

## THE CORRELATION BETWEEN DIETARY PATTERNS, NUTRITIONAL STATUS, AND BODY COMPOSITION WITH THE PERFORMANCE OF FOOTBALL ATHLETES

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### Abstract

*Aerobic Capacity Measured by  $VO_2max$  as a Primary Indicator of Athlete Performance: Its Correlation with Body Composition and Dietary Patterns*  $VO_2max$ , an essential indicator of athletic performance, is influenced by factors such as body composition and dietary patterns. However, the relationship between these factors and  $VO_2max$  in soccer athletes remains unclear. This study aims to analyze the correlation between dietary patterns, nutritional status, body composition, and  $VO_2max$  in soccer athletes in Palembang. The research utilized an analytical survey with a cross-sectional design, involving 31 male athletes aged 15–22 years selected through purposive sampling. Data collection included anthropometric measurements, Bioelectrical Impedance Analysis (BIA), and the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Statistical analysis was conducted using the chi-square test to evaluate the relationship between independent variables and  $VO_2max$ . The results revealed significant correlations between muscle mass, carbohydrate intake, and protein intake with  $VO_2max$  ( $p < 0.05$ ). Athletes with higher muscle mass and adequate carbohydrate and protein intake were more likely to achieve better  $VO_2max$  performance. Conversely, variables such as body fat percentage, energy intake, and fat intake showed no significant correlation with  $VO_2max$  ( $p > 0.05$ ). These findings highlight the importance of optimizing muscle mass and maintaining a balanced diet, particularly adequate carbohydrate and protein intake, to enhance aerobic capacity in soccer athletes. Further research with larger sample sizes and controlled designs is recommended to validate these findings.

**Keywords:**  $VO_2max$ ; Body Composition; Dietary Patterns; Football Athletes; Performance.

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### INTRODUCTION

The organization of international sports championships is often regarded as a golden opportunity to enhance national prestige on the regional stage (Ardiyanto, 2018). For Indonesia, the performance of the national football team in events such

as the Asian Games is of significant importance. In the 1958 Asian Games held in Tokyo, Indonesia reached the semifinals, one of its best achievements, although it ultimately finished fourth after losing to India in the bronze medal match. During the 2018 Asian Games, the national team advanced to the round of 16 before being defeated by the United Arab Emirates in a penalty shootout.

The Indonesian National Football Team (Timnas) has recorded several notable achievements in recent decades but has also faced significant setbacks. For instance, in the 2022 AFF Cup, Indonesia failed to secure the championship after losing 2-0 to Thailand in the final, despite a strong performance leading up to that stage. Moreover, FIFA rankings published in October 2023 placed Indonesia at 135th, a decline from its 128th position in August 2022 (FIFA Official Website, 2023). However, in 2023, Timnas Indonesia reached the round of 16 in the AFC Asian Cup held in Qatar, advancing as one of the four best third-place teams during the group stage (KEMENPORA, 2024). Despite these achievements, Indonesia continues to face challenges in securing medals in international tournaments, reflecting a decline in its regional sports performance.

At the provincial level, football performance has been inconsistent. According to research by Gema et al. (2016), football activities in South Sumatra are relatively well-developed, characterized by numerous clubs, football schools for various age groups across districts and cities, experienced coaches, and adequate football fields. These activities are overseen by the Indonesian Football Association (PSSI), a member of FIFA. However, regional competitions organized by PSSI, such as Liga Arena (Bank Sumsel League), POPDA (Regional Student Sports Week), and Liga Pelajar Indonesia (LPI), have not significantly improved the performance of local players. This is evidenced by South Sumatra's minimal achievements in national events such as the National Sports Week (PON).

Sriwijaya FC, one of the province's prominent clubs, has faced challenges in maintaining its competitiveness at the national level. During the 2022 Indonesian Liga 1 competition, Sriwijaya FC was relegated to Liga 2 after finishing at the

bottom of the standings, a stark contrast to its previous status as one of the league's strongest teams (Almy & Aldapit, 2018). In early 2024, Sriwijaya FC topped the provisional standings in the Liga 2 relegation playoffs with 13 points, marking a recovery from its relegation in 2018. These fluctuations indicate that football achievements at the provincial level remain unpredictable.

According to Law of The Republic of Indonesia No. 3 of 2005 on the National Sports System, Chapter VI, Article 20, Paragraph (3), "sports achievements are carried out through planned, tiered, and sustainable coaching and development processes supported by sports science and technology" (National Education System Law, 2003). Football, as a performance sport, requires precise and well-planned development processes. In addition to performance, factors influencing achievement include proper coaching, mental and emotional readiness, team support, competitive experience, facilities and equipment, training time management, financial support, and health monitoring (Prabowo, 2023).

According to Silahlaim & Prianto (2022), in terms of performance, mastery of basic football techniques depends on the athletes' physical condition, which includes speed, strength, agility, accuracy, flexibility, coordination, balance, and endurance. Rusdiani et al. (2024) define agility as the ability to change the direction of the body quickly and precisely without losing balance. The combination of exercise and proper nutrition can optimize an athlete's physical characteristics. Athletes with anthropometric measurements and body composition suited to their sport tend to exhibit better athletic performance (Bulqini et al., 2022).

Previous studies on the relationship between anthropometry, dietary patterns, and body composition with athletic performance, particularly among football players, remain limited in Indonesia. Therefore, this research is essential to support football players' performance, enabling them to play efficiently, swiftly, and skillfully on the field. This study aims to fill the knowledge gap by focusing specifically on football athletes at Sriwijaya State Sports School, Palembang. By considering relevant aspects, this research seeks to provide deeper insights into how

dietary patterns, nutritional status, and body composition influence the performance of football athletes at this institution.

## METHOD

This study was conducted at the Sriwijaya State Sports School, Palembang, South Sumatra, employing a quantitative research design through an analytical observational method with a cross-sectional approach. The sample consisted of 31 football athletes selected using purposive sampling. Inclusion criteria included being registered as athletes, aged 15–22 years, willing to participate, actively training, and having at least two years of athletic experience. Exclusion criteria comprised conditions such as illness, injury, or withdrawal from the study.

Data collection was carried out directly through interviews, questionnaires, and direct measurements. Instruments used in the study included the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) to gather dietary pattern information, anthropometric measurements (body weight, height, body fat percentage, and muscle mass percentage), and performance evaluation (VO<sub>2</sub> Max). Data analysis included univariate analysis to describe the characteristics of research variables using descriptive statistics and bivariate analysis to examine the relationships between dietary patterns, nutritional status, body composition, and athletic performance using the Chi-Square test.

## RESULT AND DISCUSSION

**Tabel 1.** Descriptive Data of Independent and Dependent Variables

Indicator	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	31	15	17	15.42	0.620
Z-Score (BMI-for-Age)	31	-2.18	1.26	0.0468	0.76245
Body Fat Percentage	31	7.8	22.2	16.110	3.7718
Muscle Mass Percentage	31	36.9	49.6	43.800	3.1867
Energy Intake (%)	31	38.9	151.6	88.940	24.9174
Carbohydrate Intake (%)	31	71.07	178.90	96.2181	21.09823
Protein Intake(%)	31	70.20	240.96	104.0790	37.15332
Fat Intake (%)	31	70.30	143.91	101.6613	15.40536
VO <sub>2</sub> Max (ml/kg/menit)	31	40.13	64.05	53.5842	5.86693
Valid N (listwise)	31				

Table 1 shows that the athletes have an average age of 15.42 years, with an age range between 15 and 17 years, and an average Z-score of 0.0468. The athletes

have an average body fat percentage of 16.11% and an average muscle mass percentage of 43.80%. In terms of dietary intake, the athletes have an average energy intake of 88.94% of the recommended requirement, with carbohydrate intake at 96.22%, protein intake at 104.08%, and fat intake at 101.66% of the recommended levels. Additionally, the average VO<sub>2</sub> Max value for the athletes is 53.58 ml/kg/min, reflecting their aerobic capacity.

**Tabel 2.** Frequency Distribution of Independent and Dependent Variables

Indicator	Category	n	%
Z-Score (BMI-for-Age)	Good	27	87.1
	Poor	4	12.9
Body Fat Percentage	Good	16	51.6
	Poor	15	48.4
Muscle Mass Percentage	Good	16	51.6
	Poor	15	48.4
Energy Intake (%)	Good	16	51.6
	Poor	15	48.4
Carbohydrate Intake (%)	Good	22	71.0
	Poor	9	29.0
Protein Intake (%)	Good	20	64.5
	Poor	11	35.5
Fat Intake (%)	Good	21	67.7
	Poor	10	32.3
VO <sub>2</sub> Max (ml/kg/menit)	Good	21	67.7
	Poor	10	32.3
Total		31	100

Table 2 illustrates that the majority of athletes have a good nutritional status based on the Z-Score BMI/Age indicator, with 27 athletes (87.1%) falling into the good category, while 4 athletes (12.9%) are categorized as having poor nutritional status. Body fat percentage shows a more balanced distribution, with 16 athletes (51.6%) having an adequate body fat percentage, and 15 athletes (48.4%) categorized as having poor body fat percentage. The distribution of muscle mass follows a similar pattern to body fat percentage, where 16 athletes (51.6%) are classified as having good muscle mass, and 15 athletes (48.4%) have poor muscle mass.

Regarding energy intake, the results are also balanced, with 16 athletes (51.6%) having adequate energy intake, while 15 athletes (48.4%) did not meet their daily energy requirements. Carbohydrate intake shows a higher proportion in the

good category, with 22 athletes (71.0%) meeting their carbohydrate needs, compared to 9 athletes (29.0%) with insufficient intake. For protein intake, 20 athletes (64.5%) fall into the good category, while 11 athletes (35.5%) are classified as having poor protein intake. Fat intake reveals that 21 athletes (67.7%) have met their daily fat requirements, while 10 athletes (32.3%) fall into the poor category.

Additionally, the athletes' performance, as measured by VO<sub>2</sub>max, shows positive results, with 21 athletes (67.7%) in the good category and 10 athletes (32.3%) in the poor category. Overall, these findings suggest that the majority of athletes have good nutritional status and performance, although there is still a significant proportion in the poor category for some variables such as body fat, muscle mass, and energy intake.

**Tabel 3.** The Correlation Between Dietary Patterns, Nutritional Status, and Body Composition with The Performance Of Football Athletes at Sriwijaya Sports School Palembang

Indicator	Category	Performance (VO <sub>2</sub> max)				Total		p-value	PR (CI 95%)
		Good		Poor		n	%		
		n	%	N	%				
Z-Score (BMI-for-Age)	Good	20	74.1	7	25.9	27	87.1	0.087	2.963
	Poor	1	25.0	3	75.0	4	12.9		
Body Fat Percentage	Good	11	68.8	5	31.3	16	51.6	1.000	1.031
	Poor	10	66.7	5	33.3	15	48.4		
Muscle Mass Percentage	Good	16	100	0	0.0	16	51.6	0.000	3.000
	Poor	5	33.3	10	66.7	15	48.4		
Energy Intake (%)	Good	11	68.8	5	31.3	16	51.6	1.000	1.031
	Poor	10	66.7	5	33.3	15	48.4		
Carbohydrate Intake (%)	Good	19	86.4	3	13.6	22	71.0	0.001	3.886
	Poor	2	22.2	7	77.8	9	29.0		
Protein Intake (%)	Good	17	85.0	3	15.0	20	64.5	0.013	2.338

	Poor	4	36.4	7	63.6	11	35.5		
Fat Intake (%)	Good	15	71.4	6	28.6	21	67.7	0.685	1.190
	Poor	6	60.0	4	40.0	10	32.3		

Table 3 demonstrates that the majority of athletes exhibit good nutritional status based on the BMI-for-age indicator, with 74.1% also showing good VO<sub>2</sub>max performance. Meanwhile, athletes with a poor Z-Score primarily fall within the category of poor VO<sub>2</sub>max (75.0%). The percentage of body fat does not indicate a significant difference between the good and poor categories in relation to VO<sub>2</sub>max, as athletes in both categories exhibit nearly balanced proportions. Conversely, regarding muscle mass percentage, all athletes with good muscle mass (100%) have good VO<sub>2</sub>max, whereas only 33.3% of athletes with poor muscle mass possess good VO<sub>2</sub>max.

Regarding energy intake, the results show a similar distribution between the good (68.8%) and poor (66.7%) categories in relation to VO<sub>2</sub>max. However, carbohydrate intake reveals a more pronounced difference, with 86.4% of athletes in the good carbohydrate intake category having good VO<sub>2</sub>max, compared to only 22.2% of athletes in the poor carbohydrate intake category. A similar result is observed with protein intake, where 85.0% of athletes in the good category exhibit good VO<sub>2</sub>max, compared to 36.4% in the poor category. For fat intake, athletes in the good category (71.4%) exhibit a slightly higher proportion of good VO<sub>2</sub>max compared to those in the poor category (60.0%).

## DISCUSSION

The analysis using the Chi-Square test shows that the BMI-for-age Z-Score has an influence on VO<sub>2</sub>max performance, where athletes with good nutritional status tend to perform better. Although this relationship is not statistically significant ( $p=0.087$ ), the prevalence ratio (PR = 2.963) suggests a tendency for athletes with good nutritional status to have a higher likelihood of achieving good VO<sub>2</sub>max. This finding aligns with previous research by Bimantara et al. (2023), which demonstrated that nutritional status and muscle mass have a significant

relationship with aerobic performance in athletes. High muscle mass plays an essential role in the efficiency of oxygen use during physical activity, leading to higher  $VO_{2max}$  values. However, this study contrasts with research by Basri et al. (2023), which states that nutritional status significantly affects athletic performance on the field, including in futsal, an anaerobic sport. Nutrient intake, such as carbohydrates and protein, is considered important to support endurance, muscle strength, and player concentration.

On the other hand, body fat percentage does not show a significant relationship ( $p=1.000$ ) with  $VO_{2max}$  performance. This is in accordance with research by Komala et al. (2024), which also showed that the p-value for this relationship was not significant ( $p=0.284$ ). This reinforces the idea that body fat percentage does not always directly correlate with  $VO_{2max}$  performance in athletes. Conversely, muscle mass percentage has a highly significant relationship ( $p=0.000$ ), where athletes with good muscle mass exhibit far superior  $VO_{2max}$  performance. This emphasizes the role of muscle mass in improving aerobic capacity through its contribution to the efficiency of oxygen use during physical activity. A study by Latifah et al. (2019) also found a significant positive relationship between muscle mass percentage and  $VO_{2max}$  values ( $r=0.592$ ,  $p<0.001$ ). These results suggest that the higher the muscle mass percentage, the higher the athlete's  $VO_{2max}$  values. This study highlights the critical role of muscle mass in enhancing athletes' aerobic capacity.

In terms of dietary variables, energy intake and fat intake did not show a significant relationship with  $VO_{2max}$  performance ( $p=1.000$ ) and ( $p=0.685$ ), indicating that these variables may not be primary factors influencing aerobic performance in the athletes in this study. A study by Kurnia et al. (2020) also found that high body fat does not always correlate with reduced performance, as individual metabolic factors can affect outcomes. In contrast, carbohydrate and protein intake showed a significant relationship ( $p=0.001$  and  $p=0.013$ ). Athletes with good carbohydrate intake have nearly four times the likelihood of achieving



good VO<sub>2</sub>max (PR = 3.886), which supports the role of carbohydrates as the primary energy source in aerobic activity. Adequate carbohydrate intake supports the energy needs of athletes during training and competitions, as noted by El Ghina et al. (2023). Carbohydrates are the main energy source in aerobic sports, while protein helps in muscle repair and recovery, explaining the significant relationship between protein intake and VO<sub>2</sub>max performance. Similarly, Basri et al. (2023) emphasized that sufficient carbohydrate consumption before training or competitions is crucial to support concentration and endurance.

These results underscore the importance of maintaining good nutritional status, optimal body composition, and a sufficient diet, especially in carbohydrates and protein, to support athletic performance. Further research with a larger sample size and better control of external variables is needed to validate these findings.

## CONCLUSION

The results of the study indicate that muscle mass, carbohydrate intake, and protein intake are significantly associated with the aerobic performance of football athletes, as measured by VO<sub>2</sub>max. Athletes with good muscle mass have a much higher likelihood of achieving a good VO<sub>2</sub>max compared to those with poor muscle mass. Additionally, adequate carbohydrate and protein intake play a crucial role in supporting the athletes' aerobic capacity. In contrast, the variables of BMI-for-age Z-Score, body fat percentage, energy intake, and fat intake did not show significant relationships with VO<sub>2</sub>max. These findings underscore the importance of maintaining optimal muscle mass and a balanced diet to support athletic performance. The researchers suggest that further studies with a more controlled design are necessary to validate these findings.

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