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The Role of Nutritional Status in Improving Physical Endurance in Athletes: A Literature Review

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Abstract

In the context of modern sports science, understanding the profound impact of nutritional status on athletic performance has become increasingly crucial. This study aims to review the existing literature regarding the role of nutritional status in increasing the physical endurance of athletes. Optimal nutritional status plays an important role in supporting athletic performance through mechanisms involving nutrient intake, energy metabolism, and post-workout recovery. Various studies show that malnutrition can result in decreased physical ability, increased risk of injury, and slow recovery. Conversely, adequate nutrition can improve muscle strength, cardiovascular endurance, and metabolic efficiency. This article summarizes the key findings from various studies that highlight the importance of macro and micro nutrition, hydration, and proper diet planning in supporting athletes' physical endurance. The conclusion of this review underscores that nutritional strategies tailored to the individual needs of athletes are essential to achieve optimal performance and minimize the risk of injury. More research is needed to explore the complex interactions between various nutritional factors and physical fitness components.

Keywords: Nutritional Status, Physical Endurance, Athletes, Nutrition, Recovery, Hydration.

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1. INTRODUCTION

Optimal athletic performance is the result of a complex interaction between physical training, mental strategy, and proper nutritional support (Carmichael et al., 2024; Fitzgerald et al., 2023; Zdzieblik et al., 2024). Among these factors, nutritional status plays a crucial role in supporting physical endurance and overall performance of athletes. Good nutrition ensures that athletes' bodies have enough energy, essential nutrients for muscle repair and growth, and an optimally functioning immune system. In the world of sports, understanding the role of nutritional status is becoming increasingly important as more and more scientific evidence shows a close relationship between nutritional intake and athletic performance (van der Horst et al., 2023; Wang & Zong, 2024).

Various studies have shown that good nutrition can improve athletic performance through several mechanisms. The right nutrition can help increase energy capacity and physical endurance. Carbohydrates, proteins, and fats consumed in the right amounts and proportions can provide the energy source needed for intense and prolonged physical activity (Baskerville et al., 2024; Love et al., 2024; Reitzner et al., 2024). Adequate nutrition supports the recovery process after training or competition. Adequate nutrition can speed up the repair of damaged muscle tissue, reduce fatigue, and prepare the body for the next workout session (Edwards, 2024a; Verhey & Poon, 2023). Understanding the role of nutritional status in improving physical endurance in athletes is essential because proper nutrition can improve performance, speed recovery, and reduce the risk of injury, while previous research may not fully uncover the complexity of the interactions between nutrients and physical fitness components.

According to Kussman and Choo (2024); Toro-Román et al. (2023) On the other hand, malnutrition can negatively impact athletic performance. Deficiencies in calories, protein, vitamins, and minerals can lead to decreased energy, loss of muscle mass, and an increased risk of injury. Athletes who don't get enough nutrition are also more susceptible to diseases and infections because their immune systems aren't functioning optimally (Funnell et al., 2023; Sagayama et al., 2023). Therefore, it is important for athletes to get a nutritional intake that suits their individual needs, which can vary based on the type of exercise, the intensity of the exercise, and the physical condition.

The importance of nutritional status in supporting athletic performance is also recognized in various sports nutrition guidelines (Dolan et al., 2023; Mackay & Getgood, 2024; Wei et al., 2024). International and national sports organizations have issued guidelines that emphasize the importance of balanced and timely nutritional intake for athletes. It includes advice on the type and amount of food to consume before, during, and after training or competition. In addition, adequate hydration is also emphasized as an important component of an athlete's nutrition strategy, as dehydration can significantly reduce physical and mental performance (Almousa & Bandín van Loon, 2024; Amoruso et al., 2024; Gerber et al., 2023).

Studies on the role of nutritional status in improving athletes' physical endurance have grown rapidly in recent decades. According to Villegas-Serna, Wilson, and Curtis (2024); West et al. (2023) Early research mainly focused on the relationship between calorie intake and physical performance. However, as nutrition science and exercise physiology evolve, research has expanded its scope to include the specific roles of macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals). Recent studies have also begun to explore the effects of the timing of nutrient intake, the type of nutrient, and the nutritional needs of individuals based on the type of exercise and the physical condition of athletes (Atadja et al., 2024; Azadi et al., 2024). This includes studies on periodized diets and appropriate hydration strategies to optimize athlete performance and recovery.

Additionally, advances in health and fitness monitoring technology have provided new insights into how nutrition affects athletes' performance in real-time. The use of wearable devices, nutrient tracking apps, and biomarker analysis allows for more accurate monitoring

and personalized nutrition strategies. These studies show that a personalized nutrition approach can provide greater benefits compared to a one-size-fits-all approach. This includes adjusting nutrient intake based on daily variability in energy needs, hydration levels, and the body's response to exercise.

Furthermore, studies of nutritional interventions involving dietary supplements such as whey protein, omega-3 fatty acids, and antioxidants have shown potential in improving physical endurance and muscle recovery (Reardon, Benoy, and Hitchcock 2023; Weijer et al. 2024). This study shows that certain supplements can help reduce inflammation, speed recovery, and improve energy use efficiency during physical activity. However, despite the many advances, there is still a need for more research that can identify the optimal combination of nutrition, intake timing, and dietary personalization for different types of exercise and physical conditions. As such, the field continues to evolve rapidly, offering great potential for improved athletic performance through a more targeted and evidence-based approach to nutrition.

The novelty of this study lies in a holistic approach that integrates the latest findings on macronutrients, micronutrients, intake timing, and dietary personalization with health monitoring technology to optimize athletes' physical endurance. The study contributed by providing in-depth insights into how the right combination of nutrition and personalized hydration strategies can improve athletic performance and post-workout recovery. By summarizing a range of intervention studies and the latest technologies, the study offers practical, evidence-based guidance that coaches, nutritionists, and athletes can use to design more effective and efficient nutrition strategies, tailored to the specific needs of each athlete.

This literature review aims to further explore the relationship between nutritional status and physical endurance of athletes. By summarizing the key findings from various studies, this article aims to provide insight into the importance of proper diet planning in the context of exercise. Understanding how nutrition affects athlete performance can assist coaches, nutritionists, and athletes in designing appropriate dietary strategies to achieve peak performance and minimize the risk of injury. Further research is needed to explore the complex interactions between various nutritional factors and physical fitness components, as well as to develop more specific and detailed nutritional recommendations for different types of sports and groups of athletes.

A literature review was conducted to identify, summarize, and evaluate findings in previous studies regarding the relationship between nutritional status and physical endurance in athletes, including whether there is consensus in the literature on aspects of nutrition that affect athletic performance.

2. RESEARCH METHOD

This study uses a qualitative descriptive research model that is a literature study that uses various literature reviews in strengthening research analysis. This research begins by collecting several literatures, then reviewing several important terms in the research, then collecting relevant research literature, then conducting analysis based on all the literature that has been obtained by compiling a discussion, then compiling conclusions based on the results that have been analyzed and making suggestions based on the conclusions obtained.

The data used in this study is using secondary data. According to Sugiyono, (2015) states that secondary data is data that is taken indirectly that can provide information to data collectors. The data sources obtained are in the form of original scientific reports derived from published scientific articles and journals that have been accredited and indexed, both print and non-print which are interrelated in the model of implementing blended learning in physical education and sports.

The data collection method used in this study is the documentation method. The documentation method is a method of collecting data by digging and searching for data from the literature related to what is in the formulation of the problem. The data that has been obtained from various literature is then collected as a single document that will be used in answering the problems that have been formulated.

The article search techniques in this study are through web access to Mendeley, Google Scholar, and Scinece Direct as well as on access to other journals with the words nutritional status, physical endurance, athletes, nutrition, athletic performance. Articles or journals that meet the criteria are then taken for further analysis and a summary of the journal including the name of the researcher, the year of publication of the journal, the design of the study, the purpose of the research, samples, instruments, and a summary of the results or findings. The summary of the research journal is included in a table sorted according to the alphabet and year of publication of the journal and in accordance with the format mentioned above. This review literature uses literature that can be accessed in fulltext in pdf format and scholarly (peer reviewed Journal). To further clarify the abstrack and full test, the journal is read and observed. The journal summary is analyzed on the content contained in the research objectives and research results/findings. Analysis method used to analyze journal content.

3. RESULTS AND DISCUSSION

This review literature review was conducted to determine the role of nutritional status in increasing the physical endurance of athletes. The collected literature was analyzed with a critical appraisal table to answer the measurement objectives compared to the results of simple measurements. There are as many as 5 literature that discuss the role of nutritional status in increasing athletes' physical endurance, all of these journals are international journals that are searched on the google scholar portal, Mendeley, and Science direct.com by typing the keywords "nutritional status, physical endurance, athletes, nutrition, athletic performance" which is then analyzed using critical apparsial analysis to analyze from the core of the journal, as well as the results or findings from these journals. The following is a table of critical apparsial analysis from 5 journals:

Researchers	Article Title	Research Results
(Carvalho Souza et al., 2023)	Evaluation of the relationship between nutritional status, levels of physical activity and physical strength in adolescents	These findings reinforce the connection between physical activity and the presence of overweight and obesity in adolescents and also the need to effectively intervene in this groupin order to ensure the prevention of chronic non-communicable diseases in adulthood.
(Rajabi et al., 2021)	Associations between physical activity levels with nutritional status, physical fitness and biochemical indicators in older adults	The results of the current work showed that a higher level of PA improved anthropometric indicators, PF, and lipid profile in Iranian older adults. Moreover, older nutrition should be monitor to maintain their physical health and to prevent them from developing chronic diseases and their malnutrition complications.
(Debnath et al., 2023)	Impact of nutrition education programme and controlled dietary modification on	The equilibrium in macronutrient bifurcations and relative macronutrient and micronutrient intake post-intervention indicates the effectiveness of nutritional

	nutritional status in young male athletes	enactment through an 8-week controlled dietary modification and systematic nutrition education programme on the nutritional status of young athletes. Therefore, good nutrition knowledge may improve the dietary patterns and nutrition intake of athletes. Intervention studies should emphasize nutrition education, aiming for improved athletic performance.
(Lin et al., 2021)	Protein supplementation increases adaptations to endurance training: A systematic review and meta-analysis	Protein supplementation further increased aerobic capacity, stimulated lean mass gain, and improved time trial performance during chronic endurance training in healthy and clinical populations.
(Kruger et al., 2023)	A comparative intervention trial of deer milk and an oral nutritional supplement efficacy for improving older adults' nutritional status, muscle mass and physical performance	Baseline nutritional status and BMI may modulate nutritional status, muscle mass and physical performance response to DM (as compared with ONS), suggesting DM may improve nutritional status and physical performance in women at risk of malnutrition and/or with lower BMI, and improve muscle mass in women with a higher BMI. The study was registered with the Australian New Zealand Clinical Trial Registry ACTRN12621000650897p.

DISCUSSION

From the results of the literature study of 5 articles that have been reviewed and explained, the results of research in the field of the role of nutritional status on the improvement of athletes' physical endurance highlight several significant findings. According to Barrack et al. (2023); Zhang et al. (2023), (2024) Recent studies show that there is a direct link between adequate nutritional intake and optimal athletic performance. Research shows that athletes who eat diets rich in carbohydrates, protein, and healthy fats tend to have higher energy levels, faster recovery, and better physical performance overall (Cataldi et al., 2024; Hecht et al., 2023; Keenan et al., 2023). The results of the literature review showed consistency in most previous studies in identifying the importance of nutrition for athletes' physical endurance, but some of the new findings also challenged conventional understanding by showing the complexity and variability of individual responses to nutritional intake.

The results of the study also highlight the importance of the personalization aspect in athlete nutrition planning. Each athlete has different nutritional needs based on the type of exercise, activity level, and individual physical condition. According to Luna, Rossi, and Arrieta (2024); de Miranda et al. (2024); Mitchell et al. (2024) These studies show that a nutrition approach tailored to individual needs can produce better outcomes compared to the same general approach for all athletes.

Recent research also highlights the role of technology in monitoring and optimizing athletes' nutritional intake. The use of nutrition tracking apps, wearable devices, and biomarker analysis allows athletes and medical teams to monitor athletes' nutritional needs in real-time and respond to them in the right way (Beable, 2024; Wittels et al., 2023). Thus, the results of

this study make an important contribution in directing sports nutrition practices towards a more directed, effective, and evidence-based approach.

Nutritional status plays an important role in improving the physical endurance of athletes. Optimal nutritional status can ensure an increase in physical and intellectual abilities as well as work productivity. The need for proper and balanced nutrients between intake and body needs is very important to maintain good nutritional status and optimal performance. Nutrient deficiencies can interfere with the function of organs and body systems, so that it can reduce the physical ability of athletes and affect their sports performance (Duarte Junior et al., 2023; Kapoor et al., 2023).

Blood biochemical tests can be used to determine the nutritional status of athletes and measure the level of nutrient availability in the body (Hasibuan et al., 2024; Nurdin et al., 2024; Raffiandy Putra et al., 2024). This examination includes measurements of lipid profiles, organ function, and daily dietary intake. The results of blood biochemical measurements can be used to determine appropriate nutritional interventions for athletes, so as to improve their physical endurance and sports performance.

In the context of sports, optimal nutritional status is essential to ensure optimal athlete performance. The need for proper and balanced nutrients between intake and body needs is very important to maintain good nutritional status and optimal performance (Bafirman, Zarya, et al., 2023; Bafirman, Wahyuri, et al., 2023). Blood biochemical tests can be used to determine the nutritional status of athletes and measure the level of nutrient availability in the body. Thus, blood biochemical tests can help athletes in improving their physical endurance and athletic performance.

An in-depth interpretation of this study reveals that optimal nutritional status not only serves as the foundation of athletes' general health, but also directly affects various aspects of physical performance. Carbohydrates, as a primary source of energy, have proven to be crucial in supporting high-intensity, prolonged physical activity. Protein not only plays a role in muscle repair and growth, but also in the maintenance of muscle mass, which is especially important in sports that require strength and endurance. Healthy fats, which are often overlooked, provide long-term energy reserves and support essential biological functions such as vitamin absorption and hormone production. The right combination of these macronutrients allows athletes to maintain high energy levels and minimize fatigue during workouts and competitions (Bafirman, Wahyuri, et al., 2023; Reno Putra et al., 2024).

In addition to macronutrients, micronutrients such as vitamins and minerals also play a vital role in supporting physiological functions that are essential for athletic performance. Iron, for example, is necessary for the formation of hemoglobin that transports oxygen to muscles, while calcium and vitamin D are important for bone health and injury prevention. Research shows that even small deficiencies in these micronutrients can lead to fatigue, decreased muscle strength, and an increased risk of injury. Therefore, micronutrient supplements may be necessary for athletes with deficiencies, although it is important to exercise proper monitoring and adjustments to avoid potential overdoses or negative interactions between nutrients.

Health monitoring technology has revolutionized the way athletes and medical teams manage nutritional status. With nutrition tracking apps, wearable devices, and biomarker analysis, athletes' nutritional needs can be monitored in real-time, allowing for quick and timely adjustments to nutrient intake. This allows for highly personalized nutrition strategies, which can be adjusted to daily variability in energy needs and the body's response to exercise. This interpretation confirms that health monitoring technology not only facilitates the optimization of athletes' performance, but also aids in injury prevention and more effective recovery, making it an invaluable tool in sports nutrition management.

4. CONCLUSION

The conclusion of this study is that optimal nutritional status plays a crucial role in improving athletes' physical endurance, where a personalized nutrition approach, supported by the latest health monitoring technology, can significantly improve athletic performance and accelerate recovery. This study emphasizes the importance of proper intake of macronutrients and micronutrients and emphasizes that nutritional strategies tailored to the individual needs of athletes are much more effective than general approaches, thus promoting the need for the integration of the latest scientific findings in sports nutrition practices. The main conclusion of this literature review is that individually tailored nutrition strategies are essential to achieving optimal athletic performance and preventing injury, with implications that effective nutrition management and policies that support optimal nutrition in sport should be prioritized.

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