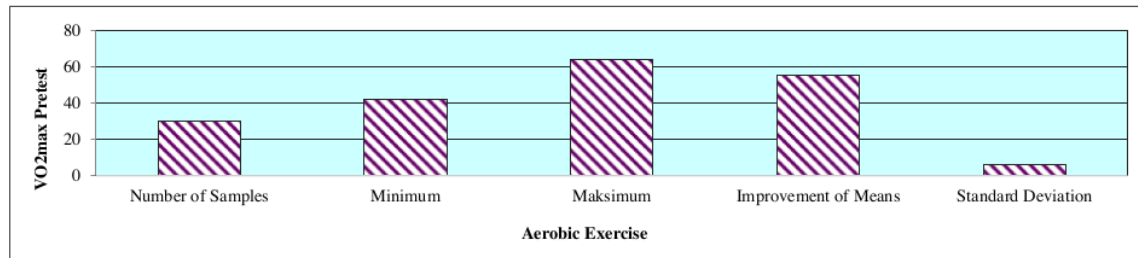


Figure 1. Diagram of Pretest VO2max Increase through Aerobic Exercise

The results of the data analysis obtained during the pretest were a minimum result of 51.24, followed by a maximum result of 69.24, with a mean of 61.57 and a standard deviation of 5.52. The descriptive data results can be contained in the following diagram:

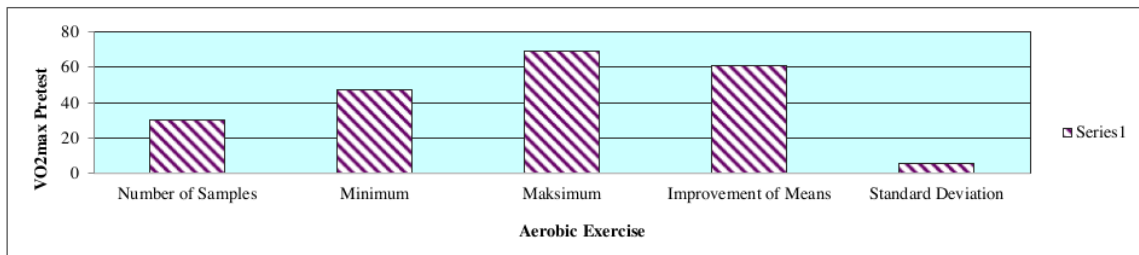


Figure 2. Diagram of Posttest VO2max Increase through Aerobic Exercise

The results of data analysis can be integrated into a frequency distribution table, where the results obtained during the pretest and posttest are presented and organized in a form that is easier to understand and analyse. Frequency distribution is a way to classify data into groups (intervals) and count the number of times each group appears in the dataset. The frequency distribution can be seen in the following table:

Table 3. Results of Frequency Distribution on Aerobic Improvement through VO2max Exercise

Aerobic Improvement in Pretest Results			Aerobic Improvement in Posttest Results		
Intervals	Frequency	Percentage	Intervals	Frequency	Percentage
42.08 - 45.98	1	3%	47.24 - 50.98	1	3%
45.99 - 49.89	4	13%	50.99 - 54.73	6	20%
49.90 - 53.80	9	30%	54.74 - 58.48	5	17%
53.81 - 57.71	3	10%	58.49 - 62.23	4	13%
57.72 - 61.62	9	30%	62.24 - 65.98	6	20%
61.63 - 65.04	4	13%	65.99 - 69.24	8	27%
Total	30	100%	Total	30	100%

Based on the implementation of the results of the frequency distribution of increasing aerobics before doing VO2max exercise, the data obtained is as many as 1 person with a percentage of 3% who has an aerobic test result of 42.08-45.98, namely as many as 4 people with a percentage of 13% who have an aerobic test result. 45.99-449.89, namely 9 people with a percentage of 30% who have aerobic test results of 49.90-553.80, namely 3 people with a percentage of 10% who have aerobic test results of 53.81-57.71, namely 9 people with a percentage of 30% who had aerobic test results of 57.72-661.62, namely 4 people with a percentage of 13% who had aerobic test results of 61.63-665.04. While the increase in aerobics after doing VO2max exercise is as much as 1 person with a percentage of 3% who has an aerobic test result of 47.24-50.98, that is as many as 6 people with a percentage of 20% who has an aerobic test result of 50.99-54.73, namely 5 people with a percentage of 17% who have aerobic test results of 54.74-58.48, namely as many as 4 people with a percentage of 13% who have aerobic test results of 58.49-62.23, namely as many as 6 people with a percentage of 20% who had aerobic test results of 62.24-65.98, namely as many as 8 people with a percentage of 27% who had aerobic test results of 65.99-69.24. The results of the normality and homogeneity tests in the study aim to determine whether the data collected follows a normal distribution and ensure that the variability between groups or treatments in an experiment is comparable or uniform. The results of the normality and homogeneity tests can be seen in the following table:

Table 4. Implementation of Normality Test Results and Data Homogeneity Test

Normality Test Based on Data Significance		Homogeneity Test Based on Data Significance	
Pretest Implementation	0.200	Statistical Results	Significance
Posttest Implementation	0.200	0.026	0.873

Based on the data normality test table during the pretest and posttest, a significance of $0.200 > 0.05$ was obtained, indicating that the results were normal. Meanwhile, the homogeneity test based on the results of the data analysis obtained a significance of $0.873 > 0.05$ with statistical result of 0.026, indicating that the pretest and posttest on increasing aerobic exercise were homogeneous. and can be continued with the t-test.

Table 5. Implementation of t-test Data Analysis

Variable	t	df	significance
Implementation of Pre and Posttest Data Analysis Results	10.36	29	0.000

Based on the results of the t-test data analysis on the pretest and posttest, it is known that the calculated t value was 10.36. Therefore, since the value is $10.36 > 0.05$, it can be concluded that there is an influence of aerobic exercise on increasing VO2max. Based on the percentage of increasing VO2max through aerobic exercise, which is equal to 9.61% of the results obtained during the pretest and posttest. The results showed a significant increase in VO2max in amateur football athletes who underwent structured aerobic training. This shows that a training approach tailored to the specific needs of football athletes can increase cardiorespiratory capacity. An increase in VO2max has direct implications for the athlete's performance on the field, so that by increasing cardiorespiratory capacity, the athlete will be better able to survive in intense game situations, accelerate recovery after periods of high intensity, and maintain consistency in training. These findings emphasise the importance of having a training approach that is structured and tailored to the specific needs of football athletes. Carefully selected and designed aerobic exercises based on the demands of the game can provide greater benefits than common training approaches. According to Güler et al. (2020), the implication of these findings is that coaches need to pay attention to the importance of integrating structured aerobic exercise into training programs. This can help improve the quality and effectiveness of training programmes, as well as athlete performance and endurance. These findings also contribute to the scientific literature on aerobic exercise and improving athlete performance. This can be the basis for further, more in-depth research on the effects of aerobic training on the performance of athletes at various levels and in various sports. The results of the study showed a significant increase in VO2max in amateur football athletes after undergoing structured aerobic training; this would support previous findings according to Ahmed et al. (2022), which

stated that aerobic exercise in general can improve cardiorespiratory fitness and have a positive impact on VO₂max. Structured aerobic exercise for increasing VO₂max can expand our knowledge of how specific types of exercise and structured approaches can provide greater benefits than general aerobic exercise.

These studies have limited study designs, such as single experimental designs or a lack of appropriate control groups. This can affect the internal validity of the study and the ability to draw strong conclusions. And because the study was conducted with a relatively small sample, this may reduce the statistical power of the results and make the generalizability of the results limited. This can reduce the reliability and representability of research results. Then according to Parmar et al. (2021), variations in the duration and intensity of the structured aerobic exercise used in the study could be a factor that influences the results because the exercise provided is quite intensive and lasts long enough to produce a significant influence on VO₂max. However, the results of this study are difficult to generalise to the population of amateur football athletes as a whole due to the unique characteristics of the sample studied, such as initial fitness level or training environment conditions. Although this study showed a significant increase in VO₂max after undergoing structured aerobic exercise, it is possible that other factors also contributed to the increase (Sharma et al., 2017). For example, changes in diet, lifestyle, psychological factors such as motivation or exercise commitment also influence results. According to Granero-Gallegos et al. (2020), another alternative interpretation is that the response to structured aerobic exercise can vary significantly between individuals. Some athletes show greater increases in VO₂max than others, which can be influenced by factors such as initial fitness level, genetics, or commitment to a training program. So increasing VO₂max is the main focus of research, and aerobic training also has a positive effect on the performance of other components of athletes, such as strength, speed, or muscle endurance. This interpretation would highlight the importance of paying attention to other aspects of performance in future research.

The results of this research are supported by Murat and Aydemir (2024) study of the relationship between VO₂max values and various parameters of football players who play on amateur football teams. In this research, there is a difference, namely using correlational research, which only looks at the relationship between variables. Meanwhile, the results of research carried out by researchers used experimental research. The similarity lies in researching amateur athletes. The results obtained using both correlational and experimental research are significant; in other words, there is a relationship, and there is also an influence on the sport of football. Future research can explore the effect of variations in structured aerobic training methods on increasing VO₂max in amateur football athletes. This could include comparisons between different types of aerobic exercise, such as interval training, resistance training, or continuous training, in the context of performance enhancement. And future research could evaluate the long-term effects of structured aerobic exercise on increasing VO₂max and performance in amateur football athletes. This will provide a better understanding of the sustainability of results and the factors influencing retention of performance improvements.

CONCLUSION

Aerobic exercise has a very important role in increasing VO₂max in amateur football athletes. Good cardiorespiratory conditioning can help improve endurance, performance, and recovery during training and competition. Through monitoring and analysis, this research can provide a deeper understanding of how various aerobic exercise methods affect certain body responses. By refining exercise methodology, such as duration, intensity, and type of exercise, this research may produce better guidelines for designing more effective exercise programs. The information obtained from this research can be applied directly to the development of better training programmes for football athletes, thereby enabling more efficient performance improvements. Through aerobic training for amateur football athletes, several recommendations for further research include variations in aerobic training that are more specific and suit the needs of football athletes, such as game simulations, situations or interval training that is more similar to the pattern of a football game. This can provide a more accurate picture of VO₂max in the context of more relevant activities. Carry out further measurements and analyses of factors that can influence VO₂max results, such as genetic factors,

nutritional aspects, and psychological factors. Investigating the relationship between these factors and responses to aerobic exercise may provide a more holistic understanding.

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CONFLICT OF INTEREST

No conflicts occurred in this study.

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