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In-depth Review: Analysis of Soccer Players' Physical Condition in Game Dynamics

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Abstract This research is based on the fact that one aspect of soccer is the physical fitness level of players. This study reviews the extent of the level of physical fitness in soccer athletes. The research was conducted using a quantitative descriptive approach. The sample in this study consisted of 18 soccer players, whose physical abilities were measured through: 1) standing broad jump to measure leg muscle explosiveness, 2) upright jump test to measure leg muscle endurance for 30 seconds, 3) dodge run test to measure agility, and 4) bleep test to measure aerobic endurance. The data analysis technique used quantitative descriptive analysis with the Statistical Product and Service Solution (SPSS) program version 29.0. Based on the results of the study, it was found that: 1) the level of agility of soccer players averaged 25.13 seconds, indicating a moderate level; 2) the explosive power of the leg muscles, with an average value of 219 cm, shows good potential; 3) strength endurance through the upright jump test for 30 seconds results in an average of 20 jumps with a standard deviation of 5.59, which is in the moderate category; and 4) the results of the bleep test show an average Maximum Oxygen Volume (VO_2 Max) value of 32.9, indicating most players fall into the moderate to less category in aerobic endurance. In this study, the physical condition of soccer players shows strength in several areas but still requires improvement in other areas through strategically designed training. The importance of continuous evaluation and monitoring of players' physical condition is highlighted to design effective training programs aimed at enhancing players' physical performance and overall performance on the field.

Keywords Football, Physical Condition, Match, Athlete

1. Introduction

Football is a renowned sport in the global community. The passion and progress of those involved in football continue to grow and are followed by everyone. It is not only seen as a sport but also as an industry that generates income for a country [1-3]. However, this sport is also complex, requiring many performance actions in both sprinting and running at high intensities, respectively [4]. Contributing to research development worldwide, it is a complex sport where various factors can influence match outcomes and final performance, with different weights depending on the context [5, 6].

Football requires excellent technical, tactical, mental, and motor skills training [7, 8]. If players are not trained to master the basic techniques and decision-making in playing football, both players and teams will struggle to develop

their game [9, 10]. Indeed, physical aspects can also play a crucial role in the success of technical performance [11].

Professional football players are expected to have high levels of fitness, skill, strategy, and mental resilience [12], and they must engage continuously in multidirectional physical and technical activities [13, 14]. In their physical preparation, football players often spend a full week training their individual strength, endurance, and speed [15]. Coordination training produces adaptations in agility, which translates into the sum of different factors such as acceleration, deceleration, change of direction (COD) [16, 17], and jumps, all interspersed with short recovery periods.

At the performance level, the ability to quickly change direction is considered a crucial physical quality related to success in youth football [18], involving explosive physical actions that require strength, power, and agility [19]. Agility is a central skill for performance and is defined as the execution of rapid movements [20]. Specifically, the athlete's aerobic capacity, plays a key role in competitive football [21, 22]. Optimal football training, among other goals, should enhance both maximal oxygen consumption (VO_2 max) and body mass index [23]. VO_2 max refers to the intensity of the aerobic process [24]. In this context, coaches and fitness specialists face significant challenges in gradually enhancing strength, speed, and power abilities in football athletes, from the early development stages to professionalism [25, 26].

Overall, extensive research has been conducted on youth football-related topics such as functional capacity [27, 28], effectiveness of training methods [29], and talent identification [30]. Furthermore, the health benefits of participating in recreational football have also been reported [31, 32]. Previous research has been carried out to explore the correlation between individual physical characteristics and outcomes in lower body explosive strength tests across various age groups [33]. Research indicates that aerobic endurance is considered a superior performance indicator in football [34, 35]. Studies on youths also note that participation in recreational football can enhance estimated aerobic fitness, 20m sprint performance, and horizontal jump performance in healthy, untrained adolescent males [36].

Based on field observations during the first half of the match, players performed well, but their physical condition deteriorated in the subsequent half, resulting in inconsistent performance. Weakness in leg muscle explosiveness led to difficulties in shooting the ball, while decreased body agility resulted in uncontrolled dribbling. This made their attacks ineffective and often resulted in the ball being taken by the opponent. Errors such as inaccurate passing and uncontrolled ball dribbling also occurred frequently. Therefore, researchers feel it is important to analyze the physical condition of the players to enhance their abilities through appropriate training. An effective training program is expected to improve player coordination, speed, endurance, and strength.

2. Materials and Methods

2.1. Participants

This type of research is descriptive and aims to describe situations or phenomena of an object. Therefore, this study only reveals and describes a phenomenon using several research variables, namely Leg Muscle Explosiveness, Strength Endurance, Agility, and Aerobic Endurance. The study consists of a sample of soccer players. All members are from beginner to senior groups, totaling 18 people, all of whom are willing to participate in this study.

2.2. Research Instruments

2.2.1. Measurement of Agility

Agility measurement is conducted through the Dodging Run test [37], aimed at assessing an individual's ability to move quickly and efficiently through obstacles. In its implementation, participants are asked to stand behind the starting line and prepare upon the command "ready." Then, upon the command "go," participants will begin running through a series of prepared obstacles, following the direction of arrows set until they pass the finish line. The time taken to complete the test is measured using a timing device, starting when the participant begins to run and stopping when they pass the finish line. The test is conducted twice for each participant, and the best time achieved is recorded [38, 39]

2.2.2. Measurement of Lower Limb Muscle Power

Lower limb muscle power can be measured through the Standing Broad Jump (SBJ) test [40, 41], SBJ is often practiced as plyometric training, which is safer and more effective than conventional weight training for adolescents to develop lower limb explosiveness [42, 43]. The test begins with the participant standing on the takeoff board with knees bent at approximately a 45 ° angle, both arms straight back, then pushing forward with both feet as forcefully as possible and landing with both feet. The total distance of the SBJ is defined as the sum of the takeoff distance, airborne distance, and landing distance [44, 45].

2.2.3. Measurement of Strength Endurance

Strength endurance can be observed through the jump test [46, 47] conducted for 30 seconds. This test is specifically designed for 15-year-old male athletes. The test procedure involves several steps. First, the testee stands comfortably with both feet on the floor beside the right goalpost. Upon the command "go," the testee jumps with both feet over the goalpost to the left side, lands, and then jumps again to the right side, repeating for 30 seconds [48]. If the testee touches or knocks down the goalpost during the test, the test is stopped and must be repeated after a recovery period. The score is determined based on how many times the testee can jump within 30 seconds,

reflecting the lower body strength endurance capability. Assessment norms for the 30-second jump test are utilized.

2.2.4. Measurement of Aerobic Endurance

Aerobic endurance can be assessed using the bleep test [47, 49]. This test aims to measure aerobic endurance and is intended for male athletes under 20 years old. In preparation for the test, a field of 20 meters in length, a measuring tape, cones (markers), bleep test tape, writing utensils, bleep test calculation forms, and assistants are required. The test begins with measuring and marking the 20-meter field. Participants are expected to warm up before participating in the test. When the test starts, the bleep test tape emits a "beep" sound three times followed by a long beep as a starting signal. The "beep" sound at each interval indicates that participants must run back in the opposite direction. Participants must ensure at least one foot is behind the boundary line before the next beep. Participants continue running until they can no longer keep up with the beep intervals or choose to stop. Participants are considered unable to continue if they fail to reach the boundary line before the beep sounds three times consecutively, stop due to exhaustion, or are no longer able to continue the test. During the test, the examiner records the VO_2 max score based on the number of successful shuttle runs completed by the participant [50].

2.3. Statistical Analysis

The use of descriptive analysis is one way to understand and interpret data. This method is commonly employed to analyze findings in various research studies. As explained by Sugiyono [51], one of the formulas that can be utilized in descriptive analysis is the formula for calculating percentages. The formula is as follows:

$$P = \frac{f}{n} x100$$

The explanation:
P: Percentage of the obtained result
F: Frequency of each somatotype
N: Total sample size

The formula will be facilitated in its analysis process using SPSS version 29.0. By utilizing this formula, researchers can calculate the percentage of each somatotype category or other data categories in the study. This aids in presenting data in a more structured manner and facilitates an understanding of the distribution or proportion of each category within the research sample. Descriptive analysis with a percentage approach is highly useful in providing a general overview of the characteristics of the analyzed data.

3. Results

3.1. Agility

Based on the dodging run test results on 18 football players, the agility measurements yielded the following results: the best score was 22.43 seconds, the lowest score was 29.23 seconds, the average score was 25.13 seconds, and the standard deviation was 1.88

Table 1. Frequency Distribution of Agility Data

No	Category	Interval (Time)	Percentage (%)
1	Excellent	< 23,07	11
2	Good	23,08 – 25,00	39
3	Fair	25,01 – 26,03	17
4	Poor	26,04 – 27,06	22
5	Very poor	> 27,07	11
Total			100

Note: The intervals are in seconds

In the research conducted on 18 athletes, the Frequency Distribution of Agility Data as shown in Table 1 was obtained. It was found that out of the 18 athletes, 2 players (11%) exhibited excellent agility, 7 players (39%) demonstrated good agility, 3 players (17%) had fair agility, 4 players (22%) showed poor agility, and 2 players (11%) displayed very poor agility (Figure 1).

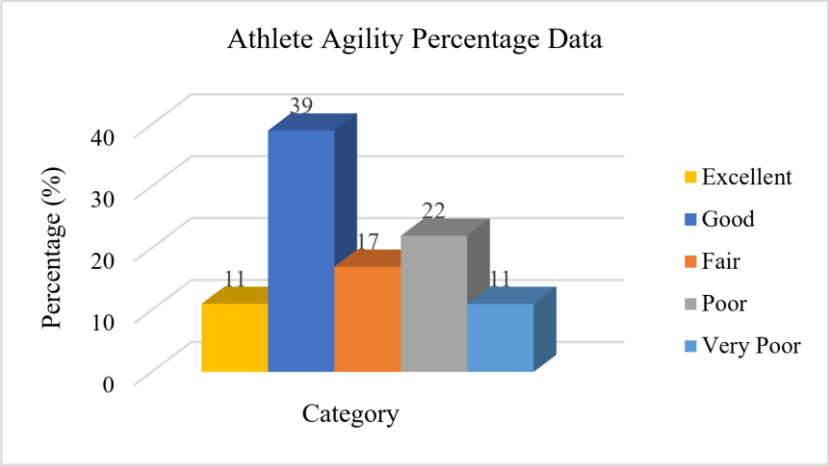

Figure 1. Histogram of agility data

3.2. Leg Muscle Explosive Power

The measurement results of leg muscle explosive power using the standing broad jump test on 18 soccer athletes yielded the following results: the highest score was 267 cm, the lowest score was 186 cm, the average score was 219 cm, and the standard deviation was 17.52.

Table 2. Frequency Distribution of Leg Muscle Explosive Power Data

No	Category	Interval (Distance)	Percentage (%)
1	Excellent	> 224	28
2	Good	188 – 224	67
3	Fair	150 – 187	6
4	Poor	113 – 149	0
5	Very poor	< 113	0
Total			100

Note: The intervals are in centimeters

Based on Table 2, out of the 18 athletes studied, 5 players (28%) exhibited leg muscle explosive power in the "excellent" category, 12 players (67%) demonstrated leg muscle explosive power in the "good" category, 1 player (6%) had leg muscle explosive power in the "fair" category, and none were categorized as "poor" or "very poor" (Figure 2).

3.3. Endurance Strength

The results of the endurance strength test using the 30-second jump test, conducted 32 times, yielded the following results: the lowest score was 13 times, the average score was 20 times, and the standard deviation was 5.59.

Table 3. Frequency Distribution of Endurance Strength Data

No	Category	Interval	Percentage (%)
1	Excellent	X > 29	6
2	Good	23 > X ≤ 29	17
3	Fair	18 > X ≤ 23	28
4	Poor	12 > X ≤ 18	44
5	Very poor	X ≤ 12	0
Total			100

Based on the research on 18 football athletes, data on the Frequency Distribution of Endurance Strength as shown in Table 3 was obtained. It was found that 1 player (6%) exhibited excellent endurance strength, 3 players (17%) demonstrated good endurance strength, 5 players (28%) had fair endurance strength, 8 players (44%) showed poor endurance strength, and none were categorized as very poor (Figure 3).

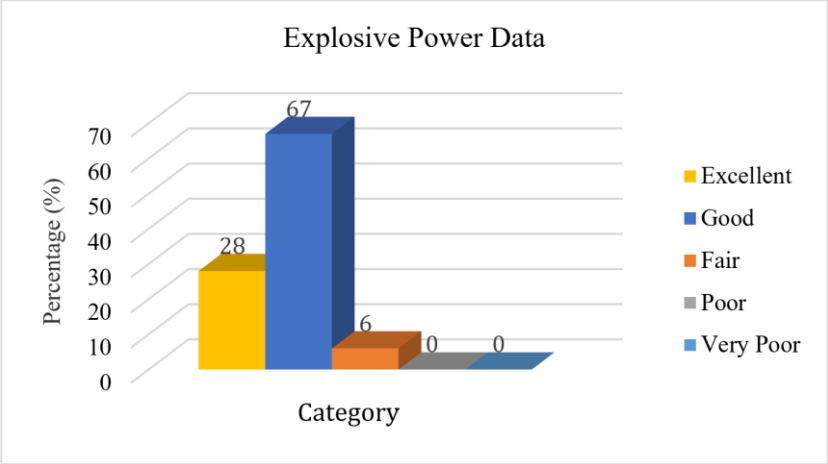

Figure 2. Histogram of leg muscle explosive power data

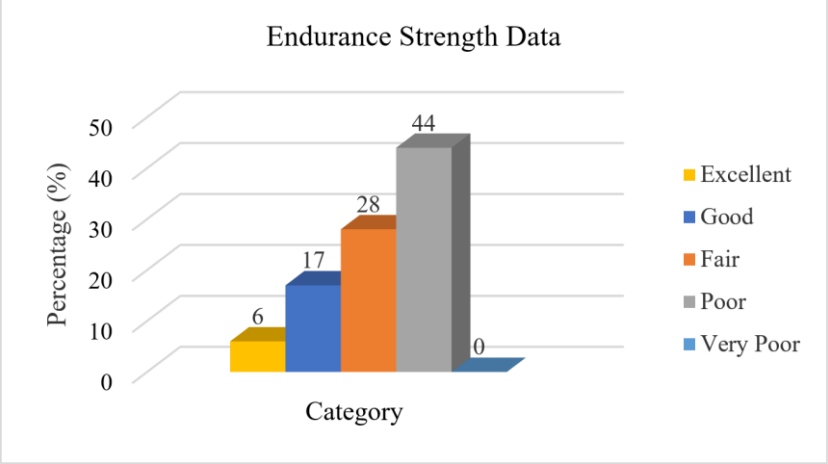

Figure 3. Histogram of endurance strength data

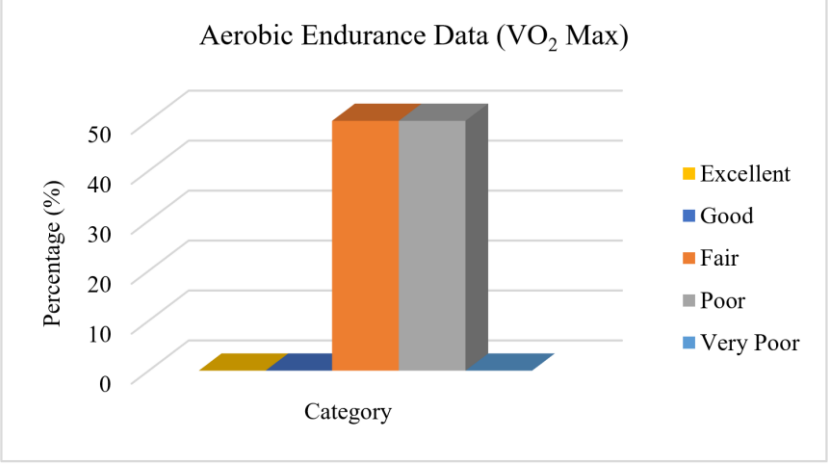

Figure 4. Histogram of aerobic endurance (VO_2 Max) data

3.4. Aerobic Endurance (VO_2 Max)

Based on the data obtained from measuring aerobic endurance using the bleep test on 18 soccer athletes, the highest score was 37.8, the lowest score was 26.2, and the average score was 32.9, with a standard deviation of 3.5. The frequency distribution table can be created as follows:

Table 4. Frequency Distribution of Aerobic Endurance (VO_2 Max) Data

No.	Category	Interval	Percentage (%)
1	Excellent	>53	0
2	Good	43–52	0
3	Moderate	34–42	50
4	Poor	25–33	50
5	Very poor	<24	0
	Total		100

Based on the research conducted on 18 participants, data on the frequency distribution as shown in Table 4 revealed that 9 players (50%) demonstrated fair aerobic endurance, while the other 9 players (50%) exhibited poor aerobic endurance. None of the participants fell into the categories of excellent, good, or very poor (Figure 4).

4. Discussion

This study is deemed important to analyze the physical condition of the soccer players of the Youth Arts and Sports Union in Pesisir Selatan Regency. Through this research, physical conditioning training can be organized, designed, and implemented effectively to enhance physical fitness capabilities when needed during future competitions/ matches. Soccer performance depends on several aspects, including technical, tactical, psychological, physical, and physiological factors [52, 53].

Several tests have begun to have better conceptual tools that include agility components, such as the butterfly agility test [54] and soccer-specific reactive agility tests [55]. There is a clear distinction between pre-planned directional changes and reactive and non-planned agility, particularly in detecting cognitive (i.e., perceptual, decision-making) and physical (i.e., conditioning capacity) capacities that determine agility [56]. Based on the analysis presented in Table 1, the average agility level is 25.13 seconds, indicating that overall, the agility level of the Youth Arts and Sports Union soccer players in Pesisir Selatan Regency can be categorized as fair.

A study conducted on eighteen young soccer players analyzing the effects of a 6-week coordination training intervention on physical fitness did not show significant differences between pre-test and post-test performance in agility [57]. Coordination training interventions appear to improve agility, strength, and in some cases, speed performance of young soccer players [58]. However, the use of such interventions is not sufficient to cover all the physical needs of players.

Referring to the results of this research, it appears that the agility possessed by some players is still far from the expected condition. This implies that the coaching staff has room for improvement to enhance the agility of the Youth Arts and Sports Union soccer players in Pesisir Selatan Regency. The training provided should be age-appropriate, disciplined, and continuous to achieve the desired level of player agility.

Similar to previous research on U17 soccer players comparing the effects of a combination of plyometric and short sprints with COD on physical variables, the intervention group (EG) showed significant improvements in jumping, sprinting, COD, repeated sprint ability, and static balance compared to the control group (CG) [59]. Therefore, considering the characteristics of soccer, implementing a mixed approach in training processes, as well as introducing strength and power training, is crucial for building tougher athletes for U16 players [60, 61].

Predicting the development of explosive leg muscle strength is a useful alternative to merely observing longitudinal data. With this approach, coaches and sports practitioners can minimize the impact of the continuous selection and deselection processes that often occur in talent development programs in soccer, which can affect long-term monitoring [62, 63].

Based on the research on leg muscle explosive power (Table 2), it is shown that the average level of explosive leg muscle power is 63 kg-m/sec. This indicates that overall, the level of explosive leg muscle power of the players can be classified in the "good" category. Therefore, it can be concluded that the Youth Arts and Sports Union soccer players in Pesisir Selatan Regency have good ability in terms of explosive leg muscle power.

Previous research has revealed that the size of explosive leg muscle strength can explain approximately 16.7% of the total variation in playing time at the senior level in the future, emphasizing the importance of athletic development in this sport [64]. Age-related differences in the rate of growth of explosive leg muscle strength have also been noted [65]. It is hypothesized that a mixed effects regression model will be able to predict leg muscle explosive power. Additionally, it is expected that predicting future performance of explosive leg muscle strength rather than using longitudinal observations will identify performance plateaus previously reported in players older than 16 years old [66]. Because the development of lower body explosive strength is associated with important attributes of high-quality sports performance such as speed and agility [67, 68], as in soccer. In line with this opinion, it is clear that having good leg muscle explosive power can facilitate players in developing fast-paced and sudden movement techniques during play, as well as in bolstering their mental resilience on the soccer field, especially when facing tough soccer teams.

Sprinting actions with ball possession are more frequent

among high-ranking teams compared to low-ranking teams, implying that sprinting actions are key to tactical objectives. Specifically, these actions enable the creation of open spaces, 1v1 situations, or penetrating passes, emphasizing the importance of physical strength and conditioning in professional soccer [69, 70]. Additionally, skills such as dribbling, passing, ball control, supporting, pressing, covering, and closing down opponents are crucial points [71]. Lower limb strength and power also tend to influence sprint times. Performance shown in a 20-meter sprint correlates with muscle strength and lower limb power [72].

The research results presented in Table 3 indicate that the endurance strength of the players' leg muscles falls into the moderate category. Previous studies have shown that endurance training or sprinting can improve linear running performance [73, 74]. In another study, it was observed that high-intensity actions and markers of player acceleration and deceleration began to decline in the last fifteen minutes of the game [75]. It is suggested that players' muscle strength and power start to decrease in the final minutes of the game, attributed to muscle fatigue. Specific sports drill exercises need to be planned and executed well on the field to prepare players for peak performance on match days. Therefore, the recommendation for coaches is to implement exercises that can improve endurance strength of the leg muscles, such as stair climbing, skipping, squat thrusts, and other exercises. Thus, it is expected to enhance the quality of play and physical endurance of soccer players.

The measurement results of aerobic endurance (VO_2 Max) using the bleep test on soccer players show a significant variation in values. The highest score reached 37.8, while the lowest score was 26.2, with an average score of 32.9 and a standard deviation of 3.5. The frequency distribution of the 18 players studied shows that 50% have moderate aerobic endurance levels, while the remaining 50% have low aerobic endurance levels. None of the players fall into the excellent, good, or very poor categories.

High-Intensity Interval Training (HIIT) is an effective tool for improving several physiological parameters crucial for performance, including cardiometabolic function, oxygen uptake kinetics, anaerobic strength and capacity, ion transport capacity, and muscle fatigue endurance [76, 77]. Certainly, HIIT stands out as a highly effective training methodology for enhancing both aerobic and anaerobic capacities and inducing various respiratory physiological adaptations [78].

When training sessions are conducted for several minutes at intensities equivalent to around 90% of maximum oxygen consumption (VO_2 max) or >90% of maximum heart rate, HIIT is highly beneficial in improving aerobic strength and capacity (e.g., with high-intensity aerobic training) [79, 80]. When HIIT is performed at much higher intensities, such as maximal effort or sprinting typically lasting 10 to 40 seconds with longer recovery periods (such as sprint interval training or speed endurance training), beneficial adaptations related to the anaerobic energy system and ion handling are generally observed [81].

However, the findings from this research indicate that most players do not yet have optimal aerobic endurance. Therefore, efforts are needed to improve their aerobic endurance capacity. Measures that can be taken include exercises such as cycling, long-distance swimming, uphill/downhill running, and long-distance running with a low and steady pace. The farther the distance that can be covered, the faster the recovery time and it demonstrates the ability to perform well under high pressure from opponents [82-85].

This research faces several limitations, including a limited and homogenous sample of 18 soccer players from the Youth Arts and Sports Union of Pesisir Selatan Regency, which may not reflect the overall population of soccer players. The measurement methodologies used to assess Leg Muscle Explosive Power, Endurance Strength, Agility, and Aerobic Endurance may face limitations in accuracy and reliability. Additionally, this study only focuses on four physical fitness variables, leaving many other aspects unexplored. The lack of longitudinal data and analysis on training programs and recovery also limits the deep understanding of the dynamics of player fitness.

Future studies require research with a broader and more diverse sample, including players from various age groups and levels of experience. The development and validation of more specific physical fitness tests for soccer, as well as the implementation of longitudinal studies, will provide insights into the development of players' physical fitness over time [86]. The importance of intervention studies to evaluate the effectiveness of specific training programs and multifactorial analyses that combine technical, tactical, and psychological aspects of soccer about physical fitness also becomes an important focus. The application of advanced technology and data science in physical fitness research will enable more personalized and accurate approaches to player development.

5. Conclusions

In the study conducted on football players, it was found that the overall agility of the players is at a satisfactory level, with an average time of 25.13 seconds in the Dodging Run test. However, there are opportunities for improvement through training aimed at sharpening directional changes and enhancing reaction speed. Regarding the aspect of lower limb explosive power, the results indicate that players have good potential, with an average value of 219 cm in the Standing Broad Jump test, indicating important strength and explosiveness for activities such as jumping and sprinting. However, the results of the 30-second jump test suggest variability in players' strength endurance, with an average of 20 jumps in that duration, indicating the need to improve muscle strength and endurance.

On the aspect of aerobic endurance, the results of the bleep test indicate variations in players' VO_2 Max values, with an average of 32.9, suggesting that most players are in

the category of adequate to insufficient aerobic endurance. This underscores the importance of developing training programs that can improve players' aerobic capacity. In conclusion, this study highlights that while there are strengths in some aspects of players' physical fitness, there are specific areas that require attention and improvement through strategically designed training. This provides valuable insights for coaches and players regarding the importance of physical fitness components in football and highlights the need for a holistic and structured training approach for optimizing players' physical performance. The study also emphasizes the importance of continuous evaluation and monitoring of players' physical condition to design training programs that meet their specific needs and enhance overall performance in matches.

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