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The role of nutrition, sports psychology, and physiotherapy in optimizing performance of karate athletes: A narrative review

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Abstract
This narrative review explores the combined roles of nutrition, sports psychology, and physiotherapy in enhancing the performance, recovery, and long-term health of karate athletes. The review discusses evidence-based nutritional strategies to support energy availability, body composition, hydration, and recovery; psychological interventions to improve motivation, confidence, focus, stress management, and competitive performance; and physiotherapy approaches for injury prevention, rehabilitation, movement optimization, flexibility, strength, balance, neuromuscular control, and return-to-sport. By integrating these three disciplines within a multidisciplinary athlete support model, the review highlights how holistic management can optimize performance, reduce injury risk, accelerate recovery, and promote sustained success in both kata and kumite athletes.

Keywords: Karate, sports nutrition, sports psychology, performance enhancement, combat sports, recovery, mental skills

Introduction

Karate is one of the most widely practiced martial arts worldwide and has evolved into a highly competitive sport recognized at the international level. It comprises two principal disciplines: kumite (sparring), which emphasizes direct combat between opponents, and kata (forms), which involves the execution of predetermined sequences of offensive and defensive techniques. Both disciplines require a combination of muscular strength, explosive power, speed, agility, flexibility, balance, coordination, and tactical decision-making to achieve optimal performance (Chaabène *et al*., 2012 [9]; Franchini & Sterkowicz-Przybycień, 2013) [14].

Elite karate athletes are often required to compete in several matches within a single tournament, placing considerable demands on both the anaerobic and aerobic energy systems. Repeated high-intensity efforts interspersed with short recovery periods necessitate excellent physical conditioning, efficient recovery strategies, and optimal nutritional support to sustain performance throughout competition (Chaabène *et al*., 2014; Slimani *et al*., 2018) [10, 37]. In addition to physical preparation, psychological readiness plays a crucial role in competitive success, as athletes must maintain concentration, regulate emotions, and make rapid tactical decisions under pressure (Weinberg & Gould, 2019) [46].

Recent advances in sports science have highlighted the close interaction between nutritional status, physiological performance, and psychological functioning. Adequate nutrition supports energy availability, muscle recovery, immune function, and cognitive performance, while psychological skills such as goal setting, imagery, self-talk, and emotional regulation enable athletes to cope effectively with competitive stress and optimize performance (Thomas *et al*., 2016; Burke, 2015; Weinberg & Gould, 2019) [5, 40, 46]. Furthermore, multidisciplinary approaches that integrate nutrition, sports psychology, and physiotherapy are increasingly recognized as essential for enhancing athletic performance, reducing injury risk, and promoting long-term athlete development. Therefore, this narrative review aims to examine the current evidence regarding the roles of nutrition, sports psychology, and physiotherapy in optimizing the performance, recovery, and overall well-being of karate athletes.

Physiological Demands of Karate

Karate is a high-intensity combat sport that places significant demands on multiple physiological systems and requires the integration of various physical capacities to achieve optimal performance. Both kata and kumite involve explosive movements such as punches, kicks, blocks, and rapid directional changes that rely heavily on muscular power, speed, agility, reaction time, and technical precision (Chaabène *et al*., 2012 [9]; Franchini & Sterkowicz-Przybycień, 2013) [14]. During competition, athletes perform repeated bouts of short-duration, high-intensity efforts interspersed with brief recovery periods, requiring efficient contributions from both the anaerobic and aerobic energy systems. The anaerobic energy system provides the immediate energy necessary for explosive attacks and defensive techniques, whereas the aerobic system plays a crucial role in facilitating recovery between exchanges and successive matches by replenishing phosphocreatine stores and removing metabolic by-products (Beneke *et al*., 2004; Chaabène *et al*., 2014) [3, 10]. In addition, effective karate performance depends on excellent neuromuscular coordination, balance, flexibility, proprioception, and postural control, enabling athletes to execute precise technical skills, maintain stability, and respond rapidly to opponents' actions (Chaabène *et al*., 2012; Sterkowicz-Przybycień *et al*., 2017) [9, 39]. Consequently, successful karate athletes require a well-developed combination of aerobic endurance, anaerobic capacity, muscular strength and power, flexibility, and neuromuscular efficiency to sustain high-performance levels throughout training and competition (Franchini & Sterkowicz-Przybycień, 2013; Slimani *et al*., 2018) [14, 37].

Importance of Nutrition in Karate Performance

Nutrition plays a fundamental role in optimizing the performance, recovery, and overall health of karate athletes. As a high-intensity combat sport, karate requires adequate energy intake and balanced nutrient consumption to support training adaptations, maintain energy availability, and enhance muscle recovery following strenuous exercise (Thomas *et al*., 2016; Burke, 2015) [5, 40]. Appropriate nutritional strategies also contribute to preserving optimal body composition, strengthening immune function, and reducing the risk of fatigue, overtraining, and sports-related injuries (Kerksick *et al*., 2018; Thomas *et al*., 2016) [21, 40]. Furthermore, sufficient intake of macronutrients and micronutrients supports cognitive function, reaction time, and concentration, all of which are essential for technical execution and tactical decision-making during competition (Burke *et al*., 2019; Thomas *et al*., 2016) [6, 40]. Since many karate athletes compete in weight categories, individualized nutrition plans are crucial for achieving and maintaining competition weight without compromising physical performance or health. Evidence indicates that well-planned nutritional strategies improve body composition, enhance recovery, and optimize competitive performance while minimizing the adverse effects associated with rapid weight loss practices commonly observed in combat sports (Artioli *et al*., 2010; Franchini *et al*., 2012) [1, 15]. Therefore, a balanced dietary approach tailored to an athlete's training load, competition schedule, body composition goals, and physiological requirements is essential for sustaining high-intensity performance, promoting efficient recovery, and supporting long-term athletic development.

1. Energy Requirements

Adequate energy availability is essential for meeting the physiological demands of karate training and competition and for supporting optimal health, recovery, and athletic performance. Daily energy requirements vary according to several factors, including age, sex, body composition, training volume and intensity, competition schedule, and individual metabolic rate (Thomas *et al*., 2016; Mountjoy *et al*., 2018) [29, 40]. Karate athletes engaged in frequent high-intensity training require sufficient caloric intake to maintain energy balance, replenish glycogen stores, support muscle repair, and facilitate physiological adaptations to training (Burke, 2015) [5]. Inadequate energy intake can result in low energy availability (LEA), which has been associated with fatigue, reduced glycogen stores, loss of lean muscle mass, impaired concentration, delayed recovery, increased susceptibility to injuries, weakened immune function, hormonal disturbances, and impaired athletic performance (Mountjoy *et al*., 2018; Thomas *et al*., 2016) [29, 40]. Prolonged energy deficiency may also contribute to overtraining, reduced bone health, and the development of Relative Energy Deficiency in Sport (RED-S), a condition that adversely affects multiple physiological systems and compromises both health and performance (Mountjoy *et al*., 2023) [27]. Conversely, excessive energy intake may increase body fat and body mass, potentially reducing speed, agility, endurance, and movement efficiency—qualities that are essential for successful performance in both kata and kumite (Burke, 2015; Franchini *et al*., 2012) [5, 9]. Therefore, individualized nutrition plans that align energy intake with training demands, competition goals, and recovery requirements are fundamental for maintaining optimal body composition, maximizing performance, and supporting the long-term development of karate athletes.

2. Macronutrient Requirements

2.1 Carbohydrates

Carbohydrates are the primary energy source for karate athletes, particularly during high-intensity training sessions and competitive bouts that involve repeated explosive movements. Adequate carbohydrate intake is essential for maintaining muscle and liver glycogen stores, which provide the readily available energy required for rapid attacks, defensive techniques, and sustained performance throughout training and competition (Thomas *et al*., 2016; Burke *et al*., 2011) [7, 40]. Sufficient glycogen availability helps delay the onset of fatigue, supports repeated high-intensity efforts, enhances recovery between training sessions, and promotes optimal cognitive function, including concentration and reaction time (Burke *et al*., 2011; Jeukendrup, 2017) [7, 20]. Current sports nutrition guidelines recommend a daily carbohydrate intake of approximately 5–7 g/kg of body weight for athletes undertaking moderate-intensity training and 6–10 g/kg of body weight for those engaged in heavy or prolonged training loads, with individual requirements varying according to exercise duration, intensity, and competition schedule (Thomas *et al*., 2016; Thomas *et al*., 2024) [40, 44]. Emphasis should be placed on consuming nutrient-dense carbohydrate sources such as rice, whole grains, potatoes, oats, fruits, pasta, and other complex carbohydrates to ensure a sustained energy supply while providing essential dietary fiber, vitamins, and minerals. In addition, appropriate timing of carbohydrate intake before, during, and after exercise enhances glycogen replenishment, accelerates recovery, maintains blood glucose concentrations, and optimizes overall performance in both kata and kumite athletes (Burke *et al*., 2011; Jeukendrup, 2017) [7, 20].

2.2 Protein

Protein is a vital macronutrient for karate athletes, playing a central role in muscle repair, growth, recovery, and the maintenance of overall physiological function. The high-intensity and repetitive nature of karate training increases muscle protein turnover and exercise-induced muscle damage, making adequate protein intake essential to stimulate muscle protein synthesis, support tissue repair, and facilitate adaptations to training (Thomas *et al*., 2016 [40]; Jäger *et al*., 2017). In addition to promoting lean muscle mass and strength development, dietary protein contributes to immune function, enzyme and hormone production, and the maintenance of connective tissues, all of which are important for sustaining athletic performance and reducing injury risk (Kerksick *et al*., 2018) [21]. Current sports nutrition guidelines recommend a daily protein intake of 1.4–2.0 g/kg of body weight for athletes, with individual requirements depending on training intensity, exercise volume, competition demands, and recovery needs (Thomas *et al*., 2016; Jäger *et al*., 2017) [34, 40]. High-quality protein sources include eggs, fish, chicken, lean meat, milk, yogurt, soy products, legumes, and lentils, as these provide all or most of the essential amino acids required for muscle repair and growth. Furthermore, distributing protein intake evenly across meals throughout the day, particularly by consuming

approximately 20–40 g of high-quality protein within the first two hours after exercise, has been shown to maximize muscle protein synthesis, accelerate recovery, and enhance subsequent training performance (Morton *et al*., 2018 [26]; Jäger *et al*., 2017). Therefore, an individualized protein strategy, integrated with overall energy and nutrient requirements, is a key component of nutritional planning for optimizing performance, recovery, and long-term athletic development in karate athletes.

2.3 Fats

Dietary fats are an essential component of the diet for karate athletes, providing a concentrated source of energy and supporting numerous physiological functions that contribute to health, recovery, and athletic performance. Healthy fats play a critical role in hormone production, particularly the synthesis of steroid hormones involved in muscle growth, tissue repair, and metabolic regulation. They are also integral to maintaining cell membrane integrity, facilitating normal nerve function, and supporting the absorption of fat-soluble vitamins (A, D, E, and K), which are essential for bone health, immune function, vision, and antioxidant defense (Thomas *et al*., 2016; Kerksick *et al*., 2018) [21, 40]. Although carbohydrates are the primary fuel source during high-intensity exercise, dietary fats become an important energy substrate during prolonged or lower-intensity activities and recovery periods, thereby helping to preserve muscle glycogen stores and sustain overall energy balance (Burke, 2015) [5]. Current sports nutrition guidelines recommend that total fat intake should account for approximately 20–35% of total daily energy intake, with an emphasis on consuming unsaturated fats while limiting saturated and trans fats (Thomas *et al*., 2016) [40]. Healthy dietary fat sources include nuts, seeds, olive oil, avocados, and fatty fish such as salmon, mackerel, and sardines, which are rich in omega-3 fatty acids. These long-chain polyunsaturated fatty acids possess anti-inflammatory properties and may reduce exercise-induced muscle damage, promote recovery, and support cardiovascular and neuromuscular health (Philpott *et al*., 2019; Kerksick *et al*., 2018) [21, 32]. Therefore, incorporating adequate amounts of healthy fats into an individualized nutrition plan contributes to optimal physiological function, enhances recovery, and supports sustained performance in karate athletes.

3. Micronutrients

Micronutrients, including vitamins and minerals, are indispensable for maintaining the health, performance, and recovery of karate athletes. Although required in relatively small amounts, these nutrients play essential roles in energy metabolism, oxygen transport, muscle contraction, bone health, immune function, antioxidant defense, and numerous enzymatic reactions essential for athletic performance (Thomas *et al*., 2016; Maughan & Burke, 2012) [24, 40]. The physiological demands of high-intensity training and frequent competition may increase the requirements for certain micronutrients, while inadequate dietary intake can impair exercise performance, delay recovery, compromise immune function, and increase the risk of illness, fatigue, and musculoskeletal injuries (Close *et al*., 2019; Kerksick *et al*., 2018) [12, 21]. Consequently, karate athletes should consume a balanced and nutrient-dense diet rich in fruits, vegetables, whole grains, lean protein sources, dairy products, legumes, nuts, and seeds to ensure sufficient intake of essential vitamins and minerals. When dietary intake is inadequate or deficiencies are clinically confirmed, targeted supplementation should be undertaken only under the supervision of qualified healthcare or sports nutrition professionals (Thomas *et al*., 2016) [40]. Among the numerous micronutrients, iron, calcium, vitamin D, and magnesium are particularly important because of their established roles in supporting oxygen delivery, skeletal integrity, neuromuscular function, energy production, and long-term athletic performance (Close *et al*., 2019; Kerksick *et al*., 2018) [12, 21].

3.1 Iron

Iron is a vital mineral involved in oxygen transport, energy metabolism, and aerobic performance. It is a key component of hemoglobin and myoglobin, which transport and store oxygen in the blood and skeletal muscles, respectively. Adequate iron status supports endurance, delays the onset of fatigue, and promotes efficient aerobic energy production during both training and competition (Thomas *et al*., 2016; Peeling *et al*., 2014) [31, 40]. Iron deficiency, which is relatively common among female athletes, adolescent athletes, and individuals with restricted dietary intake, may result in fatigue, decreased exercise capacity, impaired concentration, reduced athletic performance, weakened immune function, and delayed recovery (Peeling *et al*., 2014; Sim *et al*., 2019) [31, 36]. Good dietary sources of iron include lean red meat, poultry, fish, legumes, fortified cereals, spinach, and other leafy green vegetables. Furthermore, consuming vitamin C-rich foods alongside plant-based (non-heme) iron sources enhances iron absorption and improves iron status (Thomas *et al*., 2016) [40].

3.2 Calcium

Calcium is essential for maintaining bone health, muscle contraction, nerve transmission, and blood clotting. For karate athletes, adequate calcium intake is particularly important because the sport involves repetitive impacts, rapid movements, and high mechanical loads that place considerable stress on the skeletal system. Sufficient calcium intake supports bone mineralization, maximizes bone mineral density, reduces the risk of stress fractures, and facilitates normal muscle contraction during training and competition (Thomas *et al*., 2016; Close *et al*., 2019) [12, 40]. Excellent dietary sources of calcium include milk, yogurt, cheese, fortified plant-based beverages, leafy green vegetables, tofu, and calcium-rich fish such as sardines. Maintaining adequate calcium intake is especially important for adolescent athletes and female competitors, who are at greater risk of compromised bone health and low bone mineral density when dietary intake is insufficient (Mountjoy *et al*., 2023) [27].

3.3 Vitamin D

Vitamin D plays a crucial role in calcium absorption, bone metabolism, muscle function, and immune regulation. Adequate vitamin D status contributes to improved muscle strength, neuromuscular coordination, and reduced risk of musculoskeletal injuries, all of which are essential for optimal karate performance (Close *et al*., 2013; Thomas *et al*., 2016) [13, 40]. Conversely, vitamin D deficiency has been associated with impaired muscle function, decreased bone mineral density, increased susceptibility to stress fractures,

impaired immune function, and prolonged recovery from injury (Owens *et al*., 2018) [30]. The primary source of vitamin D is sunlight exposure, while dietary sources include fatty fish, egg yolks, fortified dairy products, and fortified cereals. In athletes with confirmed deficiency or limited sun exposure, vitamin D supplementation under professional guidance may be necessary to achieve and maintain optimal serum vitamin D concentrations (Close *et al*., 2013) [13].

3.4 Magnesium

Magnesium is an essential mineral involved in more than 300 enzymatic reactions related to energy metabolism, protein synthesis, muscle contraction and relaxation, electrolyte balance, and nervous system function. Adequate magnesium intake supports efficient ATP production, neuromuscular coordination, muscle relaxation, and recovery following intense exercise, while helping to reduce fatigue and muscle cramps (Volpe, 2015; Kerksick *et al*., 2018) [21, 45]. Rich dietary sources of magnesium include nuts, seeds, whole grains, legumes, leafy green vegetables, and dark chocolate. Ensuring sufficient magnesium intake through a balanced diet supports optimal physiological function, enhances training adaptations, and contributes to improved recovery and athletic performance in karate athletes (Volpe, 2015) [8].

Hydration

Maintaining optimal hydration is essential for maximizing the performance, health, and recovery of karate athletes. Karate training and competition involve repeated high-intensity efforts that can result in substantial fluid and electrolyte losses through sweating, particularly in hot and humid environments (Sawka *et al*., 2007; Thomas *et al*., 2016) [35, 40]. Even mild dehydration, corresponding to a loss of approximately 2% of body mass, can negatively affect physiological and cognitive functions by reducing reaction time, muscular strength, endurance, coordination, decision-making ability, and overall cognitive performance (Cheuvront & Kenefick, 2014 [11]; Casa *et al*., 2019). These impairments may compromise technical execution, tactical judgment, and competitive success. To minimize these effects, athletes should begin training and competition in a well-hydrated state by consuming adequate fluids throughout the day. During prolonged or intense training sessions lasting longer than 60 minutes, regular fluid intake is recommended to maintain hydration and prevent excessive body mass loss. Following exercise, athletes should replace fluids lost through sweat by consuming water and appropriate rehydration beverages, with electrolyte-containing drinks being particularly beneficial after prolonged or high-intensity sessions to restore sodium and other minerals lost through perspiration (Thomas *et al*., 2016) [40]. Monitoring hydration status using indicators such as urine color, body mass changes before and after exercise, and thirst perception can help athletes develop individualized hydration strategies (Casa *et al*., 2019). Proper hydration practices not only support physical performance and thermoregulation but also enhance recovery, reduce the risk of heat-related illness, and maintain optimal physiological and cognitive function during both training and competition (Sawka *et al*., 2007) [35].

Weight Management

Weight management is a critical aspect of competitive karate, as athletes compete within specific weight categories and often aim to achieve an optimal body composition without compromising performance. Maintaining an appropriate competition weight through long-term nutritional planning and structured training enhances power-to-weight ratio, agility, speed, and endurance while minimizing health risks (Franchini *et al*., 2012; Artioli *et al*., 2010) [1, 15]. However, many athletes resort to rapid weight loss (RWL) strategies immediately before competition, including severe caloric restriction, dehydration, excessive exercise, sauna use, and fluid restriction. Although these methods may produce short-term reductions in body mass, they can adversely affect physiological and psychological functioning. Rapid weight loss has been associated with decreased muscular strength and power, impaired cognitive function, slower reaction time, reduced concentration, mood disturbances, increased fatigue, diminished glycogen stores, impaired thermoregulation, delayed recovery, and a higher risk of injury and illness (Artioli *et al*., 2010; Reale *et al*., 2017) [1, 34]. Furthermore, repeated cycles of rapid weight loss and regain may negatively impact long-term metabolic health and athletic performance (Franchini *et al*., 2012) [9]. Current evidence strongly recommends gradual weight reduction through individualized nutrition plans, appropriate training periodization, and regular monitoring of body composition under the guidance of qualified sports nutritionists and healthcare professionals (Thomas *et al*., 2016) [40]. Such evidence-based approaches enable karate athletes to safely achieve competition weight while preserving physical performance, psychological well-being, and overall health.

Role of Sports Psychology

Sports psychology plays a pivotal role in optimizing the performance of karate athletes by enhancing the mental skills required for success in training and competition. In elite-level karate, where athletes often possess comparable physical abilities and technical proficiency, psychological readiness frequently becomes the determining factor in competitive outcomes (Weinberg & Gould, 2019) [46]. Effective psychological preparation enables athletes to cope with competitive pressure, maintain focus under stressful conditions, regulate emotions, and execute skills with confidence and precision. Sports psychology interventions are designed to improve motivation, self-confidence, concentration, emotional regulation, resilience, and decision-making, all of which are essential for achieving consistent performance (Birrer & Morgan, 2010) [4]. Additionally, psychological skills training helps athletes manage competition anxiety, recover from setbacks, sustain intrinsic motivation, and maintain a positive mindset throughout the training cycle. Techniques such as goal setting, imagery, positive self-talk, relaxation strategies, mindfulness, and attentional control have been shown to enhance mental toughness and performance consistency in combat sports (Gucciardi *et al*., 2009; Weinberg & Gould, 2019) [17, 46]. Therefore, integrating structured sports psychology programs into regular training can complement physical conditioning and nutritional strategies, enabling karate athletes to maximize their potential and perform effectively under the physical and psychological demands of competition.

Psychological Challenges in Karate

Karate athletes are exposed to a variety of psychological challenges throughout training and competition that can significantly influence their performance and overall well-being. The highly competitive nature of the sport, combined with the demands of technical precision, rapid decision-making, and physical confrontation, often results in considerable mental stress (Slimani *et al*., 2016) [38]. Common psychological challenges include performance anxiety, fear of failure, pressure to achieve success, stress associated with weight management, concerns related to injury and rehabilitation, and fluctuations in mood and emotional state. Excessive competitive anxiety may impair concentration, disrupt motor coordination, and reduce confidence, while fear of failure can lead to hesitation and decreased tactical effectiveness during competition (Weinberg & Gould, 2019) [46]. Athletes undergoing rapid weight loss may experience increased irritability, fatigue, reduced motivation, and impaired cognitive function, further compromising performance (Artioli *et al*., 2010) [1]. Additionally, injury-related concerns, such as fear of re-injury or prolonged absence from competition, may negatively affect self-confidence and readiness to return to sport (Podlog & Eklund, 2007) [33]. If these psychological challenges are not appropriately addressed, they can contribute to decreased performance, burnout, overtraining, and reduced athlete satisfaction. Consequently, early identification of psychological stressors and the implementation of evidence-based mental skills training, counseling, and social support are essential to enhance resilience, promote psychological well-being, and ensure consistent competitive performance in karate athletes.

Psychological Skills Training

Psychological skills training (PST) is an essential component of comprehensive athlete development, enabling karate practitioners to optimize performance by strengthening mental resilience and emotional control. Evidence suggests that structured psychological interventions enhance concentration, confidence, motivation, and the ability to perform consistently under competitive pressure (Weinberg & Gould, 2019; Birrer & Morgan, 2010) [4, 46]. Goal setting, particularly using the SMART framework, provides athletes with clear objectives, enhances motivation, and facilitates systematic progress throughout training and competition (Locke & Latham, 2002) [23]. Imagery or mental rehearsal allows athletes to visualize successful execution of techniques and tactical scenarios, thereby improving technical proficiency, tactical planning, self-confidence, and motor learning through the activation of neural pathways similar to those engaged during physical practice (Moran, 2016) [25]. Positive self-talk helps maintain confidence, reduce negative thoughts, regulate emotions, and improve attentional focus during high-pressure situations (Hatzigeorgiadis *et al*., 2011) [18]. Relaxation techniques, including deep breathing, progressive muscle relaxation, and meditation, effectively reduce competitive anxiety and promote emotional stability (Weinberg & Gould, 2019) [46]. Furthermore, mindfulness training enhances present-moment awareness, enabling athletes to minimize distractions, regulate emotions, improve decision-making, and maintain optimal attentional focus during both kata and kumite (Baltzell & Summers, 2018) [2]. Collectively, these psychological skills contribute to improved mental toughness, performance consistency, and overall competitive success in karate athletes.

Future Directions

Although considerable progress has been made in understanding the roles of nutrition and sports psychology in enhancing athletic performance, further research is needed to develop evidence-based strategies tailored specifically to karate athletes. Future studies should investigate nutritional interventions that address the distinct physiological and metabolic demands of kata and kumite, as these disciplines differ in their technical execution and energy requirements (Chaabène *et al*., 2012) [9]. Longitudinal research examining the effectiveness of sustained psychological skills training, including mindfulness, imagery, and resilience-based interventions, is also warranted to determine their long-term impact on performance and mental well-being (Birrer & Morgan, 2010) [4]. Additionally, greater emphasis should be placed on the nutritional needs of female karate athletes, considering factors such as menstrual health, energy availability, bone health, and the prevention of Relative Energy Deficiency in Sport (RED-S) (Mountjoy *et al*., 2023) [27]. Further exploration of the interactions among sleep quality, nutrition, psychological health, and recovery may provide a more comprehensive understanding of the factors influencing performance (Fullagar *et al*., 2015) [16]. Advances in wearable technologies, digital health monitoring, and artificial intelligence also present opportunities to develop personalized nutrition, physiotherapy, and psychological support programs that can continuously monitor athlete health, training load, recovery status, and performance. Such multidisciplinary and technology-driven approaches have the potential to optimize performance, reduce injury risk, and promote long-term athlete development in karate.

Conclusion

Karate performance depends on a complex interaction of physical, nutritional, and psychological factors. Appropriate nutrition provides the energy and nutrients required for training, recovery, and competition, while sports psychology equips athletes with the mental skills necessary to manage stress, sustain motivation, and perform consistently under pressure. Evidence suggests that combining individualized nutrition plans with structured psychological skills training enhances overall athletic performance and supports long-term athlete development. Coaches, sports nutritionists, psychologists, and healthcare professionals should work collaboratively to implement holistic, evidence-based strategies that optimize both physical and mental performance in karate athletes.

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