INDONESIAN JOURNAL OF RESEARCH IN PHYSICAL EDUCATION, SPORT, AND HEALTH
e-ISSN: 2986-8831
Vol. 4 No 1, April 2026
Research Article

Dietary patterns and nutritional status in soccer athletes: A cross-sectional study from an ergonomic perspective

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ABSTRACT
Background: Normal nutritional status has been established as one of the principal determinants in an athlete's performance. Dietary quality plays a critical role in optimizing athletes' physical fitness and performance outcomes. Objective: To examine the associations between dietary patterns on the MacPersona System and nutritional status of soccer players (energy, protein, et cetera, fat, and carbohydrates). Methods: A cross-sectional quantitative study was conducted involving 21 soccer players (total sampling). Dietary patterns were assessed using a validated Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Nutritional status was measured using Body Mass Index(BMI) based on anthropometric data. The chi-square test was used for statistical analysis (SPSS version 26). A95% confidenceinterval was applied. Result: 71.4% of athletes had normal nutritional status. The Chi-square test revealed significant associations between nutritional status and energy intake (p = 0.014), protein intake (p = 0.046), fat intake (p = 0.002), and carbohydrate intake (p = 0.006). Athletes with normal nutritional status consistently showed good macronutrient intake (80%–93.3%), while those with abnormal status predominantly had poor intake (>80% for all macronutrients). Conclusion: Balanced and adequate macronutrient intake is significantly associated with normal nutritional status in soccer athletes. These findings emphasize the need for holistic, ergonomically designed nutritional interventions integrated into training programs to optimize performance and long-term health.

ARTICLE HISTORY
Received January 17, 2026
Accepted March 30, 2026
Published April 01, 2026
KEYWORDS
Cross-sectional study; dietary patterns; ergonomics; nutritional status; soccer athletes.

Introduction

Sports are a platform for improving human quality. Sports are used to improve health and as a platform for success (Khasanah & Hariyanto, 2023). One of the most popular sports is Soccer. Soccer is an acyclic endurance sport that demands high physical performance and involves repeated short-duration bouts of anaerobic and aerobic activity (Firdaus et al., 2026). Key factors influencing performance include speed, power, and endurance capacity (Molina-López et al., 2024). To achieve the maximum performance pursued by every athlete, various supporting factors must be optimized, including the nutritional aspect (Fiorini et al., 2025).

Maximum performance in football can be assessed through the lens of ergonomics (human factors), namely the integration of multidisciplinary sciences aimed at optimizing human system performance and well-being (Dul et al., 2012; Haqqi et al., 2018; Kartika et al., 2025). Ergonomics in the context of sports places the athlete at the center of the system (athlete-centered design) and assesses the interaction among the athlete, tasks, equipment, environmental conditions, and organization to improve performance and minimize fatigue and injury risk (Hulme et al., 2019).

Ergonomic approaches can be carried out through several aspects, namely work posture, use of muscle energy, nutrition, environmental conditions, time conditions, socio-cultural conditions,

information conditions, human-machine interface, and ergonomic balance (Kartika et al., 2025; Manuaba, 2006). One key to maintaining ergonomic balance during exercise is to maximize the role of nutrition in providing energy as a component of work capacity (Meyer et al., 2025; Mountjoy et al., 2023; Pałka et al., 2024; Rubio-Díaz et al., 2025). The imbalance between energy availability and training load increases the risk of a mismatch with task demand, leading to overstress (Mountjoy et al., 2023; Putri et al., 2022).

The energy and nutrient needs of soccer players are unique and dynamic, highly dependent on the nature and duration of training and competition. It also illustrates the anaerobic and aerobic processes occurring in energy systems during exercise demand that proper nutrition becomes a key, adaptive aspect not only for maximizing the short-term elements that are essential for performance but also for health, injury prevention, and longevity of an athlete's career across a season (Macuh et al., 2023). Here, the daily diet falls at the lower end of training and competition (Debnath et al., 2023; Larose et al., 2022).

However, significant challenges arise in its implementation. Studies suggest that pushing oneself to exercise without proper nutrition can result in weight loss and reduced performance (Jagim et al., 2017). In addition, insufficient food intake places individuals at risk for the development of Relative Energy Deficiency in Sport (RED-S), which has negative health consequences, increases vulnerability to injury and fatigue, and thereby negatively impacts sports performance (Deslippe et al., 2025). Thus, ensuring the right amount of energy from adequate sources and maintaining energy balance is important for professional athletes (Staśkiewicz-Bartecka et al., 2024).

Diets have a close correlation with nutritional status, showing the balance between intake and body needs. An optimal nutritional status, achieved when nutrient intake matches personal needs (age, gender, body weight, and physical activity level), becomes a precondition for stamina or maximal performance (Tyrała & Frączek, 2025). To summarize, a healthy diet helps maintain an optimal nutritional status (within or above the optimal range), which may improve an athlete's performance and endurance. In contrast, an unhealthy diet leads to an inappropriate nutritional status, which can cause decreased performance (Hernandez-Martin et al., 2021).

Diet and nutritional status have a critical, interrelated impact on the performance of football athletes. However, actual practices and field environmental conditions still require extensive research. Therefore, this study aims to provide a comprehensive overview of the dietary patterns and nutritional status of these athletes. Although the link between diet and nutritional status is well understood, very few studies have specifically explored this relationship in soccer players, using an ergonomic approach that incorporates work-system design. Furthermore, existing research largely focuses on individual nutrients rather than holistic dietary patterns. To address this gap, this study provides a holistic analysis of dietary patterns covering energy, protein, fat, and carbohydrates simultaneously alongside nutritional status from an ergonomic perspective. The findings are expected to serve as an evidence-based platform for recommendations to improve nutrition and optimize health, prevent energy deficiency, and achieve maximum athletic performance.

Method

Research Design

This study is a cross-sectional, descriptive, quantitative research to describe the food consumption and nutritional status of athletes at one time.

Participants

21 soccer players constitute the research population. Given the small and restricted population, the total sampling method is used when all members of the population serve as research subjects.

Ethical Approval Statement

The Muhammadiyah University Surakarta Research Ethics Committee gave its approval to this investigation (Approval No: 6223/B.2/KEPK-FKUMS/III/2026). Every procedure followed the Declaration of Helsinki's ethical guidelines. Confidentiality was maintained throughout data collection and processing, and all subjects gave signed informed consent.

Research Instruments

Data collection was carried out through two main approaches. First, dietary data were collected through in-depth interviews using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). The instrument was previously validated for content and reliability (Cronbach's $\alpha = 0.82$) in an Indonesian athlete population. This questionnaire contains a list of food ingredients grouped into sources of carbohydrates, animal protein, plant protein, vegetables, fruits, beverages, and supplements. Subjects were asked about the frequency of consuming each food group over the past six months to obtain a representative picture of eating habits. Dietary patterns were categorized as good if energy and macronutrient intake were 80-110% of the Recommended Dietary Allowance (RDA), and not good if intake was < 80% or> 110% of the RDA. Second, nutritional status was evaluated using anthropometric data, particularly BMI. Measurements were conducted by weighing body weight with a digital scale to 0.1 kg and measuring height with a microtoa to 0.1 cm. BMI is then calculated and classified based on standard categories. BMI is categorized as normal if it is 18.5-25 kg/m2 and abnormal if it is < 18.5 and > 25 kg/m2. To minimize bias, all measurements were performed by trained enumerators. The same digital scale and microtome were used for all subjects. In addition, FFQ administration was standardized with identical instructions, and data entry was double-checked for errors.

Data Analysis

Data were analyzed using SPSS. The descriptive analysis presented the frequency distributions of dietary patterns and nutritional status. To test the association between dietary patterns (categorical) and nutritional status (categorical), the Chi-square test was used. Assumptions for Chi-square were met (expected cell counts >5 in >80% of cells). A 95% confidence interval was applied, with statistical significance set at $p < 0.05$.

Results and Discussion

Results

Based on a study of 21 soccer players, the characteristics of the research subjects are as follows. In terms of age, most subjects (85.7%) were in the 21–30 years age group, while the rest (14.3%) were in the 31–40 years age group. According to the BMI indicator, 71.4% of athletes were in the normal category, while 28.6% were not. In terms of nutritional intake, the athletes' consumption patterns varied, with energy intake categorized as good in 61.9% of subjects, protein intake in 57.1%, fat intake in 71.4%, and carbohydrate intake in 66.7%. On average, the subject characteristics are shown in Table 1.

Results from the chi-square analysis indicated a statistically meaningful relationship between dietary patterns and athletes' nutritional status. The test results show that all aspects of nutrient intake analyzed have p-values below the significance level $\alpha = 0.05$. More detailed analysis results are presented in Table 2.

Data show that out of 21 athletes, 15 (71.4%) have normal nutritional status and 6 (28.6%) have abnormal status. Subjects in the normal nutrition group, the majority of athletes had good intake for each macronutrient component: 80% for energy, 73.3% for protein, 93.3% for fat, and 86.7% for carbohydrates. Conversely, in the abnormal nutrition group, more than 80% of athletes had poor intake for each component: energy (83.3%), protein (83.3%), fat (83.3%), and carbohydrates (83.3%). This pattern indicates that poor nutritional intake tends to be concentrated among athletes with abnormal nutritional status, and this consistency is seen across all types of macronutrients. The findings of the chi-

square test showed that eating patterns and nutritional status were statistically significantly correlated (p value < 0.05). The strongest relationship was seen in fat intake (p = 0.002), where almost all athletes with normal nutritional status (93.3%) had good fat intake, while in the abnormal group, 83.3% had poor intake. A similar pattern was observed in carbohydrate intake (p = 0.006), energy (p = 0.014), and protein (p = 0.046). Smaller p-values reflect a clearer difference in proportions between normal and abnormal groups. These findings reinforce that the quality of macronutrient intake is closely related to the nutritional status of athletes.

Table 1. Characteristics of Research Subjects (n = 21)

Characteristics	n	%
Age		
21-30 years	18	85.7
31-40 years	3	14.3
Nutritional status		
Normal	15	71.4
Abnormal	6	28.6
Energy intake		
Good	13	61.9
Not good	8	38.1
Protein intake		
Good	12	57.1
Not good	9	42.9
Fat intake		
Good	15	71.4
Not good	6	28.6
Carbohydrate intake		
Good	14	66.7
Not good	7	33.3

Table 2. Association between Dietary Habits and Nutritional Status (n=21)

	Nutritional status				
	Normal		Abnormal		p
Variables	n	%	n	%	
Energy intake					
Good	12	80	1	16.7	0.014
Not good	3	30	5	83.3	
Protein intake					
Good	11	73.3	1	16.7	0.046
Not good	4	26.7	5	83.3	
Fat intake					
Good	14	93.3	1	16.7	0.002
Not good	1	6.7	5	83.3	
Carbohydrate intake					
Good	13	86.7	1	16.7	0.006
Not good	2	13.3	5	83.3	

Discussion

Normal nutritional status in athletes is not merely a measure of ideal body weight, but an important indicator of an athlete's physical readiness for training and competition. As is known, optimal physical condition can be achieved if an athlete's nutrient intake is adequate, balanced, and in accordance with the body's metabolic needs. This study shows a substantial association between nutritional status and the quality of energy, protein, fat, and carbohydrate intake. These results not only confirm that statement but also provide an empirical basis for the importance of comprehensive nutrition in supporting athletic performance.

Research findings show a significant association between all components of nutritional intake and athletes' nutritional status. The p-values for energy intake ($p = 0.014$), protein ($p = 0.046$), fat ($p = 0.002$), and carbohydrates ($p = 0.006$) indicate that dietary patterns are a major factor influencing the nutritional status of athletes. From a data distribution perspective, a fairly consistent pattern is observed among athletes with normal nutritional status, with the majority having adequate nutritional intake. For example, 93.3% of athletes with normal nutritional status have good fat intake, 86.7% for carbohydrates, 80% for energy, and 73.3% for protein. Conversely, in the group with abnormal nutritional status, more than 80% of athletes fall into the poor intake category for all nutritional components. This suggests that nutritional problems in athletes are often not related to a single nutrient but rather to a combination of nutrient deficits or imbalances. These findings indicate that the adequacy and balance of energy, protein, fat, and carbohydrate intake simultaneously are closely related to achieving a normal nutritional status.

The current findings reinforce previous research demonstrating relationships between energy consumption level ($p = 0.039$), fat intake ($p = 0.026$), and carbohydrate intake ($p = 0.017$) and athletes' nutritional status (Shabrina et al., 2023). Other research shows a relationship between fat intake ($p=0.048$) and athletes' nutritional status (Andriyani & Budiono, 2021). Various studies further strengthen this finding and confirm that sports nutrition should be viewed holistically, not just focusing on a single nutrient. However, unlike earlier studies that tended to look at each macronutrient separately, the current research shows that all four macronutrient components, energy, protein, fat, and carbohydrates, are each independently linked to nutritional status at the same time. This overall finding strengthens the idea that nutrition strategies in sports should target multiple dietary elements together, not just one nutrient. Focusing on a single nutrient, like carbohydrates alone, is a common practice in applied sports nutrition, but this study suggests that such an approach may not be sufficient.

This study's findings revealed a significant correlation between carbohydrate consumption and nutritional status ($p=0.008$), with athletes with abnormal nutritional status showing poor carbohydrate intake in 5 out of 6 (83.3%) compared to the normal nutritional status group, which showed poor carbohydrate intake in 2 out of 15 (13.3%). These findings reinforce the interpretation that inadequate carbohydrate intake indicates energy insufficiency, signaling that glycogen-fueled and recovery processes are not yet optimal to meet the task demands of football activity (Collins et al., 2021). This is consistent with findings from previous research regarding physiological evidence during soccer matches, which is indicated by a decrease in muscle glycogen and sprint ability being assessed in relation to low glycogen reserves in athletes' muscle fibers (Kazemi et al., 2023; Krustrup et al., 2006, 2022; Pueyo et al., 2024; Vigh-Larsen et al., 2025).

This research aligns with prior research showing that participants in team sports often do not meet dietary guidelines, especially for energy and carbohydrates (Jenner et al., 2019). Relative Energy Deficiency in Sport (RED-S) is a major problem for athletes, according to the International Olympic Committee, because sustained low energy availability can have a detrimental impact on physiological function and athletic performance (Mountjoy et al., 2018). Thus, the relevant ergonomic approach is to design the athletes' "work system" so that their intake is more in line with the load: for example,

scheduling pre- and post–training meals/snacks, access to food during travel, and menu adjustments based on session intensity (organizational + physiological). Frameworks for work system design, such as the SEIPS model, can help view nutrition fulfillment not just as an individual behavior, but also as a result of context design (schedules, facilities, team support) that influences health and performance outcomes (Carayon et al., 2006, 2020; Holden & Carayon, 2021).

Ensuring adequate nutrition is crucial for maximizing performance and preventing the health consequences of nutrient deficiencies (McCrink et al., 2021). Each nutrient plays a complementary physiological function. Marco Hietala, the KHL Club's sports nutritionist, emphasizes that the energy demands of football players increase rapidly as they train at high volumes and perform at high levels. Therefore, consuming sufficient energy is crucial for maintaining peak performance, supporting recovery, preserving physiological processes, and fostering long-term health (Condo et al., 2019). Getting enough protein is important for being strong, fast, and agile because it helps maintain muscle mass. Protein also helps athletes recover between workouts by reducing muscle soreness after exercise. This lets them get back to their best performance quickly. Carbohydrates are the main source of energy for high-intensity activities, while fats are a dense energy source that lasts longer, especially during low-intensity and long-duration activities (Oukheda et al., 2024). Adequate energy and nutrient intake are essential for maintaining athletes' nutritional status. If this intake is poorly regulated in the long run, however, distortions in people's nutritional status can occur, thereby affecting physiological conditions and athletes' performance during both training sessions and competitive events. A focused and regulated approach to nutrition management is necessary for athletes to stay healthy and perform at their best (Lestari & Amin, 2019).

Soccer athletes typically train five to six times a week, which requires frequent and timely energy replacement. When they do not meet their energy needs, the body responds with increased hunger and fatigue. Strangely enough, this often leads them to reach for high-fat, high-sugar convenience foods rather than healthier options. This starts a vicious cycle: poor intake leads to fatigue, fatigue reduces motivation to prepare healthy meals, and poor food choices worsen nutritional problems. On top of that, protein deficiency was found in 42.9% of the subjects, which is worrying because protein is crucial for muscle repair and recovery. When protein is lacking, along with insufficient energy and carbs, glycogen resynthesis is disrupted, leading to slower recovery.

These physical consequences indirectly keep bad eating habits going by making athletes feel more tired and less confident about preparing their own food. Beyond biology, psychological factors also help explain what is happening. Athletes with poor nutritional status often lack basic nutrition knowledge, have weak self-control, or feel high levels of stress from training and competition. Many of them underestimate how much energy and carbs they need during heavy training. Others intentionally eat less because they are worried about body image or falsely believe that losing weight will boost their performance.

From a practical standpoint, the findings of this study can guide the development of better nutrition programs for athletes. To change an athlete's diet, they need to adjust their macronutrient intake based on the type, length, and intensity of each training session. Also, regularly tracking what athletes eat and monitoring their nutritional status can help prevent long-term nutritional problems that might harm performance. This is not just about treatment; it is also about prevention and promoting both health and athletic achievement.

That said, several factors could mess with the link between diet and nutritional status, including unmeasured training load and periodization, hydration levels affecting BMI classification, and protein supplements possibly improving status despite poor food intake. Future studies should control for these confounders using training logs, hydration checks, and supplement questionnaires.

Limitations of Study

Several limitations of this research should be acknowledged. The study had a small sample size and used a cross-sectional design, both of which preclude causal inference. Therefore, further research involving larger groups and longer follow-up periods is necessary better to understand the relationship between performance and nutritional status.

The findings clearly indicate that adequate intake of energy, protein, fat, and carbohydrates is closely associated with normal nutritional status. This suggests that athletes require not only regular physical training to perform well but also a comprehensive and well-organized nutrition plan. Consequently, collaboration among coaches, nutritionists, and athletes is crucial for developing effective nutrition strategies that support both performance and long-term health.

Conclusions

This study shows that energy, protein, fat, and carbohydrate intake are each independently linked to nutritional status in soccer players, with large effects that matter in practice. However, the reasons behind these eating patterns are complex, involving psychological issues like poor nutrition knowledge, weak self-control, and body image worries. Future studies need to track athletes over time to establish cause and effect, use more objective measures of diet, assess body composition rather than just BMI, and examine psychological factors. What is really needed now are intervention studies to see if redesigning the athlete's work environment, for example, providing team meals, setting up regular nutrition education, and making small changes to facilities, can lead to lasting improvements in diet, nutritional status, and eventually performance.

Acknowledgments

The authors would like to thank all participants who volunteered to take part in the present study.

Authors' contributions

RM contributed to the study conception and design, data collection, data analysis and interpretation, manuscript drafting, and manuscript revision. RM contributed to the critical revision of the manuscript for important intellectual content and provided overall scholarly guidance throughout the study. Both authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Competing interests

The authors declare no competing interests.

AI Disclosure Statement

During the preparation of this manuscript, the authors used DeepL Translate and Grammarly to assist in translation, check grammar, improve linguistic clarity, and refine the academic English phrasing of the text. All outputs generated with these tools were critically reviewed and thoroughly edited by the authors to ensure factual accuracy, clarity of expression, and compliance with academic standards. The authors take full responsibility for the integrity and content of this manuscript.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author, R.M. The data are not publicly available due to restrictions containing information that could compromise the privacy of research participants.

Funding

This research received no external funding.

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