Kinestetik : Jurnal Ilmiah Pendidikan Jasmani 10 (1) (2026)
Kinestetik : Jurnal Ilmiah Pendidikan Jasmani
https://ejournal.unib.ac.id/index.php/kinestetik/index
DOI : 10.33369/jk.v10i1.48380

Aerobic Endurance VO2Max: Evaluation Study of U17 Athletes at Darul Amanah Football Academy

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Article Info

Article History :

Received : February 2026
Revised : March 2026
Accepted : March 2026

Keywords:

Aerobic Endurance
Soccer
U17 Athlete

Abstract

Aerobic endurance is a very important component for soccer players, especially for adolescent athletes who are still in the performance development stage. The purpose of this study was to measure the aerobic endurance level of U17 soccer athletes at the Darul Amanah Football Academy in Kendal using VO2max measurements, which is the main indicator of aerobic endurance, showing the body's ability to utilize oxygen to the maximum during physical activity. This study used a quantitative descriptive research design with total sampling of all 30 U17 athletes. The results of the research data collected using the Multistage Fitness Test (MFT) instrument showed that the athletes had a VO2Max value with an average of 52.02 ml/kg/minute, which is a good result. Most athletes were in the good to excellent class, but there were still some in the moderate class. These findings indicate that athletes generally have sufficient aerobic endurance. However, based on the research results, a more focused training program is still needed to improve the fitness of athletes so that they have consistent results.

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ISSN 2685-6514 (Online)
ISSN 2477-331X (Print)

INTRODUCTION

Soccer is loved around the world, from children to the elderly. Soccer is almost certainly known throughout the world (Fauzi & Hariyadi, 2021). Soccer is also a very fast-paced sport that requires a lot of energy. The various movements performed by players include running, kicking, and jumping (Yusni & Amiruddin, 2021). Soccer is a major ball game that emphasizes endurance, strength, and speed (Dolci et al., 2020). However, the basis of a player's physical condition in all sports is endurance (Farley et al., 2020). Soccer is a type of sport that requires excellent aerobic endurance because it involves moderate to high intensity physical activity performed over a long period of time (Sardiyan et al., 2025). VO2max, or the body's ability to absorb, transport, and utilize oxygen to the maximum extent during strenuous physical activity, is one of the main physiological indicators of aerobic endurance (Srivastava et al., 2024). VO2max is very important for teenagers, especially U17 soccer players, because this is a transitional phase towards more competitive training. Soccer players must be in good physical condition (Utama, 2025). Since the primary energy used by soccer players is generated by aerobic metabolism, players must have aerobic fitness (Firmansah, 2021).

Adequate aerobic fitness or VO2max allows players to perform high-intensity actions repeatedly during a soccer match, speeds up recovery, and maintains physical condition (Attamimi et al., 2024). Throughout the season, they were at their best. Athletes with good VO2max tend to be better able to maintain their technique and tactics consistently throughout the game and experience less fatigue (Pratama et al., 2025).

Although many studies confirm that VO2max is an important indicator in determining the aerobic work capacity of soccer players, there is still a gap in research related to the aerobic fitness profile of adolescent academy athletes at the training level in Indonesia. Most previous studies have focused on the relationship between VO2max and game performance or the effectiveness of specific training methods, while research that specifically evaluates the baseline VO2max of academy athletes as a basis for planning training programs is still limited.

In modern soccer, VO2max plays an important role in supporting players ability to perform high-intensity activities repeatedly, maintain performance during matches, and accelerate the recovery process during breaks in play (Agustiyawan, 2022). If aerobic capacity is adequate, players will experience a decrease in game intensity in the final phase of the match. Therefore, research is needed to specifically identify the aerobic capacity levels of youth athletes so that coaches can design more targeted training programs.

The purpose of this study was to measure the aerobic endurance level of soccer players through VO2max measurements and to see how aerobic

ability is distributed among players based on their characteristics (Fatoni et al., 2024). The results of this study are expected to provide an overview of the aerobic fitness of athletes, which can be used as a basis for creating physical training programs that are more focused on improving performance (Manggala et al., 2023). Theoretically, this study contributes to sports science research, particularly regarding the understanding of VO2max in adolescent athletes (Nugraha, 2017). In practice, it can be used by coaches, academies, and sports practitioners as evaluation and reference material in the physical training of young soccer players (Romero-Caballero et al., 2020).

To evaluate how to improve the endurance of soccer players, training interventions such as different training arrangements, training in hot places or at high altitudes, and the amount of time spent training can be used (Amory & Satria, 2025). Based on these conditions, this study attempts to fill the research gap by presenting an empirical evaluation of the VO2max of U17 athletes at the Darul Amanah Football Academy, thereby providing a realistic picture of the aerobic endurance of athletes in training and serving as a scientific basis for the development of physical training programs for youth soccer. This study focuses on an assessment that specifically evaluates the VO2max of U17 athletes at the Darul Amanah Football Academy in Kendal, while also presenting data that can be used as a reference for physical training based on the actual needs of athletes. The study also presents a descriptive profile of VO2max and offers references for improving the quality of training and physical readiness of athletes to achieve higher competitive levels.

This study presents an empirical profile of VO2max in U17 athletes in a development-based soccer academy environment using a fitness evaluation approach through the Multistage Fitness Test (MFT). This study not only presents the average VO2max value but also describes the distribution of athletes' aerobic fitness categories in detail based on international standards. This data provides a new contribution in the form of an aerobic fitness database for teenage soccer academy athletes in Indonesia, which can be used as a reference in developing more targeted and evidence-based training programs. Thus, this research is significant in supporting the development of youth football training based on scientific data, particularly in the aspect of aerobic endurance (Nasrulloh et al., 2021). The results of the study are expected to help the club conduct evaluations and improve the quality of training.

METHODS

This study uses a quantitative descriptive method with data collection based on tests and measurements (Sugiyono, 2025). Using the Multistage Fitness Test (MFT) instrument to determine the aerobic strength of athletes. The data obtained was the primary quantitative score of VO2max (ml/kg/minute) for each athlete. Data

analysis used raw data to determine VO2max values, followed by descriptive statistical analysis covering minimum, maximum, and average values. Next, the VO2max values were classified into categories based on the MFT test literature norms.

Participants

In this study, the sample consisted of 30 male U17 athletes from the Darul Amanah Football Academy. The entire sample played different positions in soccer, including 3 goalkeepers, 13 defenders, 6 midfielders, and 8 forwards. All athletes had different levels of aerobic endurance.

Sampling Procedures

Characteristics of criteria in sample selection based on age. In this study, the sample used was selected using the sampling technique (total sampling) where all 30 athletes from the Darul Amanah Football Academy U17 were used as the research sample. The researcher selected the sample based on the research objectives and desired characteristics. The research location was at the Darul Amanah Football Academy Sports Building so that in collecting data, all athletes could perform to their full potential without any unwanted distractions.

Materials and Apparatus

The tools and materials used in this study were adjusted to the Multistage Fitness Test (MFT) requirements as an instrument to measure the VO2max value of U17 athletes at the Darul Amanah Football Academy in Kendal.

The main equipment used is a flat field with a 20-meter track measured with a tape measure and marked as a back-and-forth track using cones. In addition, audio devices, such as active speakers or sound systems, are used to play MFT beep recordings to indicate speed and test levels. Furthermore, a stopwatch is used as a tool to control time. During the test, each athlete records their level and last shuttle on a record sheet and writing instrument. The VO2max assessment norm format based on the 14–19 year old standard was used as supporting material for this study. All of this equipment was used to ensure that data collection was carried out systematically, objectively, and in accordance with standard protocols for aerobic fitness tests. Thus, the data collected was valid and could be used to accurately describe the athletes' aerobic endurance levels.

Procedures

The main equipment used is a flat field with a 20-meter track measured with a tape measure and marked as a back-and-forth track using cones. In addition, audio devices, such as active speakers or sound systems, are used to play MFT beep recordings to indicate speed and test levels. Furthermore, a stopwatch is used as a tool to control time. During the test, each athlete records their level and last shuttle on a record sheet and writing instrument. The VO2max assessment norm format based on the 14–19 year old standard was used as supporting material

for this study. All of this equipment was used to ensure that data collection was carried out systematically, objectively, and in accordance with standard protocols for aerobic fitness tests. Thus, the data collected was valid and could be used to accurately describe the athletes' aerobic endurance levels. The implementation process begins with a briefing by the researcher on the purpose of the test, the procedures, and the criteria for stopping the test. The researcher is also responsible for organizing the test, providing technical instructions, controlling time and sound, and recording the results of each sample's level and feedback. Before the entire procedure begins, all samples have been given a thorough explanation of the purpose of the research, the benefits, and the minimal risks of the test. In addition, each athlete openly gives informed consent to participate in the research.

Design or Data Analysis

The research design used quantitative descriptive with a test and measurement approach. The collected data was then processed and analyzed through several stages. Data analysis techniques began with testing athletes to measure their abilities. Next, the raw data was analyzed using test norms to estimate the maximum, minimum, and average aerobic endurance levels of the athletes.

RESULT

The results of this study indicate that the aerobic endurance levels of the study participants (U17 athletes from the Darul Amanah Football Academy in Kendal) varied based on their VO2max values, which were measured using the Multistage Fitness Test. The results obtained from 30 athletes produced an analysis of aerobic endurance with a minimum score range of 40.4 ml/kg/minute, a maximum score of 60.9 ml/kg/minute, an average of 52.02 ml/kg/minute, a median of 51.85 ml/kg/minute, and a mode of 57.3 ml/kg/minute. Most athletes were in the good to excellent category, and their VO2max met the minimum physiological requirements for 17-year-old soccer players. However, there were also some in the moderate category. The collected data shows that VO2max values largely reflect the endurance capacity of youth soccer players in accordance with international standards. Ideal VO2max values indicate that athletes' cardiorespiratory and musculoskeletal systems are strong enough to perform moderate to high-intensity activities repeatedly during matches.

Tables & Figures

Tables 1. MFT Test Assessment Standards for Ages 14-19 (Source: https://www.brianmac.co.uk)

Category	Male	Female
Superior	>55	>41
Very Good	51 – 55	39 – 41
Good	45 – 50	35 – 38
Currently	38 – 44	31 – 34
Bad	35 – 37	25 – 30
Very Bad	<35	<25

Tables 2. Description of MFT Test Results

Category	Frequency	Percentage
Superior	9	30%
Very Good	9	30%
Good	8	27%
Currently	4	13%
Bad	0	0%
Very Bad	0	0%
Total	30	100%

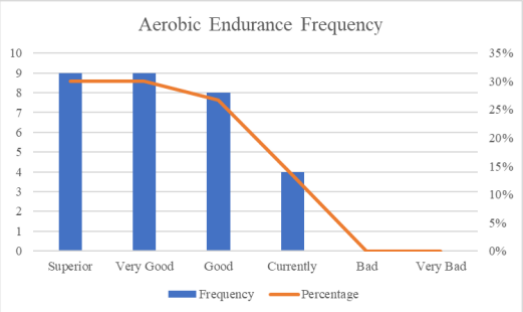

Figure 1. Aerobic Endurance Frequency

DISCUSSION

Based on the results presented in Table 2, the distribution of VO2max categories among athletes shows that most athletes are in the excellent and very good categories, with 9 athletes in each category. In addition, there are 8 athletes in the good category, while 4 athletes are in the moderate category. No athletes were found in the poor or very poor categories. This distribution indicates that, in general, the aerobic fitness level of the U17 Darul Amanah Football Academy athletes is quite high and meets the physiological requirements for teenage soccer players.

Figure 1 visually depicts the frequency distribution of athletes' VO2max. The graph shows that the largest concentration of athletes is in the excellent to good category, indicating that most athletes have adequate cardiorespiratory capacity to support high-intensity competition activities. However, the presence of several athletes in the moderate category shows that there is still variation in fitness levels within the Darul Amanah Football Academy group of athletes. These differences may be due to various factors, such as differences in training adaptation levels, playing experience, recovery quality, or individual physiological factors. Therefore, the distribution results in this table and graph are important for coaches to conduct individual evaluations of athletes' physical conditions, so that training programs can be tailored to the needs of each player to improve aerobic capacity more evenly.

The VO2max levels of the U17 athletes in this study support the theory that VO2max is the primary measure of aerobic fitness and physical capacity in soccer players (Düking et al., 2024). A high VO2max indicates the efficiency of the oxygen transport system and the body's ability to maintain high game intensity repeatedly (Slimani & Nikolaidis, 2019). This is in line with research conducted by (Higino et al., 2017) which shows a significant relationship between VO2max and performance in high-intensity, repetitive soccer activities. However, large variations in VO2max between individuals indicate that there are differences in adaptive responses to training loads and non-training factors

such as genetics, nutritional intake, and recovery quality (Bossi et al., 2024). To improve their performance, athletes with low VO2max should follow a focused training program, such as high-intensity interval training (HIIT), or a combination of aerobic and anaerobic exercises (Ma et al., 2023).

The results of this study, when compared to previous studies, show quite clear differences. A study conducted by (Yullianto et al., 2021) found that the majority of teenage soccer players have very low to low VO2max, indicating that most athletes have not yet reached the aerobic capacity required to play in competitive competitions. The cardiovascular endurance (VO2max) data of Negaroa U-15 SSB students in 2020 was low, meaning they were unable to play soccer well throughout a full match. According to the results of the Multistage Fitness Test (MFT) conducted on 15 students, none of the students fell into the excellent (0%) or very good (0%) categories. Most of the students fell into the very poor category, namely 10 students (66.67%), and the fair category, namely 2 students (13.33%). The last category was poor, with 1 student (6.67%). These very poor scores indicate that SSB Negaroa students do not meet the fitness standards required in general soccer in terms of heart, lung, and oxygen systems. The poor physical performance of athletes during matches, in particular, meant that players were unable to maintain the intensity of the game for two halves (2 × 45 minutes). Field observations revealed that players tire easily and can only play effectively during the first 30 minutes of the match, as indicated by the VO2max data collected.

Compared to research by (Wahyudi et al., 2024) found that most soccer players had moderate to good VO2max, with an average of 44.56 ml/kg/min, and only a few had very low VO2max. In contrast, Negaroa SSB athletes had a very low proportion of this category. This shows that physical conditioning, especially aerobic endurance, has not yet reached an optimal level. Therefore, the results of this study indicate that the main factor causing SSB Negaroa students to fail at soccer is low cardiovascular endurance. These results also provide coaches with empirical evidence for creating training programs that focus more on increasing VO2max. All of this is done without neglecting tactical and technical aspects.

Research conducted at Darul Amanah Football Academy shows that athletes have better aerobic capacity with an average score of 52.02 ml/kg/minute and a maximum score of 60.9 ml/kg/minute. Conversely, the results of this study are comparable to the results (Heriyansah et al., 2024) which shows that the VO2max of youth soccer players has an average value of 51.7 ml/kg/minute and a maximum value of 56.3 ml/kg/minute. This similarity indicates that, despite improvements in several aspects, variations in aerobic fitness among groups of young athletes still exist. The results of this study explain that the aerobic endurance of U17 soccer

players already meets the required fitness standards. The fact that most athletes have moderate to good VO2max indicates that the current training program can improve overall aerobic fitness. However, athletes with low VO2max indicate that the training program is not yet fully effective for everyone. This is consistent with the theory (Manser et al., 2021) that adaptation to exercise is greatly influenced by individual factors, so exercise program design must be tailored to each individual.

The results of this study support the scientific understanding that aerobic capacity is an important measure of athletic performance. However, to understand the value of VO2max, it is necessary to understand other components that affect fitness. Future researchers can expand the variables measured, such as lactate threshold and repeated running speed, and apply experimental designs that allow for a more in-depth evaluation of the impact of training on aerobic aspects.

CONCLUSION

Based on the research objective to measure the aerobic endurance of U17 soccer athletes at the Darul Amanah Football Academy Kendal through VO2max measurements, it can be concluded that athletes generally have good to excellent aerobic endurance levels. The results of the Multistage Fitness Test show that most athletes are in the excellent and very good categories, with an average VO2max of 52.2 ml/kg/minute. However, some athletes were in the moderate category. The results show that the overall aerobic fitness of athletes meets the physiological standards required to support youth soccer skills in matches, especially in terms of maintaining game intensity and accelerating recovery during matches. However, variations in VO2max values among athletes indicate that adaptation to training is not yet completely uniform. Therefore, a more specific and tailored training program is still needed for athletes with moderate aerobic capacity. Scientifically, the results of this study contribute data on the VO2max capacity of U17 soccer players, which can enrich sports science research, particularly in the field of evaluating and developing the physical condition of adolescent athletes. This research can also serve as a basis for further research to determine how specific training methods, such as high-intensity interval training or a combination of aerobic and anaerobic training, can improve VO2max in young soccer players more evenly and efficiently.

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