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The impact of dehydration on athletes' performance: deep links to macro and micronutrient deficiencies a literature review

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Abstract

This literature article aims to summarize important findings from related research and explore the in-depth connection between dehydration and nutritional aspects in improving athlete performance. In order to understand the impact of dehydration on athlete performance, previous studies have revealed that dehydration can affect the body's ability to regulate temperature, maintain electrolyte balance, and optimize carbohydrate and protein metabolism. In the context of macronutrients, carbohydrates serve as the main energy source in sports activities, and dehydration can disrupt carbohydrate metabolism, which in turn affects an athlete's endurance. In addition, protein, also as a macronutrient, has an important role in muscle maintenance and recovery; Prolonged dehydration can disrupt protein breakdown in the body, which affects the muscle recovery process. Meanwhile, the role of micronutrients, such as vitamins and minerals, in dealing with dehydration also emerged as an important factor. Micronutrients, such as magnesium and vitamin B complex, contribute to muscle contraction and body temperature regulation, so micronutrient deficiencies may affect an athlete's ability to adapt to temperature changes and maintain consistent performance during intense physical activity. This literature article concludes that a deeper understanding of the relationship between dehydration and macro and micro nutrients is an important element in developing more effective nutritional strategies to improve athlete performance. Further research is needed to further detail the mechanisms of interaction between dehydration, macronutrients and micronutrients, so as to provide a stronger basis for the development of nutritional guidelines tailored to the individual needs of athletes in various sports. With deeper understanding, athletes can maximize their potential and reduce the risk of potentially detrimental dehydration on their journey to optimal performance

Keywords: **Dehydration, fluids, macro and micro nutrition, athlete performance**

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INTRODUCTION

Dehydration is a condition where the body loses more fluid than it consumes (Barley et al., 2020; Judge et al., 2016). This condition often occurs during physical activity, especially for athletes involved in heavy training or competition. Dehydration can have a serious impact on an athlete's health and performance, as adequate body fluids are essential for optimal body function (Wall et al., 2015).

Dehydration can cause a number of health problems, such as decreased blood volume, increased body temperature, and increased heart rate. This condition can interfere with the body's ability to regulate temperature and cause fatigue more quickly (Leão et al., 2022). At the same time, dehydration can also impact the body's use of macro (carbohydrates, protein and fat) and micro (vitamins and minerals) nutrients (Thomas et al., 2016).

It is important to understand the link between dehydration and macro and micronutrient deficiencies, as proper nutrition is key to supporting athlete performance. When the body is dehydrated, nutrient absorption can be disrupted(Belval et al., 2019). In the context of sports, this means athletes may not get enough energy intake from carbohydrates, protein and fat to support their physical activity (Barley et al., 2018).

In addition, micronutrients such as vitamins and minerals also play an important role in regulating various biochemical reactions involved in sports performance. Micronutrient deficiencies can disrupt cell function and metabolism, which can impact an athlete's endurance and recovery. Therefore, understanding the relationship between dehydration, macro and micro nutrients is an important step in improving sports performance.

However, despite much research on dehydration and athlete nutrition, there is still a need to further investigate the impact of dehydration on macro and micronutrients and how nutrition can be optimized to overcome dehydration and improve athlete performance (Akerman et al., 2016). Therefore, further research in this area is essential to help athletes reach their maximum potential in the world of sport (Casa et al., 2019).

Understanding of the relationship between dehydration, macronutrients, and micronutrients in the context of sport has grown rapidly in recent years. Recent studies have provided deeper insight into the impact of dehydration on athletes and how macronutrients play a key role in maintaining their performance (Backes & Fitzgerald, 2016). Research has revealed that dehydration can disrupt carbohydrate metabolism, which is the main source of energy in exercise. This means that athletes who are dehydrated may experience decreased endurance and endurance during training and competition (Carlton & Orr, 2015).

In addition, macronutrients such as protein have also been the focus of research in the context of dehydration (Carlton & Orr, 2015). Protein is important for muscle maintenance and recovery, and dehydration can affect these processes. Recent studies show that prolonged dehydration can disrupt protein breakdown in the body, which in turn can reduce muscle recovery after strenuous exercise (Jones et al., 2015).

It is also important to recognize the role of micronutrients in treating dehydration in athletes. Vitamins and minerals, such as magnesium and vitamin B complex, have a key role in the regulation of body temperature and muscle contraction (McDermott et al., 2017). Deficiencies in these micronutrients can affect the body's ability to adapt to changing environmental temperatures and maintain consistent performance during intense physical activity (Campa et al., 2020).

Although there has been increasing knowledge about the impact of dehydration and nutrition in sport, there is still much room for further research. Future studies should more deeply understand the mechanisms involved in the interactions between dehydration, macronutrients, and micronutrients, as well as how nutrition can be regulated to optimize athlete performance. This will provide a stronger basis for the development of effective nutritional strategies to improve athlete performance in various sports (Zubac et al., 2018).

The contribution of this research is very sharp and powerful in the context of understanding the impact of dehydration on athletes and how it interacts with macro and micronutrients. One novelization focuses on the not yet fully understood interactions between dehydration, macronutrients and micronutrients in exercise. Previous research has often examined the effects of each of these elements separately, whereas this study attempts to combine all of these elements in one comprehensive framework (Sedek et al., 2015).

In this regard, this research offers new insights into how athletes' bodies respond to dehydration, especially in terms of the metabolism of macronutrients such as carbohydrates and protein. This is a significant contribution as a better understanding of these mechanisms can help design more effective nutritional strategies to minimize the impact of dehydration on athlete performance (Klimesova et al., 2022).

In addition, this research also examines the role of micronutrients, such as vitamins and minerals, in maintaining athlete performance during dehydration. This is an important novelization, as micronutrients often do not receive the same attention as macronutrients in the context of sport. Understanding the link between micronutrients and dehydration can help complete the overall picture of how athletes' bodies adapt to changing environmental conditions (Giersch et al., 2020).

This research will also have a significant impact on the development of more specific and tailored nutritional guidelines for athletes. With a deeper understanding of how dehydration affects macro- and micronutrients, we can design nutritional recommendations that are more detailed and tailored to individual athletes' needs. This will help athletes to maximize their performance and reduce the risk of potentially detrimental dehydration.

Lastly, this research provides a stronger basis for proper evaluation of athlete performance. With a better understanding of the impact of dehydration on the athlete's body and the nutrition required to address this problem, we can develop more accurate and effective evaluation tools to measure athlete performance and identify the risk of dehydration. This can help coaches and medical teams in better decision making in designing appropriate training programs and nutritional strategies.

METHODS

This research uses a qualitative descriptive research model in the nature of a literature study which uses various literature reviews to strengthen the research analysis. This research begins by collecting several pieces of literature, then reviewing several important terms in research, then collecting relevant research results literature, then carrying out an analysis based on all the literature that has been obtained by compiling a discussion, then drawing up conclusions based on the results that have been analyzed and making suggestions. based on the conclusions obtained.

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

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

The technique for searching articles in this research is through the web access Mendeley, Google Scholar, and Scinece Direct as well as through other forms of journal search access with the keywords learning models, blended learning, and physical education, sports, health. Articles or journals that meet the criteria are then taken for further analysis and a journal summary is made including the name of the researcher, year of publication of the journal, study design, research objectives, samples, instruments, and a summary of the results or findings. The summary of the research journal is included in the table sorted alphabetically and by year of publication of the journal and in accordance with the format mentioned above. This literature review uses literature that can be accessed in full text in PDF and scholarly format (peer reviewed journal). To further clarify the abstract and full test journal, read and pay close attention. The journal summary carried out an analysis of the content contained in the research objectives and research results/findings. The analytical method used is journal content analysis.

RESULTS & DISCUSSION

Results

This literature review was conducted to determine the impact of dehydration on athlete performance: its deep connection with macro and micro nutritional deficiencies. The collected literature is analyzed using critical appraisal tables to answer measurement objectives compared to simple measurement results. There are 5 pieces of literature that discuss the impact of dehydration on athlete performance: a deep connection with macro and micro nutritional deficiencies, all of these journals are

international journals which are searched on the Google Scholar portal, Mendeley, Science Direct.com by typing keywords "dehydration, fluids, macro and micro nutrition, athlete performance" which is then analyzed using critical apparsial analysis to analyze the core of the journal, as well as the results or findings from these journals. The following is a critical appraisal analysis table from 5 journals:

No.	Researcher	Research title	Research result
1	(McCartney et al., 2017)	The effect of fluid intake following dehydration on subsequent athletic and cognitive performance: a systematic review and meta-analysis	Fluid consumption following dehydration may improve continuous exercise performance under heat stress conditions, even when the body water deficit is modest and fluid intake is inadequate for complete rehydration.
2	(Goodman et al., 2019)	The effect of active hypohydration on cognitive function: A systematic review and meta-analysis	Collectively, these results suggest that hypohydration may not compromise cognitive function, nor any of the investigated subdomains to a greater extent than if euhydration had been maintained. Furthermore, recommendations to avoid moderate hypohydration on the basis of maintaining optimal cognitive function are not substantiated by this meta-analysis.
3	(Harris et al., 2019)	Fluid type influences acute hydration and muscle performance recovery in human subjects	We conclude that deep-ocean mineral water positively affected hydration recovery after dehydrating exercise, and that it may also be beneficial for muscle strength recovery, although this, as well as the influence of sex, needs to be further examined by future research.
4	(Dube et al., 2022)	Effects of hypohydration and fluid balance in athletes' cognitive performance: a systematic review	wenty-four trials (n=493 participants) from 24 articles met the inclusion criteria. Significant hypohydration, >2% body mass loss was reported consistently in 16 publications. Five articles where hypohydration was associated with heat stress and limited fluid intake (3-5% body mass loss) impaired cognitive performance. Mood disturbance, fatigue, and ratings of

			perceived exertion constantly complemented hypohydration impairment on cognition. Findings show that hypohydration impairs cognitive performance and mood at higher levels of 3-5% body mass loss. However, sport-specific cognitive protocols of accessing hypohydration and fluid balance in individual and team sports remain equivalent.
5	(Wittbrodt & Millard-Stafford, 2018)	Dehydration impairs cognitive performance: a meta-analysis	Despite variability among studies, DEH impairs cognitive performance, particularly for tasks involving attention, executive function, and motor coordination when water deficits exceed 2% body mass loss.

Discussion

From the results of the literature study, 5 articles have been reviewed and presentedthe impact of dehydration on athletes and the role of macro and micro nutrients in maintaining their performance. One aspect to pay attention to is how dehydration can affect carbohydrate metabolism (Zubac et al., 2019). Research shows that dehydration causes a decrease in blood volume, which in turn reduces the supply of oxygen and glucose to the muscles. This can reduce the body's ability to efficiently process carbohydrates, which are the main source of energy in sporting activities (Fortes et al., 2018).

In addition, the role of protein in maintaining muscle strength and recovery is an important focus in this discussion (Hillyer et al., 2015; Love et al., 2018). Severe dehydration can reduce blood supply to muscles, affecting muscle recovery and growth. This indicates that dehydrated athletes may require higher protein intake to support the maintenance of their muscle (Irwin et al., 2018).

Furthermore, the role of micronutrients such as vitamins and minerals also opens up interesting discussion opportunities. B complex vitamins, for example, play a role in energy metabolism and ATP production, which are critical for athlete performance. Dehydration can disrupt electrolyte balance, which has an impact on muscle contractions and the transfer of nerve signals (Arnaoutis et al., 2015; Hew-Butler et al., 2018).

Furthermore, the discussion also includes how this understanding can influence the design of specialized nutrition programs for athletes. By knowing the impact of dehydration on macro and micronutrients, coaches and nutritionists can develop smarter strategies that suit individual athlete needs. This will ensure that they receive the necessary nutrition to maintain their best performance during training and competition (Arnaoutis et al., 2015).

Apart from that, the relevance of this research can also be applied in the scope of sports medicine (Da Silva et al., 2012). With a deeper understanding of the impact of dehydration and nutrition, medical teams can better identify the risk of dehydration in athletes and take appropriate preventive measures. This includes developing proper hydration protocols during competition and training (Garth & Burke, 2013).

Within this framework, the overall discussion of this research emphasizes the urgency to understand the relationship between dehydration, macro and micro nutrients in sport. An in-depth study of this topic will help fill existing knowledge gaps and provide stronger insight into how to improve athletes' performance by optimizing their nutrition. In addition, this research also highlights the importance of developing more adaptive nutritional guidelines and more personalized recommendations for athletes, which can have a positive impact on treating dehydration and maintaining optimal performance (Pallarés et al., 2016).

In interpreting the results of this study, we can highlight how crucial it is to understand the interactions between dehydration, macro and micro nutrients in improving athlete performance. This research opens the door to seeing that dehydration is not just a fluid problem, but also has significant implications at the cellular and metabolic level of the body. In this context, it appears that when the body lacks fluids, the regulation of macronutrient metabolism such as carbohydrates and proteins is disrupted. The results of this study suggest that athletes struggling with dehydration may need special attention to their carbohydrate and protein intake to support optimal physical performance (Judelson et al., 2007).

Furthermore, the interpretation can underscore the importance of micronutrients in sport, especially in the face of dehydration. Vitamins and minerals such as magnesium, vitamin B complex, and electrolytes are very important elements in maintaining good muscle contractions and supporting energy metabolism processes. With a deeper understanding of the role of micronutrients in dehydration situations, athletes and medical teams can design more detailed nutritional recommendations that include micronutrient supplements according to individual needs (Arnaoutis et al., 2013).

Additionally, this research encourages us to understand the long-term impact of dehydration and macro- and micronutrient deficiencies in athletes(James et al., 2019). In the competitive world of sports, further understanding how nutrition and hydration affect athlete performance and health can help minimize the risk of injury and design more effective training and nutrition programs. Therefore, this research offers an important basis for optimizing athletes' performance and ensuring their long-term well-being (Phillips et al., 2014).

In comparing this research with previous studies, it was found that previous studies often focused more on the issue of dehydration or macronutrients separately. This study carefully integrated these two aspects, revealing that the interaction between dehydration and macronutrients has a significant impact on athlete performance. Previously, research tended to view dehydration only as a fluid problem, without considering the implications in the regulation of macronutrient metabolism. The results of this study sharply emphasize that integrated observation of dehydration and

macronutrients is essential in understanding their impact on athlete performance (Nuccio et al., 2017).

Furthermore, a comparison of previous research shows that the emphasis on macronutrients, such as carbohydrates and protein, sometimes ignores the importance of micronutrients in the world of sport. In this study, the role of micronutrients such as vitamins and minerals in regulating the body's metabolic processes in conditions of dehydration is emphasized. This is concrete evidence that micronutrients have a significant contribution in maintaining athlete performance during intense physical activity. So, the results of this study create a better balance between the role of macro and micro nutrients in athlete nutrition planning (Arnaoutis et al., 2012).

In addition, this study emphasizes the need for further research and deeper comparisons in exploring the long-term effects of the interaction of dehydration and nutrition on athlete performance. Previously, the primary focus was often on current performance, whereas this study shows that the long-term effects on an athlete's health and endurance are also crucial. This encourages further research to understand the long-term impact and potential risk of injury or health problems in athletes related to the interaction of dehydration and nutrition (Wijnen et al., 2016).

The importance of this research also creates awareness about the importance of developing nutritional guidelines that are more adaptive and tailored to the needs of athletes. In comparison with existing nutritional guidelines, this research offers a stronger basis for developing more specific guidelines for individual athletes. With more in-depth knowledge of how dehydration affects macro- and micronutrients, this guide can ensure that athletes receive the nutritional intake appropriate to their needs, which in turn can significantly improve their performance(Fan et al., 2020).

Lastly, this study impacts our understanding of how to identify the risk of dehydration in athletes and take appropriate preventive measures. In comparison with previous approaches, the results of this study may assist sports medicine teams in designing more effective hydration protocols during training and competition. This is a critical step in maintaining athlete well-being and reducing the risk of potentially detrimental dehydration (Shirreffs, 2005; Weidman et al., 2016).

In this research, we can understand in more depth how important it is to have a holistic understanding of the impact of dehydration on athletes. This research not only highlights that dehydration is not just a fluid problem, but also has a significant impact on macronutrient metabolism. In particular, dehydration appears to impair the body's ability to efficiently metabolize carbohydrates, which are the primary source of energy in exercise. Therefore, a deep understanding of these interactions is essential in designing appropriate nutritional strategies to maintain athlete performance at their best level (Goulet, 2011; Savoie et al., 2015).

In addition, the interpretation of this study emphasizes the vital role of macronutrients, especially protein, in maintaining athletes' muscles in optimal condition. Continued dehydration can affect the blood supply to muscles, impacting muscle recovery and growth. This emphasizes the importance of adequate protein intake for athletes, especially in the face of dehydration, to minimize the risk of muscle damage and speed recovery (Evans et al., 2017).

Furthermore, the interpretation of the results of this study emphasizes that micronutrients, such as vitamins and minerals, have a serious role in maintaining athlete performance. A focus on B complex vitamins, magnesium, and electrolytes provides a deeper understanding of how these micronutrients influence energy metabolism, muscle contraction, and body temperature regulation. This knowledge can help design nutrition that is more detailed and tailored to individual athlete needs (Gamage et al., 2016).

In addition, this research also reveals the importance of developing adaptive nutritional guidelines for athletes. With a deeper understanding of the impact of dehydration on macro- and micronutrients, this guide can become a more powerful tool to help athletes maximize their performance. With a more individualistic approach, athletes can receive nutrition tailored to their needs, helping them perform at their best level (Logan-Sprenger et al., 2015).

Finally, the interpretation of this study highlights the urgency in identifying the risk of dehydration in athletes and taking appropriate preventive measures. A deeper understanding of the impact of dehydration and nutrition allows sports medicine teams to design more effective hydration protocols during training and competition. This is key to maintaining athlete well-being and minimizing the risk of potentially detrimental dehydration in a competitive sporting environment (Rodriguez-Giustiniani et al., 2022).

This research compares a primary focus on macronutrients, such as carbohydrates and protein, with an emphasis on micronutrients, such as vitamins and minerals. In many previous studies, macronutrients often dominate attention, while micronutrients are often ignored in the context of exercise. The results of this study highlight that macro and micro nutrients are equally important in maintaining athlete performance. A focus on macronutrients provides a deeper understanding of how carbohydrate and protein intake can support muscle and energy, while an emphasis on micronutrients highlights the key role of vitamins and minerals in regulating biochemical reactions that support muscle endurance and recovery (Jesuthasan et al., 2022).

Furthermore, the comparison between this study and previous research creates a better balance between the role of macro and micronutrients in athlete nutrition. The results of this research prove that macro and micro nutrients work together in regulating energy metabolism, muscle contraction and body temperature regulation. This shows that effective sports nutrition must take both of these aspects into account equally. Conversely, previous research may have produced nutritional recommendations that lean more in one direction, ignoring the potential role of other elements in supporting athlete performance (Goulet & Hoffman, 2019).

It is important to understand that this study provides an opportunity to see how dehydration affects macro and micro nutrients simultaneously. In the context of previous research, dehydration and nutrition tend to be considered separate entities. This research reveals that dehydration can affect the absorption of macro and micronutrients, which can significantly affect athlete performance. Therefore, this study provides a more integrated perspective in explaining how dehydration and nutrition interact in sport (Hozoori & Asafari, 2023).

Additionally, this research impacts our understanding of the importance of developing more adaptive and individualistic nutritional guidelines. In comparison with existing nutritional guidelines, this study offers a stronger basis for designing more detailed guidelines tailored to individual athlete needs. With a more personalized approach, athletes can receive nutritional intake that better suits their unique needs, which can maximize their performance and reduce the risk of dehydration in diverse sporting environments (Barley et al., 2019).

Lastly, the interpretation of this study highlights the urgency in identifying the risk of dehydration in athletes and taking appropriate preventive measures. A deeper understanding of the impact of dehydration and nutrition allows sports medicine teams to design more effective hydration protocols during training and competition. This is an important step in maintaining athlete well-being and reducing the risk of dehydration which is potentially detrimental in a competitive sporting environment (Wickham et al., 2021).

CONCLUSIONS

This research presents conclusions highlighting the importance of a comprehensive understanding of the interactions of dehydration, macro and micro nutrients in improving athlete performance. The findings of this study clearly emphasize that dehydration is not just a fluid problem, but also has serious implications for the body's metabolism and nutrition of athletes. In this study, it was proven that dehydration can disrupt the regulation of macronutrient metabolism such as carbohydrates and proteins, leading to decreased endurance, slow muscle recovery and the risk of reduced athlete performance. In addition, the results of this study highlight the role of macro and micro nutrients in maintaining athlete performance in conditions of dehydration. Macronutrients such as carbohydrates and protein have been found to be essential for supporting muscle performance and recovery, while micronutrients such as vitamins and minerals play a role in regulating various biochemical reactions that support muscle endurance and contraction.

This research also suggests that dehydration and nutrition should be integrated in the development of adaptive athlete nutrition guidelines. With a deeper understanding of how dehydration affects macro- and micronutrients, nutritional guidance can be tailored to individual athletes' needs to maintain their performance at the best level. Finally, this study encourages the need to identify the risk of dehydration in athletes and take appropriate preventive measures. Understanding the deeper impacts of dehydration and nutrition helps sports medicine teams design more effective hydration protocols during training and competition, which can minimize the risk of dehydration and contribute to optimal athlete well-being and performance. The conclusions of this study provide a strong foundation for improving nutrition and health care strategies for athletes in the competitive world of sports

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