



A Review: Exploring Nutrition Approaches to Improve Mental Health Among Athletes: Focus on Depression and Disordered Eating

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Abstract

Elite sports environments can increase psychiatric conditions like stress and depression due to social pressure for specific body shapes, encouraging disordered eating behaviors, especially in endurance, aesthetic, and weight-dependent sports. This review aims to investigate eating habits among athletes suffering from poor mental health and identify dietary strategies or nutritional advice to mitigate these conditions in physically active individuals. The review focused on studies conducted after 2010 involving adults in any level of regular physical activity, showcasing psychiatric symptoms related to a disordered relationship with food, including depression and various eating disorders. The search on the literature databases was conducted on 20th October 2023 through multiple electronic databases (PubMed, SCOPUS, and Google Scholar) to capture as many relevant citations as possible. Exclusions were made for studies on children or psychiatric patients. The research was sourced from significant databases, emphasizing the correlation between dietary habits and mental health in athletes. Findings reveal that athletes, particularly in ultra-endurance and weight-dependent sports, are susceptible to psychiatric disorders such as depression, anxiety, and exercise addiction. Competitive bodybuilders also showed higher levels of depression and orthorexia nervosa symptoms. Tailored nutrition therapy, guided by healthcare professionals and adjusted to each athlete's specific needs and preferences, is crucial for addressing psychiatric symptoms and eating disorders in athletes. A holistic approach to recovery and well-being can significantly enhance both performance and overall quality of life, underscoring the importance of high-quality, balanced diets in supporting mental health and athletes' achievement.

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INTRODUCTION

Mental health is defined as a state of well-being that encompasses a person's cognitive, emotional, and social functioning, which enables individuals to cope with the normal stresses of life, realize their abilities, work productively, and contribute to their community (Fusar-Poli et al., 2020). Healthy lifestyle choices, such as consuming a well-balanced and nutritious diet, along with regular physical activity, while avoiding smoking and substance abuse, prioritizing a good quality sleep, managing stress, and engaging social connections have been implicated in the prevention of both medical and psychiatric conditions, at the same time promoting overall well being (Zaman et al., 2019). Athletes' mental health is often jeopardized by the unique pressures and challenges they face in the competitive world of sports.

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For an athlete, maintaining mental health is not only essential for his or her well-being but is also a crucial factor that affects performance on the field. The pressure to perform, fear of injury, expectations from coaches and fans, and the challenge of maintaining a career-life balance can create a highly stressful environment. When athletes' mental health is not well maintained, they can experience a range of psychological disorders such as anxiety, depression, eating disorders, and even substance use to cope with the pressure. The impact of poor mental health is not only limited to reduced athletes' performance but can also result in fractured interpersonal relationships, conflict management difficulties, and decreased motivation or satisfaction in sports. Unaddressed mental health issues can lead to burnout or extreme fatigue that causes athletes to want to withdraw from sports completely. Furthermore, the stigma associated with mental health issues in sports often discourages athletes from seeking help for fear of being perceived as weak or incompetent, exacerbating an already existing situation.

The development and cultivation of health-promoting lifestyle habits seem to be of particular importance to high-achieving individuals, including athletes. The exposure to significant pressures in professional athletes, such as the need to maintain peak performance and meet external expectations, is a well-documented aspect of elite sports. Athletes face stressors, including difficult relationships between coaches and athletes, injuries, challenging opponents, and the scrutiny of the media. Increased stress levels may contribute to the increased prevalence of mental health problems, with research demonstrating that up to 35% of elite athletes may suffer from eating disorders, burnout, depression, and anxiety (Rice et al., 2016). Therefore, minimizing the impact of general and athlete-specific risk factors on mental health subsequently leads to an increased need for developing a comprehensive framework to support athletes. One of the approaches adopted in nutrition education is based on epidemiological evidence that shows the crucial role of diet and eating patterns in maintaining overall mental and physical well-being. To date, research into stress and diet has shown that certain nutrients can bring benefits for managing stress and improve mental well-being, with calcium, magnesium, complex carbohydrates, and omega-3 fatty acids being examples (Bremner et al., 2020). In addition, balancing eating habits related to the consumption of certain foods can also be an integral part of prevention against negative health consequences of eating disorders and recovery from depression and disordered eating (Jeffrey & Heruc, 2020). To date, various research has confirmed a strong relationship between nutrition status and mental health outcomes among athletes (McCabe et al., 2021). Therefore, the main aim of this exploratory review is to outline the common mental health conditions caused by sports discipline, with a primary focus on depression and disordered eating. These psychiatric conditions, discussed in the context of professional and amateur athletes, will be then assessed in the context of dietary habits to explore if certain nutritional advice focused on dietary patterns and/or consumption of certain foods and supplementation may help to decrease the prevalence of these conditions among the athletic populations.

METHOD

The primary goal of this narrative exploratory literature review was to examine the occurrence and types of disordered eating among sports athletes across different disciplines and to recommend potential dietary interventions that could help reduce these conditions' prevalence (Czarniawska-Joerges, 1998). This would not only aid in improving the athletes' well-being but also enhance their performance. The review focused on studies conducted after 2010 involving adults engaged in any level of regular physical activity, from amateur to professional, that reported psychiatric symptoms indicating a disordered relationship with food, specifically depression and various forms of disordered eating such as binge eating, emotional eating, bulimia, and anorexia. Following a thorough search through multiple electronic databases like PubMed, SCOPUS, and Google Scholar on 20th October 2023, relevant studies were identified, screened, and assessed for inclusion based on titles, abstracts, and full texts. This process was meticulously conducted to ensure comprehensive coverage of the topic. Discrepancies between reviewers were settled through consensus. After screening and selection, the studies were categorized by sport discipline, and based on the evidence gathered, innovative dietary interventions were proposed to mitigate disordered eating among athletes, thereby fostering both their well-being and performance.

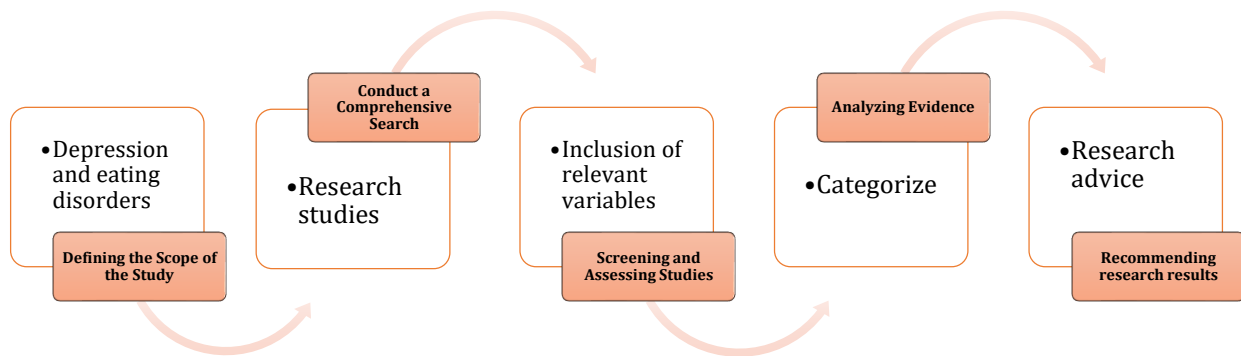


Figure 1. Research Flow

RESULTS AND DISCUSSION

Results

Despite the potential benefits of physical activity on mental well-being, the pressures of elite sports can contribute to mental health problems among athletes. Depression, also known as Major Depressive Disorder (MDD), is a serious mood disorder that can be characterized by persistent feelings of sadness, a loss of interest or pleasure in activities, feelings of worthlessness or guilt, and difficulty concentrating or making decisions. Changes in appetite, sleep disturbances, and fatigue over at least two weeks can significantly compromise the quality of life and well-being (Cui, 2015). Although depression can affect everyone, exposure to certain risk factors, including medical history of depression, major negative life changes, trauma/serious chronic illness (e.g., diabetes, cancer, cardiovascular disease), or any form of persistent chronic stress can increase the chances of developing this condition. These can be of particular importance for athletic populations, as being exposed to either mental or physical distress or being linked with a demanding training regime and the pressure of competing can make them vulnerable to MDD. In particular, individuals engaging in sports professionally, such as elite athletes, despite the common belief that their success, can be at higher risk of depression and/or disordered eating conditions, which may negatively impact their well-being as well as sports performance. Interestingly, the MDD was identified as one of the mental health conditions that can be experienced by athletes (Åkesdotter et al., 2020), with studies showing that around 33.6% of athletes reporting symptoms of anxiety/depression (Nicholls et al., 2020) and the prevalence rate of depression in these populations can range from as low as 15.6% to as high as 21% (Wolanin et al., 2015).

In addition, depression has been implicated as an important factor significantly affecting body image as well as individual relationships with food, leading to changes in appetite, overeating, or undereating (Keski-Rahkonen & Mustelin, 2016). Research to date demonstrated a strong connection between depression and eating disorders, showing that experiencing depressive states and behaviors can contribute to the development or maintenance of eating disorders of restrictive eating or bingeing/purging (Sander et al., 2021). Although eating disorders can affect anyone at any stage of life, they are frequently reported in young people and adolescents, in particular, women who seem to be twice as likely to struggle with these conditions (Hay et al., 2023). Nevertheless, the prevalence of eating disorders in athletes is of significant concern, as current evidence indicates that up to 45% of female athletes and 19% of male athletes may be diagnosed with eating disorders. The desire to achieve a sport-specific body shape or weight, as well as the pressure to excel in performance, can contribute to unhealthy relations with food and disordered eating patterns (Mancine et al., 2020). Actually, 13.5% of athletes struggle with an eating disorder (El Ghoch et al., 2013), including up to 45 % of female and 19% of male athletes (Conviser et al., 2018). A recent study examining eating behaviors in athletes and non-athletes revealed that despite lower levels of body dissatisfaction reported in athletes when compared to non-athletes, increased drive for thinness in the athletes has been linked with higher chances for the development of food-restricting behaviors and loss-of-control eating, especially in individuals competing in aesthetic/lean sports compared to non-aesthetic/non-lean sports (Chapa et al., 2022). Therefore, mentioned disordered eating behaviors, such as skipping meals, restricting overall energy or macronutrient-specific food intake, and purging, may lead to primary eating disorders like Anorexia Nervosa, Restrictive (AN-R), and

Bulimia Nervosa (BN) (Roberts et al., 2022); however, the Binge-Eating Disorder (BED) is the most common, in particular in those who struggle with stress coping. BED is characterized by consuming large amounts of food in a short period, despite a lack of hunger, while experiencing feelings of guilt and emotional distress (Jiang, 2021). It is also a significant concern for the athletic community, with research suggesting that rates of BED in athletes may be higher than those seen in the general population, ranging from 10 to 15% (Hay, 2020).

Interestingly, BED prevalence rates in male athletes appear to be equal or even greater than those seen in female athletes, explained by the pressure to achieve a certain body image or weight, the pursuit of performance goals, the stigma surrounding help-seeking behaviors, and societal expectations related to body image and masculinity (Paul et al., 2023). Interestingly, research has found a correlation between disordered eating and perfectionism, with an emphasis on precision and personal expectation for an athlete to achieve a sport-specific body to improve performance (Brown et al., 2012). One of the critical risk factors and symptoms of disordered eating among athletes is perfectionism, which has been linked with unrealistic expectations, followed by dissatisfaction with body image and sports performance (Mancine et al., 2020).

Disordered Eating in Athletic Population by the Sports Discipline

Disordered eating behaviors are visible in a variety of sports disciplines in different ways. Their causes and side effects might be different; hence, it is important to view them as categorized sports. Balancing energy intake with energy expenditure is crucial to prevent an energy deficit or excess, enhance athletic performance, and promote short and long-term health. In particular, high-performing athletes have specific dietary requirements to account for increased energy expenditure resulting from training load, optimal performance, and enhanced recovery. These requirements include energy balance, timing of food consumption, macronutrient and micronutrient intake, and hydration. Athletes need to approximate their energy requirements, which are influenced by factors such as training, environmental exposure, stress, and illness. Energy balance occurs when energy intake equals total energy expenditure, which is a summation of basal metabolic rate, thermic effect of food, and thermic effect. The timing of food consumption is important to optimize performance, with meals to be eaten a minimum of 3 hours before exercise and recovery foods to be consumed within 30 minutes to 2 hours of exercise. An ideal diet for athletes comprises 45% to 65% carbohydrates, 10% to 30% protein, and 25% to 35% fat. Protein consumption is essential in the recovery period after training, and athletes can benefit from having some carbohydrates both before and after exercise to ensure adequate performance. Athletes trying to lose weight on a reduced energy diet may benefit from increased protein intake of up to 2.0 g/kg of body weight per day (Roberts et al., 2022).

Athletes participating in sports that emphasize leanness, such as distance running, wrestling, gymnastics, figure skating, dance, and weight-dependent sports, are more susceptible to disordered eating behaviors. Research has shown that athletes in lean sports have been reported to have a significantly higher risk of eating disorder pathology compared to non-competitive athletes, with 84% of the female athletes who screened positive participating in lean sports. Additionally, male athletes, regardless of sport type, may be vulnerable to subclinical eating disorders, and there is a need for further research in this area. The emphasis on achieving and maintaining a specific body type or weight in lean sports can contribute to the development of disordered eating behaviors, which can have a significant impact on the health and performance of athletes (Mancine et al., 2020).

Aesthetic Sports

Aesthetic sports are classified under the lean sports category, including gymnastics, diving, ice skating, ballet, and dancing, due to the belief that a lower body weight results in more favorable judging and scoring higher results of performance. Consequently, athletes tend to purposely reduce their food intake by skipping meals or limiting their food intake with the idea of having a fitter body; however, such behaviors are signs of disordered eating, which may become long-term and become an eating disorder (Mancine et al., 2020). Interestingly, elite athletes performing aesthetic sports have been shown a higher risk of developing eating disorders, which has been linked to the social pressures to get thinner and consequently achieve better performance (Krentz & Warschburger, 2011) and being under the social pressure of the environment. Judges use many factors when

determining the performance of an individual or group in aesthetic sports; judging uses a complex set of rules; thus, appearance is a major factor in judging (Mancine et al., 2020).

Endurance Sports

Endurance sports, being another example of lean sports, including activities of cycling, rowing, running, swimming, cross-country skiing, and speed skating, also promote a lean body with lower body weight, which is typically associated with a higher level of competition and better performance. Similarly to aesthetic sports disciplines, this leads to an increased tendency to engage in abnormal eating behaviors. This can be especially dangerous for the health of athletes, as high metabolic requirements are attributed to high-volume aerobic training and may result in severe metabolic imbalances, being resultant from glycogen depletion, immune suppression, as well as reduced hydration and nutritional deficiencies (Mancine et al., 2020).

Although evidence suggests that physical activity can promote good health and reduce the risk of mental conditions, actually engaging in professional or excessive endurance training may result in a higher risk of psychiatric disorders. For example, Ultra-Endurance-Athletes (UEA) being involved in extremely high training volumes indicate that they are exercising beyond moderation, such as ultra-marathons, Ironman triathlon, endurance cycling, and endurance swimming have implications for the mental health and risk of disordered eating in athletes (Colangelo et al., 2023). To date several mental health disorders have been associated with UEA, of which depression, anxiety, exercise addiction, eating disorders, and sleep disturbances were the most common, probably arising from the increased mental, behavioral, and physical demands of training and competition. For example, endurance athletes can also be at higher risk of exercise dependence (EXD), with an occurrence of more than 50% among triathletes (Hauck et al., 2020). In the general population, it is maintained in the range of 0.5–3.5% (Hauck et al., 2020). The most vulnerable seem to be long-distance runners, who are prone to Negative Running Addiction (NRA). They manifested a greater degree of commitment to running, often beyond other aspects of living lives, which can lead to withdrawal syndrome, anxiety, and irritability in case of missing the training session. Primarily, NRA was mainly reported in men, but in recent years, studies have found that females can also experience it. In females, NRA is either a primary addiction, with the absence of eating disorders, or a secondary addiction, accompanied by eating disorders, such as anorexia nervosa or Bulimia Nervosa, in which excessive exercise is performed to control energy expenditure (Hernández et al., 2021). Interestingly, a study investigating the relationship between NRA and the tendency to be a compulsive eater performed on 167 Spanish cohorts of cross-country and track runners found that 97.1% of the surveyed individuals showed compulsive eating behavior and 65.9% of them had the three highest scores (9 or more actions of 11 listed, with relation to disordered eating) (Hernández et al., 2021). Interestingly, a similar tendency was reported in competitive cyclists, who focus on the power-to-body weight ratio as a determinant of success. They appear to have a higher risk of developing eating disorders (Roberts et al., 2022), reported as 17.9% among Spanish triathletes (Muros et al., 2020).

Weight-dependent Sports

Weight-dependent sports, including disciplines of wrestling, karate, weight-lifting, and boxing, use classification systems that categorize athletes based on their body weight. Consequently, these disciplines emphasize the individuals' ability to achieve and maintain a lower body weight, as it is believed to provide a competitive advantage. Athletes competing in these sports are at an increased risk of developing disordered eating behaviors compared to nonathletes, as they are more prone to engage in disordered eating to control their weight to achieve lower body weight while maintaining muscle mass. The prevalence of mental health issues, including eating disorders and exercise addiction, is reported to be high in athletes participating in weight-dependent sports, emphasizing the need for awareness and support for the well-being of these athletes. The emphasis on achieving a low body weight in these sports can contribute to the development of disordered eating behaviors and other mental health challenges (Mancine et al., 2020).

Bodybuilding is a sport that emphasizes the growth of muscles and ranks participants on body muscularity, leanness, and size (MacPhail & Oberle, 2022). Muscle Dysmorphia (MD) is a behavior of a fixation on muscle appearance and concern that one's body is not lean or muscular enough. Orthorexia Nervosa (ON) is a condition characterized by healthy eating and restricted diets,

as well as experiencing emotional distress if someone were to veer away from this diet (MacPhail & Oberle, 2022). Due to the emphasis on muscle size and leanness in the sport, bodybuilders adhere to specific exercises and nutritional strategies to achieve their desired body. Such carefully selected diets are more common in turn to lead to conditions such as orthorexia nervosa.

Furthermore, the bodybuilders' use of strict dietary constraints and an intensive exercise regime lifestyle seems like an environment where the development of MD is feasible. Supporting this claim is a meta-analysis of several studies revealing that MD symptomatology is significantly greater among bodybuilders than among non-bodybuilding strength/resistance trainers (MacPhail & Oberle, 2022; Mitchell et al., 2017). Moreover, in bodybuilders, MD levels were greater among competitive bodybuilders than non-competitive bodybuilders (Mitchell et al., 2017) and greater among bodybuilders currently using steroids than either non-using bodybuilders (Harris et al., 2019) or former-using bodybuilders (Greenway & Price, 2020; MacPhail & Oberle, 2022). Many factors may contribute to MD, such as social anxiety symptoms, mood intolerance, self-oriented perfectionism, low self-esteem, and exposure to highly developed physiques through mass media (MacPhail & Oberle, 2022).

Studies have found a positive correlation between muscle dysmorphia and orthorexia nervosa, meaning that a higher risk for ON is associated with a higher risk for MD as well. In that case, bodybuilders seem to endorse feelings related to MD more often than fitness practitioners and strength athletes (Cerea et al., 2018), signifying that MD is more prevalent among bodybuilders (MacPhail & Oberle, 2022). Additionally, ON was found to be a significant predictor for MD among the bodybuilders in this study. Understanding the lifestyle, beliefs, and behaviors associated with bodybuilding is key to knowing how MD and ON can be prevalent in this sport (MacPhail & Oberle, 2022). These psychiatric conditions discussed in the context of professional and amateur athletes will be then assessed in the context of dietary habits to explore if certain nutritional advice focused on dietary patterns and/or consumption of certain foods and supplementation may help to decrease the prevalence of these conditions among the athletic populations.

Discussion

The role of nutrition in reducing the incidence of disordered eating *is that* the relationship between nutrition and depression is bidirectional, as food choices and diet quality can influence depression risk and depression status, while depressive symptoms may affect food choices and diet quality (Pols, 2018). To date, research has demonstrated the relationship between depression risk and dietary habits, which can either promote well-being or lead to unhealthy eating behaviors (Ekinici & Sanlier, 2023), including eating disorders, like binge eating or bulimia nervosa (Pols, 2018). In particular, poor-quality diets, composed of highly processed foods, refined grains, refined sugars, sweetened beverages, foods high in saturated and trans fats, as well as high-glycemic foods have been associated with a higher risk of depression, whereas high-quality diets promoting the intake of unprocessed foods, like whole grains, fruits, and vegetables, along with unsaturated fats, and lean sources of both animal and plant protein promote optimal wellbeing. Intriguingly, people affected by mental health disorders like depression tend to have poorer diet quality, as they consume little fruits and vegetables, fish, poultry, whole grains, and low-fat dairy products (Paans et al., 2019), which may further contribute to the onset and progression of depression (Ekinici & Sanlier, 2023). On the other hand, promoting a high-quality diet, regardless of its type, can be efficient in the treatment of mental disorders, in particular, lowering the risk of depressive symptoms (Molendijk et al., 2018).

Depression is a prevalent mental health concern affecting a substantial portion of the global population. While the connection between diet and mental health is well-established in the general population, its implications for athletes are gaining attention. Athletes being subjected to rigorous physical and mental demands may make them more susceptible to depression, with rates ranging from 15.6% to 22.3% among college athletes (Weber et al., 2023; Wolanin et al., 2015). Therefore, athletes, similar to the general population, can benefit significantly from dietary interventions aimed at reducing the risk of depression and the risk of eating disorders.

Athletes are prone to low-grade inflammation, as intense physical exertion can induce both acute and chronic inflammatory responses. Therefore, adopting anti-inflammatory diets, characterized by the consumption of foods rich in antioxidants, plays a crucial role in reducing inflammation and may benefit their performance and recovery as well as mental status. Some of the

best choices with impacted anti-inflammatory, anti-oxidative, and antidepressant properties include fatty fish, berries, green leafy vegetables, and fermented foods. For example, berries, including strawberries, blueberries, raspberries, and blackberries, being a rich source of vitamin C, dietary fiber, potassium, and magnesium, as well as plant bioactives like flavonoids when consumed regularly can aid the reduction of depressive symptoms (Di Lorenzo et al., 2019; Fisk et al., 2020; Nabavi et al., 2018; Rafael et al., 2020). Similarly, green leafy vegetables, such as spinach, kale, and watercress, showcase their potential for mental health prevention because of their high levels of iron, magnesium, calcium, potassium, folate, vitamins A and C, and antioxidants. Cross-sectional studies highlight the association between higher consumption of green leafy vegetables and a lower likelihood of depressive symptoms, with some indication of antidepressant and anti-stress properties (Baharzadeh et al., 2018; LaChance & Ramsey, 2018; Son et al., 2018). In addition, fish are a source of high-quality protein, vitamins, minerals, and fatty acids; specifically, immunoregulatory omega-3 fatty acids have been linked to a reduced risk of depression and improved immune status (Grosso et al., 2016; Morales-Suárez-Varela et al., 2023; Smith et al., 2014; Yang et al., 2018). Finally, enriching diets with fermented foods containing probiotic microorganisms along with their health-promoting bioactives, such as probiotic yogurt, kefir, kimchi, and sauerkraut, can improve gut health, promote better mental health, lower depression risk, as well as improve sleep and reduce perceived stress. Interestingly, probiotic-rich diets have been associated with lower depression severity, particularly in men, and fermented dairy products like yogurt and cheese have demonstrated a significant correlation with lower depression risk (Karbownik et al., 2022; Kim & Shin, 2019; Luo et al., 2023; Şanlıer et al., 2019).

Furthermore, traditional dietary patterns focusing on regular consumption of these products, such as the Mediterranean, Paleo, and plant-based diets, show promise; it is crucial to tailor nutritional approaches towards the unique needs of athletes, as they can vary depending on the performance level, sports discipline, and the training load (Janiczak et al., 2024). For example, the Mediterranean diet originated from the countries associated with the Mediterranean Sea, such as Italy, Greece, Spain, Morocco, Egypt, and Lebanon, and is primarily based on plants and seafood, allowing for moderate consumption of other animal proteins. High daily intakes of whole grains, fruits, vegetables, beans and legumes, olive oil, and nuts characterize it. Several studies focus on the impact of the Mediterranean diet on depression (Adjibade et al., 2018), showing that their components may lead to a reduction in depressive symptoms (Gibson-Smith et al., 2020). Higher consumption of traditional Mediterranean foods, such as non-refined grains, vegetables, fruit, olive oil, and potatoes, has been associated with lower depression severity.

Moreover, people who drank moderate amounts of rich in polyphenols red wine were also found to have fewer depressive symptoms than non-drinkers. These findings were confirmed in later studies showing that high and medium adherence to the Mediterranean diet was associated with a lower risk of depression study (Oliván-Blázquez et al., 2021; Yin et al., 2021). A potential benefit for improving mental health status can also be attributed to the Paleolithic diet, also known as the Paleo, which consists of foods that were thought to be eaten by primary tubes, including meat, fish, vegetables, fruits, and nuts, while excluding grains, legumes, dairy products, and processed foods. Compared to the Mediterranean diet, fat sources in the Paleo diet are mainly animal fats like butter or lard (Zamani et al., 2023). Although the research exploring the effects of the Paleo diet on depression is limited, preliminary evidence suggests that adherence to the Paleolithic diet may contribute to lower odds of depressive symptoms and other psychological disorders.

While there is evidence to suggest that a well-rounded diet, including a balance of carbohydrates, proteins, and fats, is essential for cognitive function and mental wellness, the specific impact of lipid intake on depression in athletes is not fully understood. However, some studies have proposed a potential link between macronutrient intake and depressive symptoms in athletes. For example, high protein diets, commonly embraced by athletes for muscle building and recovery, present a complex relationship with depression. While contradictory findings exist, some studies suggest that increased protein intake may offer protective effects against depression among Swiss adolescent elite athletes (Gerber et al., 2023), effects of carbohydrates and lipids have shown inconsistent effects. Carbohydrates play a crucial role in providing energy for both physical and mental performance, and exercising in a carbohydrate-depleted state can result in higher levels of stress hormones, thereby leading to exercise-induced immunodepression (Gunzer et al., 2012).

Consequently, increasing carbohydrate consumption in athletes ensures that glycogen stores in muscles are replenished. Diets rich in carbohydrates have been suggested to be better suited to prevent depressive symptoms (Gerber et al., 2023). Additionally, studies have shown that carbohydrate load is associated with quicker race speeds in ultra-marathon sporting events (Ravindra et al., 2022); consuming drinks containing glucose before, during, and two hours after exercise has been shown to improve performance in elite female rowers (Henson et al., 2000). Nonetheless, further research should be carried out to determine if carbohydrates could affect depression in athletes, with a specific focus on how performance affected by carbohydrates could impact mental health. Some studies have indicated that a high-fat diet may induce continuous low-grade inflammation, which can have implications for mental health. While intake of omega-6 fatty acids can increase the levels of pro-inflammatory cytokines and inflammatory prostaglandins, both of which cause a higher level of inflammation, intake of omega-3 fatty acids may decrease the levels of cytokines and prostaglandins, possibly reducing the risk of chronic inflammatory state (Buonocore et al., 2015). Similarly to carbohydrates, further research is required to establish the relationship between lipids and depression in athletes (Bagchi et al., 2012).

Micronutrient supplementation and its relationship to the risk of depression in athletes is an area of interest. Some micronutrients closely linked to mental health include folic acid, vitamin B6, vitamin B12, vitamin D, zinc, and magnesium. Insufficient intake of these micronutrients can contribute to feelings of irritability, anxiety, and low energy, which are associated with depression (Sánchez-Villegas et al., 2018). Additionally, a comprehensive systematic review of the literature in sports medicine emphasized the importance of micronutrients for athletes' health, physical performance, and mental well-being. It suggested that by ensuring adequate levels of micronutrients, athletes can give themselves a competitive edge and maximize the potential of their training (Ghazzawi et al., 2023). For example, higher intakes of vitamin B, particularly B7, have been linked to a lower incidence of depression in the general population (Mahdavifar et al., 2021). While direct studies on the relationship between folate (B9), B6, B12, and depression in athletes are scarce, evidence suggests a potential connection between increased B vitamin intake, physical activity, and reduced depressive symptoms (Lang et al., 2015; Yary, 2013). Similarly, magnesium supplementation may help to prevent the development of depressive symptoms, as elite athletes may be predisposed to magnesium deficiency due to engaging in high-load training (Rajizadeh et al., 2017). In addition, magnesium acting as an NMDA receptor antagonist has been implicated in maintaining adequate serotonin levels, which are important in reducing depression risk (Lang et al., 2015; Rajizadeh et al., 2017). Also, for vegetarian or vegan athletes, careful monitoring of micronutrients like folate, iron, vitamin D, and vitamin B12 is essential to prevent deficiencies (Devrim-Lanpir et al., 2021). Vitamin D supplementation has shown promise in mitigating depression risk, with studies indicating a correlation between decreased vitamin D levels and increased depression scores in athletes (Hoang et al., 2011; Tomlinson et al., 2021). Similarly, dietary supplementation is an important aspect for individuals with disordered eating who demonstrate nutritional deficiencies. Vitamin D, B1, B12, and B9, as well as minerals like zinc, iron, copper, and selenium, are commonly lacking (Hanachi et al., 2019). Correcting these deficiencies through appropriate supplementation or incorporating nutrient-rich foods, such as antioxidant-rich foods, i.e., blueberries, spinach, dark chocolate, pecans, strawberries, and artichokes, could be beneficial (Moyano et al., 1999). Additionally, limiting caffeine consumption (Marino et al., 2009) while also avoiding restrictive dieting and promoting a regular pattern of nutritionally balanced, planned meals and snacks throughout the day can further enhance recovery (Rock & Curran-Celentano, 1996).

Given the implications of nutritional interventions in preventing depression among athletes, also introducing changes in dietary habits may bring benefits in reducing the risk of eating disorders in these physically active individuals, as they are uniquely vulnerable to disordered eating and exercise behaviors. Evidence to date has shown that athletes with subclinical eating disorders are at higher risk of developing dietary deficiencies linked with inappropriate intakes of energy, protein, carbohydrates, and certain micronutrients being below recommended levels, highlighting the importance of proper nutrition (Beals & Manore, 1998). Nevertheless, the use of specific diets should be carefully monitored, as they may be associated with disordered eating behaviors (De Borja et al., 2021). For example, diet-adherent athletes in 68.5% appear to suffer from at least one eating disorder compared to non-diet-adherent athletes, in which case 41.8% of individuals were affected

by the eating disorder (De Borja et al., 2021). Also, the use of low-carbohydrate diets characterized by a reduction of daily carbohydrate intake to less than 100g/day to even less than 50g/day (De Borja et al., 2021), without clinical indications, is linked with increased prevalence of disordered eating in adhering athletes compared to those who were non-diet-adherent. Specifically, the restriction of carbohydrates may be a common method that athletes use to manage or lose weight, which can be associated with the development of eating disorders (De Borja et al., 2021).

Additionally, athletes on low-carbohydrate diets may be more prone to restrictive eating tendencies, which can weaken muscles and lead to complications (Kaufman et al., 2023). In addition, being in the metabolic state of ketosis, induced by severe restriction in carbohydrate intake, may contribute to this association, as maintaining adequate carbohydrate intake seems crucial to prevent energy deficits and support overall athletic performance (De Borja et al., 2021). However, the research into the effects of KDs on eating disorder outcomes in athletes is limited, and there are concerns over the risks of diabetic ketoacidosis and other potential side effects (Schneider et al., 2022).

Similarly, both gluten-free and dairy-free diets are characterized as eating patterns entirely excluding foods that either contain gluten or lactose. In certain individuals, this can cause gastrointestinal symptoms resulting from increased sensitivity or development of tolerance of these components. Chosen without medical necessity, these diets were prevalent among athletes suffering from eating disorders (De Borja et al., 2021). Such diets, when not clinically indicated, may result in suboptimal intake of essential macronutrients and micronutrients, leading to deficiencies in B vitamins, calcium, vitamin D, iron, and potassium. These deficiencies are associated with EDs, such as anorexia nervosa (Achamrah et al., 2017).

Consequently, athletes should maintain a recommended daily intake of gluten and dairy unless a diagnosed sensitivity or medical condition necessitates their exclusion. The effect of promoting plant-based diets, depending on their type, may have certain advantages and disadvantages, as various restrictions, from pescetarian to vegan, can impact athletes differently. Whereas plant-based eating has been associated with benefits for both mental and physical health, including improved arterial function, effective glycogen storage, reduced body fat, and lower levels of oxidative stress and inflammation, which altogether may contribute to enhanced performance and faster recovery (Shaw et al., 2022); strict adherence to restrictive plant-based diets, particularly those avoiding multiple food groups, like vegan or vegetarian version excluding intake of dairy or eggs, have been linked with higher rates of reported eating disorders (De Borja et al., 2021), and nutrient deficiencies, particularly in iron, calcium, vitamin D, zinc, and vitamin B12, which are essential for athletes to avoid to Relative Energy Deficiency in Sport (RED-S). One dietary intervention that promotes well-balanced and nutrient-dense foods is the Mediterranean pattern of eating. This diet, being rich in unprocessed foods like green leafy vegetables, fatty fish, berries, nuts, and olive oil, has been linked with many physical and mental health benefits associated with reduced inflammation and oxidative stress in both depression and intensive training (Marx et al., 2021). Incorporating such a diet may promote overall well-being in athletes as long as it's introduced in a non-restrictive and mindful manner.

The contributions of this research provide significant insight into the complex relationship between mental health, eating disorders, and athletic performance, highlighting the importance of nutritional interventions in preventing depression and eating disorders among athletes. The findings suggest that sports organizations, coaches, and health professionals should prioritize mental health screening and support services for athletes, as well as develop policies that integrate nutritional and mental health support into training programs and competitive environments to enhance the holistic well-being of athletes. The review provided exploratory and valuable insights into the complex relationship between mental health, disordered eating, and athletic performance. However, the limited number of studies, along with the high variability in the methodology used, need to be acknowledged and considered as a key limitation of this study. The review only includes studies that meet the proposed eligibility criteria, which may introduce selection bias, as only studies focusing on adults engaged in regular physical activity were included. This may overlook valuable information from studies involving other populations or age groups that could contribute to a more comprehensive understanding of disordered eating in athletes. Many of the studies included in the review may be cross-sectional, providing a snapshot of disordered eating behaviors and mental

health symptoms at a specific point in time. Longitudinal studies would offer more robust evidence regarding the causal relationships and long-term effects of dietary habits on mental health outcomes among athletes. Also, this review discusses evidence retrieved from the dietary interventions. It may lack sufficient interventional evidence to support specific recommendations. Finally, this review was focused on specific sports disciplines, such as ultra-endurance, weight-dependent sports, and bodybuilding. Thus, distinct demands and pressures of other disciplines may influence the prevalence and manifestation of disordered eating behaviors.

Consequently, the findings of the review may not be universally applicable to all athletes, as the focus of this study is on professional or highly competitive individuals, and the requirements of recreational or amateur athletes may differ significantly, impacting the generalizability of the conclusions. Addressing these limitations can strengthen the validity and applicability of the findings, providing a more nuanced understanding of the interplay between nutrition, mental health, and athletic performance. Future research should aim to include more interventional studies to evaluate the effectiveness of dietary strategies in mitigating disordered eating behaviors and improving mental health outcomes among athletes.

Despite certain limitations, the findings of this exploratory narrative review have several implications for practice, policy, and future research in the realms of athlete mental health and nutrition. Practically, sports organizations, coaches, and healthcare professionals should prioritize mental health screening and support services for athletes, particularly those engaged in ultra-endurance, weight-dependent sports, and bodybuilding, where a higher prevalence of psychiatric disorders and disordered eating behaviors are noted. Policies should be developed to promote a holistic approach to athlete well-being, integrating mental health and nutritional support into training programs and competitive environments. Future research efforts should focus on longitudinal studies to elucidate the causal relationships between dietary habits, mental health outcomes, and athletic performance, considering the diverse array of sports disciplines and athlete populations. Interventional research should explore the efficacy of tailored dietary interventions in preventing and managing disordered eating behaviors and mental health conditions among athletes while also considering potential contextual factors such as socio-cultural influences and sport-specific demands. Additionally, collaboration between researchers, practitioners, and policymakers is essential to develop evidence-based guidelines and interventions that optimize athlete health and performance while mitigating the risks associated with poor mental health and disordered eating (Purcell et al., 2019; Strock et al., 2023).

CONCLUSION

Nutrition's role in enhancing athletes' mental health and managing conditions like depression and disordered eating is increasingly acknowledged. Elite sports environments often intensify stress, depression, and unhealthy eating behaviors due to pressures for specific body shapes and performance targets. Individualized nutrition therapy, under professional supervision, is critical for addressing these psychiatric symptoms, focusing on creating a balanced relationship with food, mind, body image, and physical activity for holistic recovery. Poor diets rich in refined sugars and fats can escalate depression risks and degrade performance, while balanced diets with whole foods, lean proteins, and anti-inflammatory components like fatty fish and berries can promote health and improve mood. Customizing dietary plans to each athlete's needs is essential, especially avoiding restrictive diets that can trigger disordered eating unless medically necessary. Nutritional strategies, including careful supplementation, are vital for reducing depression and eating disorders risk, emphasizing the importance of maintaining proper nutrient intake, especially for those on plant-based or restrictive diets. Education on healthy eating and targeted nutritional interventions can significantly improve athletes' mental health and performance. These efforts, starting from collegiate programs, aim to enhance nutritional awareness and prevent injuries, supported by evidence that nutritional counseling improves athletes' dietary habits and mental well-being. Integrating mental health support with nutritional care is crucial for athletes to achieve peak performance while maintaining overall health. Future research will further define optimal nutrition guidelines for supporting athlete mental health.

AUTHOR CONTRIBUTION STATEMENT

ZM led the conceptual and methodological design and drafted the manuscript. I-MH managed data collection and analysis, applying statistical methods for interpretation. JM developed the software for the study and validated the findings, ensuring accuracy. JMJ supervised the project, provided guidance, and critically reviewed and refined the manuscript.

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