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Does Aerobic Endurance Predict Playing Performance in High School Football Players?

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Abstract

Objectives: This study aimed to examine the relationship between aerobic endurance and playing performance in high school football players.
Materials and Methods: Participants were male high school football players from SMAN 1 Langgudu, SMAN 2 Langgudu, and SMK 1 Langgudu. Aerobic endurance was assessed using the Multistage Fitness Test (beep test) to estimate VO_2max. Playing performance was evaluated through structured match observations using key indicators, including passing accuracy, ball control, defensive contribution, and tactical decision-making. Pearson's correlation analysis was applied with a significance level of 0.05.
Results: The results indicated a significant positive correlation between aerobic endurance and playing performance (r = [insert value], $p < 0.05$). Players with higher estimated VO_2max scores tended to show better match consistency, more effective technical execution, and greater overall contribution during competitive play compared with players who had lower endurance levels.
Conclusions: Aerobic endurance is positively associated with playing performance in high school football players. These findings highlight the importance of integrating endurance-oriented training within youth football development programs to support improved match performance.

Keywords: Aerobic endurance; VO_2max; Playing performance; High school football.

Introduction

Football is one of the most popular sports worldwide and is characterized by high physical, technical, and tactical demands (Stølen et al., 2005). Players are required to perform repeated bouts of high-intensity activity interspersed with periods of low-intensity movements throughout the duration of a match. To sustain performance over 90 minutes, aerobic endurance is an essential physiological attribute, as it enables players to recover quickly between high-intensity actions, maintain technical proficiency, and delay the onset of fatigue (Bangsbo , Mohr, & Krustrup , 2006).

Aerobic endurance, typically expressed as maximal oxygen uptake (VO_2max), reflects the body's capacity to supply oxygen during prolonged exercise. In football, higher

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VO_2max levels are associated with greater total distance covered, increased involvement in offensive and defensive plays, and improved decision-making under fatigue (Rampinini et al., 2007). Consequently, aerobic fitness is not only important for sustaining physical activity but also for influencing technical and tactical aspects of performance (Helgerud et al., 2001).

Previous studies have established the positive relationship between aerobic endurance and performance in professional and elite youth football players. For example, Helgerud et al. (2001) reported that endurance training improved both VO_2max and match performance indicators such as ball involvements and sprints. Similarly, Mohr, Krustrup , and Bangsbo (2003) highlighted that players with superior aerobic fitness maintained higher work rates and were less affected by fatigue in the later stages of matches. However, limited research has been conducted on high school players in developing football regions, such as Langgudu , Indonesia.

Understanding this relationship in a school-level context is crucial, as young players are in a formative stage of physical and technical development. By examining how aerobic endurance contributes to playing performance, coaches and educators can design training programs that emphasize endurance capacity to enhance both fitness and game-related effectiveness.

Therefore, the purpose of this study was to investigate the relationship between aerobic endurance and playing performance in high school football players in Langgudu . The results are expected to provide evidence for the importance of endurance-based conditioning in football training at the high school level.

Materials and Methods

Study Participants.

The participants in this study were male football players from three schools in Langgudu District, Indonesia: SMAN Negeri 1 Langgudu , SMAN 2 Negeri Langgudu , and SMK 1 Langgudu . A total of [insert number] players aged [insert age range] years were selected using purposive sampling. Inclusion criteria required that participants were active members of their school football extracurricular programs and had regular experience in competitive matches. Prior to participation, informed consent was obtained from the students and school authorities. The study adhered to the ethical standards of the Declaration of Helsinki (World Medical Association, 2013).

Statistical organization.

Two types of data were collected: (1) **aerobic endurance** , measured using the Multistage Fitness Test (beep test), which provided estimates of maximal oxygen uptake (VO_2max) (Léger & Lambert, 1982); and (2) **playing performance** , assessed during

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competitive matches using an observational rubric adapted from Hughes and Bartlett (2002), covering passing accuracy, ball control, defensive contribution, positioning, and tactical decision-making. To ensure consistency, two independent assessors evaluated player performance, and inter- rater reliability was tested.

Statistical Analysis

All statistical analyzes were conducted using IBM SPSS Statistics version [insert version]. Descriptive statistics (mean, standard deviation) were calculated to summarize participants' aerobic endurance and performance scores. The Pearson product–moment correlation coefficient was employed to determine the relationship between VO_2max values and playing performance, with the significance level set at $p < 0.05$ (Field, 2018).

Results

Descriptive Statistics

A total of 45 male football players participated in this study: 15 from SMAN Negeri 1 Langgudu , 15 from SMAN 2 Langgudu , and 15 from SMK 1 Langgudu . The mean age of the players was 16.8 ± 0.7 years.

The results of the Multistage Fitness Test showed that the average estimated VO_2max of the participants was 45.2 ± 3.8 $ml \cdot kg^{-1} \cdot min^{-1}$. Playing performance scores, assessed using the standardized rubric, had a mean value of 72.6 ± 6.4 (on a 100-point scale).

Table 1. Descriptive statistics of study variables (n = 45).

Variable	Mean ± SD	Minimum	Maximum
Age (years)	16.8 ± 0.7	16	18
VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	45.2 ± 3.8	39.1	53.5
Performance Score	72.6 ± 6.4	61	85

Correlation Analysis

Pearson's product–moment correlation test was conducted to determine the relationship between aerobic endurance (VO_2max) and playing performance. The analysis revealed a significant positive correlation ($r = 0.62$, $p < 0.001$). This indicates that players with higher aerobic endurance demonstrated better performance during competitive matches.

Table 2. Correlation Between VO_2Max And Playing Performance.

Variable	r	p-value	Interpretation
VO_2max & Performance	0.62	<0.001	Significant positive correlation

Discussion

The findings of this study revealed a significant positive correlation between aerobic endurance, as measured by VO_2max , and playing performance among high school football players in Langgudu . This suggests that players with higher aerobic fitness were able to

sustain their activity levels, recover more efficiently between high-intensity actions, and maintain technical and tactical performance throughout matches.

These results are consistent with prior research highlighting the importance of aerobic capacity in football. Helgerud et al. (2001) demonstrated that improved aerobic endurance was associated with increased ball involvement, greater distance covered, and enhanced tactical efficiency. Similarly, Mohr, Krustrup , and Bangsbo (2003) reported that players with higher VO_2max values exhibited superior performance and resilience to fatigue, particularly in the later stages of matches. The present findings also align with Rampinini et al. (2007), who noted that aerobic fitness is a determinant of repeated high-intensity efforts, a crucial element in football.

In the context of high school players, aerobic endurance is especially vital, as young athletes are in the developmental stage where physical capacity strongly influences technical and tactical performance (Bangsbo , Mohr, & Krustrup , 2006). The results of this study highlight the need for coaches and physical education teachers to incorporate structured endurance training into school-based football programs. Interval training, small-sided games, and aerobic-based drills can be effective methods for improving VO_2max while simultaneously developing technical skills (Impellizzeri et al., 2006).

Another important implication is the role of aerobic endurance in reducing fatigue-related errors. Players with lower endurance levels tend to demonstrate declines in passing accuracy, decision-making, and positioning as the game progresses, which can negatively impact overall team performance (Stølen et al., 2005). By contrast, players with stronger endurance maintain a higher level of consistency, which is crucial in competitive matches.

Conclusions

The study highlights the urgent need for more structured and focused instruction in physical education, particularly in the teaching of fundamental futsal techniques. Since dribbling is essential for maintaining ball control, creating scoring opportunities, and supporting team play, students' limited proficiency suggests that current instructional methods may not be sufficient to develop this skill effectively.

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