

Correlational Study of VO₂max and Basic Football Techniques in First-Year Sports Science Students

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Abstract

Football is one of the most popular sports worldwide, demanding both technical proficiency and optimal physical fitness. VO₂max, a key indicator of aerobic capacity, plays a crucial role in supporting physical performance and may influence the ability to master football skills, especially among early-year students in sports education settings. This study aimed to analyze the relationship between VO₂max and fundamental football skills among early-year students in the Sports Science Program. A cross-sectional research design was employed involving 155 second-semester students enrolled in the Sports Science Program. Participants were selected using total sampling. VO₂max was assessed using the Multistage Fitness Test (bleep test). Technical football skills measured included passing, receiving, dribbling, shooting, and heading. Data were analyzed using Spearman rank correlation to determine the relationship between VO₂max and each football skill. The analysis revealed significant correlations between VO₂max and several football skills: passing ($\rho = 0.300$; $p < 0.01$), receiving ($\rho = 0.531$; $p < 0.01$), dribbling ($\rho = -0.645$; $p < 0.01$), and heading ($\rho = 0.482$; $p < 0.01$). No significant correlation was found between VO₂max and shooting ($\rho = 0.146$; $p = 0.070$). The data suggest that higher VO₂max is associated with better performance in most basic football techniques, except for shooting. VO₂max significantly contributes to the mastery of fundamental football skills—particularly passing, receiving, dribbling, and heading—among early-year sports science students. Aerobic capacity should be considered a critical component in football training and education programs.

Keywords: VO₂max, technical skills, college students, football.

INTRODUCTION

Football is one of the most popular sports in the world. Its global acceptance has made it a widely played sport across continents (Bason & Senaux, 2023). In Indonesia, football has evolved into a mandatory course in the early stages of higher education, particularly in sports science programs. It is strategically positioned as a foundational step toward realizing Indonesia's vision of becoming a strong football nation that aligns with international standards (Cheng et al., 2015).

First-year students often come from various sports backgrounds, requiring a structured approach to developing football technical skills. Even students with early football experience often demonstrate limited mastery of basic techniques. This is largely due to the conventional training methods still prevalent in many football academies (Sekolah Sepak Bola or SSB), which are characterized by repetitive drills and a lack of variation in the techniques taught (Pratama & Permadi, 2024). Research by Saputra (2019) also revealed that mastery of basic football skills among SSB students remains relatively low. The lack of technical proficiency (Irfan et al., 2020; Jonni et al., 2025; Purnomo et al., 2024; Sasmita, 2023) has become a significant barrier to achieving the expected competencies in football courses at the university level.

Technical ability is one of the four fundamental elements of modern football and is considered the most rapidly evolving aspect compared to the other three elements (Song & Xu, 2013). Mastery of basic techniques such as ball control, shooting, passing, heading, and dribbling is essential for improving overall playing skills (Nurcahyo et al., 2025). Ideally, technical training should begin at an early age to ensure long-term success (Slaidiņš & Fernāte, 2021). However, in the context of university students with diverse sports interests, this training may not have been adequately provided. Therefore, there is a need for effective and efficient instructional models to ensure the acquisition of basic football skills within a limited timeframe.

Physical fitness is a critical determinant in performing football skills effectively and efficiently (Abderrahmen et al., 2024). Optimal physical fitness can be achieved through structured and continuous training programs tailored to specific goals (Winartin et al., 2023), and it is often directly linked to overall health status. The current physical health condition of university students is concerning, with increasing rates of obesity and myopia (nearsightedness) being reported (Gao, 2025). These issues may hinder students' ability to develop basic football skills, thus affecting their competence in the course.

In addition, general physical condition—particularly endurance—is an important factor in football performance (Koltai et al., 2016). First-year university students typically exhibit lower levels of physical fitness. Findings by Kurniawan & Ala (2021) indicate that students in sports coaching programs still fall below fitness standards. Physical fitness has been shown to significantly influence academic performance, especially among first-year students (Sunadi et al., 2018). One of the main learning outcomes of the football course is students' mastery of basic football techniques. Therefore, physical fitness—especially cardiorespiratory fitness—should be a primary focus in the learning process.

Each football playing technique requires different components of physical fitness. For example, in passing, fatigue indicators have been shown to decrease passing accuracy scores (Mulazimoglu, 2016), while enhancing aerobic training can improve agility in delivering passes during gameplay (Luqman et al., 2024). Similarly, dribbling is dominated by running while controlling the ball, thus requiring good aerobic capacity. Many studies have implemented training methods based on actual game scenarios, such as the small-sided game method, to

improve both football techniques and players' physical condition (Arifan et al., 2024). In contrast, shooting places greater emphasis on strength (power) as the key determinant of performance, and thus strength training programs can be highly beneficial in optimizing shooting ability (Lee, 2018). These distinctions suggest that VO₂max may contribute differently to each technical skill.

Based on these considerations, this study aims to analyze the relationship between VO₂max capacity and basic football technique performance among second-semester students in the Sports Science study program.

METHOD

Design

This study employed a cross-sectional research design with a quantitative correlational approach to examine the relationship between VO₂max capacity and basic football technique skills at a single point in time.

Participants

The study population consisted of first-year (second-semester) students enrolled in the football course. The inclusion criteria included: active enrollment in the Sports Science program, no current injuries, and willingness to participate in all measurement procedures. The exclusion criteria were: students currently injured or absent during data collection. Based on these criteria, a total of 155 eligible subjects were included in the study. Participants were first provided with a detailed explanation of the tests and measurements to be conducted if they agreed to take part in the study. They were also informed about the potential risks and hazards that might arise during the measurement procedures. Subsequently, participants who consented to participate signed an informed consent form prior to their inclusion in the study.

Data Collection

VO₂max Measurement

VO₂max capacity was assessed using the Multistage Fitness Test (MFT), also known as the bleep test. The test was conducted on a flat indoor court with a 20-meter running lane marked by cones at each end. Participants were instructed to run back and forth between the cones, following a series of beeping sounds played through an audio device. The running speed progressively increased in accordance with the levels and sections of the test. A participant was considered to have completed the test when they failed to reach the designated line twice consecutively before the beep. The final result recorded was the highest level and stage completed, which was then converted into ml/kg/min to estimate VO₂max.

Assessment of Basic Football Techniques

Basic football technique skills were evaluated using a test developed by Nusri et al. (2023), which was designed based on real-game scenarios. Nusri et al. (2023) conducted expert validation and then conducted small-scale and large-scale trials. The test measured five core techniques: short passing, receiving, dribbling, shooting, and heading. All 155 participants performed the skill assessments on the same day prior to VO₂max testing.

1. Short Passing Test: Participants passed the ball from a distance of 10 meters toward a wall marked with five scoring zones (1–3 points). Each participant had five attempts.
2. Receiving Test: Measured by counting the number of successful ball controls within 20 seconds after bouncing the ball off a wall from 3 meters.
3. Dribbling Test: Conducted on a zig-zag path with five cones, with time to completion used as a performance indicator.

4. Shooting Test: Executed from 16 meters (males) or 12 meters (females) towards a wall target simulating a goal area. Scoring was based on accuracy, with five shot attempts per participant.
5. Heading Test: Conducted from a distance of 150 cm toward a wall, performed over 20 seconds, with the score based on the number of successful headers hitting the target zone.

These tests collectively provided a comprehensive assessment of the participants' basic football technical proficiency.

Data Analysis

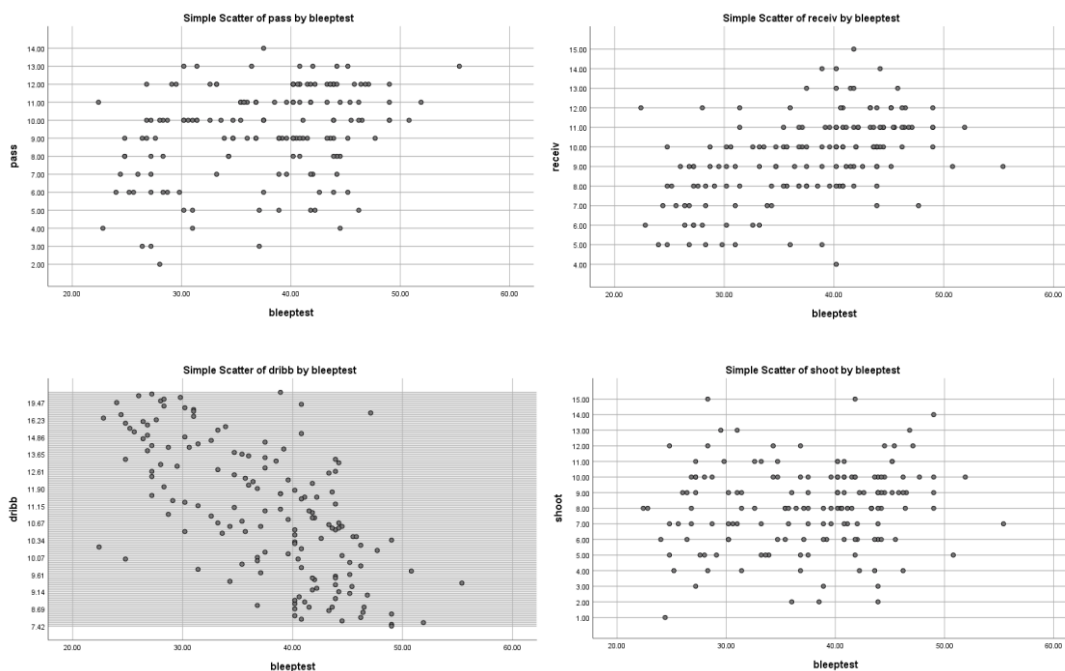
A Pearson Product-Moment Correlation was used to examine the linear relationship between VO₂max and basic football skills, including passing, receiving, dribbling, shooting, and heading. Prior to analysis, the normality of the data was assessed using the Shapiro–Wilk test, and several variables were found to deviate significantly from a normal distribution ($p < 0.05$). Therefore, Spearman's rank correlation coefficient was used to examine the relationships between variables.

RESULTS

Descriptive data from the 155 participants provided an initial overview of both basic football technique proficiency and physical fitness levels. These findings are presented in Table 1.

Table 1. Descriptive Statistics n=155

Variable	Mean ± SD
Passing	9.4 ± 2.53
Receiving	9.4 ± 2.16
Dribbling	12.1 ± 3.54
Shooting	8.1 ± 2.62
Heading	10.2 ± 4.64
Bleep Test	37.5 ± 7.20



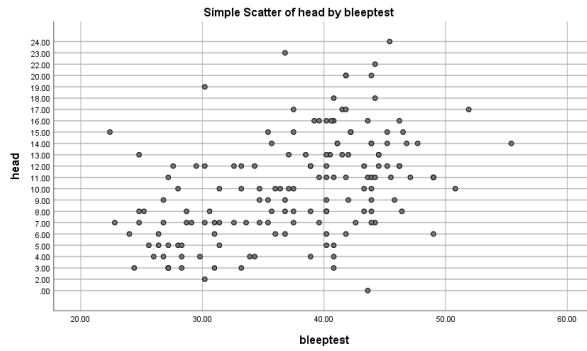


Figure 1. Descriptive statistics of technical skill and VO₂max variables. Scatter plots illustrating the relationship between *bleep test* performance and fundamental soccer skills, including passing, receiving, dribbling, shooting, and heading. The plots indicate a general positive association between *bleep test* scores and passing, receiving, shooting, and heading abilities, while dribbling shows a negative trend. Each point represents an individual participant.

The correlation analysis between basic football technique skills and physical fitness variables is presented in Table 2.

Table 2. Correlation Analysis Between Basic Football Skills and Physical Fitness

No	Basic Football Techniques	Correlation coefficient (ρ)	Sig. (2-tailed)	Interpretation
1	Passing	0.300**	0.000	Significant (positive, weak to moderate)
2	Receiving	0.531**	0.000	Significant (positive, moderate to strong)
3	Dribbling	-0.645**	0.000	Significant (negative, strong)
4	Shooting	0.146	0.070	Not significant
5	Heading	0.482**	0.000	Significant (positive, moderate)

*Note: ** $p < 0.001$. Asterisks indicate statistically significant correlations.

DISCUSSION

The findings of this study demonstrate a significant relationship between VO₂max capacity and basic football technical skills among first-year Sports Science students. Among the measured skills, passing, receiving, dribbling, and heading were found to have significant correlations with VO₂max, while shooting showed no such relationship.

According to Harsono (2013), the physical, technical, tactical, and mental components of training are an integrated unit that cannot be separated. In this context, physical fitness and technical skill development support each other simultaneously. First-year students are often still in the process of adapting to physically active learning environments. As stated by Putra et al. (2024), approximately 75% of students fall into the "poor" or "very poor" VO₂max categories. These findings are supported by Suwanto (2024), who reported that only 4% of students had VO₂max values categorized as "very good".

Football is a high-metabolic sport that demands optimal cardiovascular endurance. It requires not only technical and tactical execution and decision-making, but also strong cardiorespiratory stamina (Muryadi et al., 2023). Previous studies have shown that VO₂max improves with high-intensity interval training, frequency of sprints, and frequency of ball involvement—up to 24% improvement—indicating that players who excel in passing, dribbling,

and receiving tend to have higher VO₂max values (Helgerud et al., 2001). In the present study, passing and receiving were measured through repeated execution (five repetitions), aligning with findings by Sanders et al. (2017), who emphasized that football players must perform repeated actions without significant decline in speed or power, which is strongly associated with aerobic capacity.

Moreover, VO₂max also influences dribbling ability (Haryesa et al., 2021), as dribbling involves navigating the ball past opponents while maintaining control and speed. High-intensity dribbling training performed in 4-minute intervals has proven effective in improving VO₂max in football players (McMillan et al., 2005).

On the other hand, shooting did not show a significant correlation with VO₂max in this study. Shooting is a complex skill that involves power, agility, balance, speed, flexibility, reaction time, and explosiveness (Hidayat, 2018). VO₂max, however, is an indicator of cardiorespiratory endurance and does not directly reflect explosive power or neuromuscular coordination. Lower-limb explosive strength—critical for effective shooting—is not typically associated with VO₂max (Ahsan & Ali, 2021). Given the physiological and biomechanical nature of the shooting skill, the absence of a significant relationship between shooting and VO₂max is understandable. Shooting performance is dominated by anaerobic and neuromuscular components, which are not primarily dependent on maximal aerobic capacity. This study is limited to correlational findings without experimental intervention. Further research using experimental design or involving female participants is recommended.

CONCLUSION

This study concludes that VO₂max capacity is significantly correlated with the basic football technical skills of passing, receiving, dribbling, and heading among first-year Sports Science students. In contrast, no significant relationship was found between VO₂max and shooting, which is more influenced by explosive power and neuromuscular factors. These findings underscore the importance of developing aerobic capacity as a foundational component in the training of basic football techniques for university students.

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ETHICAL ASPECTS AND CONFLICT OF INTEREST

The author hereby declares that this research is free from conflicts of interest with any party

AUTHOR CONTRIBUTIONS

Conception and design (AN, NFA), data collection (AN, AP, YSB), data analysis and interpretation (NFA, AN), manuscript draft (NFA, AN), critical review of the manuscript (AN, NFA, AP, YSB), final approval of the manuscript (AN, NFA, AP, YSB).

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