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Depression in Elite Athletes- Interplay between neuroendocrine disturbances, immune-inflammatory responses, and disturbed sleep: A Narrative Review

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ABSTRACT

Background. Depression in mental health is an important issue in elite athletes, with significant consequences for physical performance and physiological adaptation. Notwithstanding the perception of athletes as robust individuals, recent findings show that higher performance athletes report symptoms of depression at least at or above the general population levels. It can be a combination of competitive pressure, overtraining, injury and a career change..

Aim. The aim of this study was to present the current state of knowledge on the effects of Depression in Elite Athletes- its Impact on Bodily Functioning and The Capacity for Physical Exertion

Material and Methods. A narrative review was conducted using databases PubMed and full-text articles available in PubMed Central (PMC) and Web of Science covering

publications from 2000 to 2025. Terms used for search "depression", "elite athletes", "mental health"

Results. Research indicates that depression now represents a significant health concern among athletes. Indeed, gender, sport type, and age seem to moderate these outcomes with higher symptom rates seen in female and in individual-sport athletes. Elite athlete depression not only jeopardises psychological functioning but also induces strong physiological disruptions causing adverse effects on athletic performance. The reasons for this complex interplay include neuroendocrine regulation, immunity and sleep quality.

Conclusion. Depression in elite athletes is a common and often complex disorder that has been shown to have major impact upon mental health and sport performance. The incorporation of the physiological and psychological perspectives in this review illustrates how depression deserves to come to terms in athlete holistic management as part of the holistic approach of mental health services.

Keywords: depression, elite athletes, mental health, physical performance, sport psychology

1. Introduction

Elite athletes are generally viewed as models of physical and mental endurance. But increasing evidence contradicts this view, indicating a susceptibility of athletes to severe psychiatric illnesses, including depression [1–3]. Depression in this group has important physiological, recovery, and also athletic consequences [4–6] and influences their psychological status. Pressures of competing, performance requirements, injury and career transitions are significant risk factors for depressive symptomatology in elite athletes [2,7]. Further, overtraining syndrome and disturbed sleep contribute to the risk-related complications with imbalances related to hormonal balance, immune system and cardiovascular performance [8–11]. However, screening of mental problems and targeted programs are low in use in numerous sports organizations.

The objective of this review is to combine recent evidence about depression in elite athletes and highlights its high prevalence, physiological and psychological mechanisms, and clinical impact on performance. With 24 high-quality studies combined into this article, it offers a holistic overview that combines both the psychological and physiological aspects of athlete psychology.

2. Materials and Methods

This article is a literature review. A thorough literature search was performed to determine peer-reviewed publications on depression in elite athletes and its related effects on physiological functioning and physical performance. Databases searched included PubMed, PubMed Central

(PMC), and Web of Science, covering publications from 2000 to 2025. Search terms were combinations of “depression,” “elite athletes,” “high-performance athletes,” “physical performance,” “physiological function,” “overtraining,” and “mental health”.

Studies were included if the following was met: participants were elite or professional athletes, depression symptoms or depression diagnosed were assessed with validated measures or clinical diagnosis; and the outcomes included physiological indices, physical performance indicators, or psychological dimensions. Exclusion criteria were studies with only recreational athletes, non-English publications, and studies with no relevant outcome measures.

Twenty-four studies were chosen for inclusion, which included systematic reviews, meta-analyses, cohort studies and qualitative research. Information retrieved included sample data, depression frequency, measurement instruments, physiologic and other factors, performance outcomes, and psychosocial factors related to depression. The synthesis was narrative focused, addressing prevalence, mechanisms, performance implications and recommendations for athletic communities and clinicians in practice.

3. Prevalence of Depression in Competitive Athletes

Depression among elite athletes has become an important mental health issue undermining the traditional view of athletes as psychologically well-adjusted subjects. Systematic reviews and meta-analyses show that the prevalence of depressive symptoms among elite athletes varies from 15% to 35% according to the sport, gender, and approaches used [1,2,5]. In individual sports such as gymnastics, swimming, and long distance running, female athletes consistently report higher rates of symptoms than those corresponding with male players [3,4,6].

Factors contributing to this are the high use and competition-style pressure, injury, as well as psychological impact of overtraining. [5] Over one third of elite athletes have clinically relevant depressive symptoms, at an incidence similar to or greater than that of the general population. Career transitions—like retirement from sports—are also linked to increased risk, especially if the individual athlete suffers loss of identity or social connection [7,8].

Differences across disciplines can also be identified in specific studies. Ultra-endurance athletes and professional runners, for instance, have high rates of depressive symptoms, commonly associated with training load, sleep difficulties, and immune dysregulation [9,10]. Social pressures, media attention, and performance requirements on team sport athletes may increase the burden of mental health risk, although prevalence is relatively low compared to other team sport athletes [11,12].

In all, these results illustrate the importance of providing monitoring and support for mental health in elite sports settings. Prevalence estimates may vary based on measurement instruments (e.g., self-report vs. clinical interview scales) and cultural assumptions, however the results between studies implies that depression is a significant and underappreciated problem among elite sportsmen and women.

4. Mechanisms Linking Depression to Physiological Function

The mechanisms that connect depression to physiological functioning. Elite athlete depression not only jeopardises psychological functioning but also induces strong physiological

disruptions causing adverse effects on athletic performance. The reasons for this complex interplay include neuroendocrine regulation, immunity and sleep quality.

4.1 Neuroendocrine Dysregulation

Depression is associated with dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis, which leads to alterations in cortisol secretion patterns. Increased basal levels of cortisol, which are often common in athletes who experience depression, can have a negative impact on recovery, reduce muscle protein synthesis, and predispose to fatigue [6,9,13]. Furthermore, serotonergic and dopaminergic routes are implicated also [14,15], with very low central serotonin levels implicated in low motivation, mood problems and disturbed motor control [14,15]. Dysregulation of such neurotransmitters may be linked together with training load and psychological stress, generating ongoing feedback loop events that elevate depressive symptoms more and lower physiological performance.

4.2 Immune and Inflammatory Responses

Chronic depressive symptoms accompany high levels in pro-inflammatory cytokines such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF- α) and other cytokines, and they can even be associated with more severe symptoms of depression [6,12,16]. In elite athletes the inflammatory response can be aggravated with intensive training and poor recovery. Elevated inflammatory markers are associated with not just mood regulation, but impairment of muscle functioning, endurance and general physical capacity. Studies show an association among ultra-endurance and high-load athletes of depressive symptoms with increased inflammation and lower recovery efficiency [9,10].

4.3 Sleep Disturbances

Sleep disturbance is a symptom as well as a mechanism of in elite athletes. Poor depression sleep quality has been constantly associated with depressive symptoms, cognitive impairment, and athletic performance [8,11,17]. Sleep problem-modifying factors interfere with hormones (growth hormone; testosterone), which are important for tissue repair, metabolic adjustment, and neuromuscular coordination. Those suffering from depression show difficulty getting to sleep or in keeping up with their sleep, which contributes to accumulative deficits that magnify the deleterious effects of overtraining and high-performance competition.

4.4 Interactions Between Physiological Systems

These mechanisms -- neuroendocrine, immune -- and sleep do not act separately. Instead, they are connected in a network that may amplify the effect of depression symptoms on physiologic activity. For instance, HPA axis dysregulation might increase inflammatory signaling, whereas sleep loss exacerbates cortisol dysregulation at the cellular level. Together these are deleterious to physical performance, fatigue perception and poor aerobic and anaerobic performance [6,10,12,15].

4.5 Implications for Performance and Recovery

We know the mechanisms can help inform interventions which will reduce the incidence of depression in athletes. In particular, integrated, psychological, endocrine, and inflammatory based measures—i.e. targeted mental health programs, sleep hygiene strategies, or regular training plans—may mitigate the detrimental impact of depression on physiological function. Detection and monitoring of symptoms of depression, in combination with the use of biomarkers (cortisol and cytokines), can inform personalized interventions to optimize performance and support the psychological state [6,9,16].

5. Impact on Physical Performance

Depression amongst elite athletes can affect athletes' physical performance and hence influence both their objective physical abilities as well as their subjective assessment of fatigue and motivation. Interplay between neuroendocrine disturbances, immune-inflammatory responses, and disturbed sleep can further facilitate the multi-faceted pathway.

5.1 Aerobic and Anaerobic Performance

There is some evidence that depressive symptoms lead to decrements in aerobic and anaerobic performance metrics. In elite endurance athletes studies revealed that depression was found to be associated with VO_2 max reduction, slower time-trial execution, and lowered lactate threshold [9,10,12]. Part of that reduction is due to HPA axis dysregulation resulting in energy metabolism and cardiovascular activity dysregulation [6,13]. Sudden alterations in neuromuscular activity and diminished motivation can also lead to impaired anaerobic performance, with sprint ability and peak power output, especially seen in sports with dynamic challenge [14,15].

5.2 Recovery and Overtraining Syndrome

Depression frequently occurs concurrent with overtraining syndrome (OTS), which is defined as long-term tiredness, performance degradation and mood related difficulties [8,11,16]. Depression may amplify the physiological consequences associated with OTS by increasing recovery time and impairing muscle repair capacity, and increasing risk of injury. Studies show that athletes with enduring depressive symptoms take longer to return to pre-training performance after extended training blocks [6,9].

5.3 Perceived Fatigue and Motivation

Depression impacts subjective perceptions of effort, motivation, and more. Athletes with depressive symptoms find greater sense of effort in training and competition, diminished enjoyment of sport, and less dedication to their athletic scheduling [5,7,10]. These two aspects create a self-perpetuating cycle: motivation decreases, training quality reduces, and then performance decreases, compounding depressive manifestations.

5.4 Context-based considerations across these studies

The frequency of deterioration in sports performance depends on the type of sport. Individual sport athletes, including swimmers, runners, and gymnasts, are among those most likely to experience performance decrement due to depressive symptoms due to the heavy dependency on self-motivation and inner pressure [3,4,6]. Though social buffering and collective responsibility may benefit team sport athletes [11,12], competitive stress, public scrutiny, and role-related pressures remain contributors to performance impairments.

5.5 Summary of Implications for Monitoring and Intervention

The effects of depression on both aerobic and anaerobic function can only prove to be the evidence for establishing mental health routine monitoring as part of athletes management. Combining psychological assessment tools, physiologic biomarkers including cortisol and inflammatory markers, and performance metrics allows for early detection of athletes at risk. Sports psychology-based interventions, as well as a combination of medical and training interventions, have been found to ameliorate performance-related impairments and depressive symptoms [6,8,16].

6. Psychological and Social Factors

If physiological mechanisms account for part of the influence of depression to athletic performance, the other major contributors to the development, as well as maintenance, of depressive disease behavior are psychosocial factors affecting the development and persistence of symptoms in elite athletes. It is imperative to identify these to be able to design preventive/intervention efforts.

6.1 Competitive rivalry and performance expectancy in athletes

High-level athletes are under intense competition pressure from coaches, sponsors, and national federations. It has been well documented repeatedly that prolonged exposure to performance-related stress is associated with depressive symptoms [1,2,5]. Athletes who experience a discrepancy between performance expectation and performance result may feel critical of the self, experiencing negative self-evaluations and low internalized self-worth, and develop depressions. This can be very dramatic in isolated sport that only the players are ultimately responsible for the success of the sport [3,4,6].

6.2 Career Shifts and Identity Difficulties

Career transitions, in the form of injury-related breaks, changing teams, or retirement, are also vulnerable periods for mental health. Most athletes feel strongly and with a sense of identity within sport, making this lifestyle transformation can mean loss of purpose, social isolation and a depressive attack [7,8].

6.3 Social Support and Stigma

Social networks in the form of teammates, family and coaches have shown to be protective against depression. Social networks with supportive relationships were protective from any drop in the productivity at school. High levels of comfort and assistance received by an athlete with a support system is associated with lower symptom severity of symptoms and coping strategies developed [10,11]. In contrast, stigma concerning mental health in sport culture of the community dissuades athletes from asking for help, the impact of stigma persists; athletes are further stuck inside the pain and their game is diminished. Qualitative studies have been reported in sport context showing the underreport of depression-related feelings amongst athletes, in relation to being perceived as weak or endangering status in team [5,12,14].

6.4 Coping skills and psychologic mechanisms

Adaptive coping strategies including cognitive restructuring, mindfulness and goal-setting have been linked to resilience to depressive symptoms [13,15]. Psychological skills training can be effective to improve motivation, attention as well as emotional regulation that in turn mitigates the psychological AND physiological effects of depression. Athletes trained using these methods display better coping of stress, less perceived exercise, and better recovery indicating a coordination relation in mental skills and physical performance [6,9,16].

6.5 Interplays of Social Psychological and Physical Factors

Depression among high level athletes is a product of a dynamic interaction between physiologic vulnerabilities and psychosocial stressors. Social strain and perceived failure lead to enhanced HPA axis activation, elevated levels of inflammatory cytokines, disturbed sleep patterns, in combination reducing performance [6,9,12]. An appreciation of these intersections, underlies that the field of athlete mental health is holistic: the psychological components must combine with the social aspects of sport — as well as the physiological components.

7. Practical Implications

There remains need to be a proactive approach to depression in elite athletes that can entail multidisciplinary intervention strategies, mental health screening and evidence-based intervention. The literature suggests programmatic approaches are an important safeguard for psychological and physical well-being.

7.1 Systematic Mental Health Screening

The evidence base is broad and a systemic approach to screening mental health is vital at the level of the body. Regularly screen for symptoms of depression on the field can be integrated into athletes monitoring schedules. It has been found that validated instruments including PHQ-9, BDI and other validated instruments can identify early symptoms of depression with the ability to intervene in a timely manner [1,5,6]. Accurate detection is improved by using clinical

interviewing as an adjunct to self-report measures especially in people in disadvantaged populations, for whom stigma will lead to underreporting.

7.2 Cross-disciplinary Assistance Provisions

Management depression in athletes has a multidisciplinary team approach including the role of sport psychologists, doctors, physiologists, nutritionists and coaches. Individualized plans addressing mental health, training load, nutrition, and recovery can be tailored by multidisciplinary teams [6,8,9]. Data show athletes in integrated support receive a faster reduction of symptoms with better maintenance of performance maintenance compared to those receiving isolated interventions.

7.3 Training Phase Breakdown and Load Management

Redesigning work strategies to avoid overtraining and burnout is important to reducing depressive symptoms. Thus, monitoring of physiological markers such as heart rate variability and cortisol, periodization strategies that maintain a regular balance between sessions that are particularly strong and are appropriately restorative during periods of stress have been shown to reduce depressive risk due to stress [6,9,16]. Providing coaches information on the warning signs of psychological strain can reduce anxiety, therefore adjusting training accordingly can be proactive.

7.4 Psychological Interventions

Cognitive-behavioral therapy (CBT), mindfulness-based stress reduction (MBSR) and resilience training have been shown to be effective in alleviating depressive symptoms and developing coping mechanisms in athletes [5,13,15]. Psychological skills training also improves focus, motivation, and emotional regulation, which helps reduce the effects of depression on performance.

7.5 Sleep and Recovery Optimization

Structured sleep hygiene programs, which include maintaining regular hours of sleep for seven days, exposure to light in controlled ways and pre-sleep relaxation techniques, have been found to improve sleep quality and lead to decreased depressive symptoms [8,11,17]. Adequate recovery interventions—such as massage, hydrotherapy and active recovery—promote both physiological restoration and psychological well-being.

7.6 Policy and Cultural recommendations

Sport organizations should include mental health in their development plans for athletes. Encouraging people to seek help, breaking down the stigma associated with mental health and facilitating non-disclosure of necessary confidential mental health support, can contribute to the uptake and effect [5,10,12]. A commitment from leadership is also important, with coaches

and staff promoting openness about mental health. They must introduce psychological care into regular athlete management as part of routine management for all. This is very important indeed if mental health is not something which goes unacknowledged but to be taken seriously.

7.7 Practical Recommendations Summary

1. Conduct routine mental health screening with validated tools.
2. Form multidisciplinary teams of support staff for integrated patient care.
3. Adapt training loads to avoid overtraining and burnout.
4. Offer psychological modalities (CBT, MBSR, resilience training).
5. Optimize sleep and recovery strategies.
6. Implement stigma reduction and help-seeking policies.
- 7.

8. Limitations

Although the literature on depression in elite athletes is increasing, a number of methodological and conceptual obstacles limit the interpretation of and generalization of the results to other populations.

8.1 Heterogeneity of Study Designs

The reviewed studies are of high heterogeneity across designs, covering the entire spectrum from cross-sectional surveys to cohort and qualitative studies [1–5,9]. Variations in the sample size, characteristics of participants, and assessing techniques complicate comparison and synthesis of prevalence rates. For example, there are some studies that use self-report questionnaires and some with clinical diagnostic interviews, which imply that reported scores of depressive symptom severity may vary.

8.2 Measurement Variability

The available assessment methodologies of depression scales are sensitive and specific to specific sports populations and are highly variable across settings across different populations. Common measures such as the PHQ-9 or BDI may not reflect sport-specific stressors or the expression of depressive symptoms from various sport-specific stressors or culturally relevant symptoms of depression [6,8,11]. Furthermore, the evaluation of performance outcomes is commonly assessed in non-uniform measures using standardized measures compared to studies or populations, making it difficult to make strong inferences about the physiological consequences of depression.

8.3 Cross-Sectional vs. Longitudinal Data

A number of these studies are cross-sectional, giving a snapshot of depressive symptoms at one time point. These designs restrict causal inference on the influence of depression on physiological function and performance [2,7,10]. Longitudinal studies are few and far between, but they are essential for understanding how depressive symptoms evolve over time and how these symptoms are influenced by training cycles, injury, and changes in career transitions.

8.4 Sample Representativeness

Elite athletes are extraordinarily selective players with remarkable physical attributes and psychological strengths. Findings might not be generalizable to different sports, competing levels, or cultural contexts. Some studies have overrepresented female athletes and athletes in individual sports, and there are insufficient reports of team sport athletes or male athletes in some disciplines [3,4,6,12].

8.5 Confounding Factors

Performance outcomes are compromised by many confounding variables, including nutritional and training load, injury condition factors, and genetic predisposition. Most studies have failed to control for these factors, preventing the determination of specific influences of depression on physiological functioning [6,9,16]. In addition, comorbidities with anxiety, eating disorders, or substance use will add to the difficulties that are experienced.

8.6 Future Directions

Future research should focus on longitudinal, multi-sport studies with combined psychological, physiological, and performance measures. Standardization of measures of assessment and the inclusion of heterogeneous athlete populations will increase the generalizability and more accurate classification of causal relationships. Research on whether integrated intervention programs, including mental health treatments, training, and recovery methods really work are also urgently needed.

9. Conclusions

Depression in elite athletes is a common and often complex disorder that has been shown to have major impact upon mental health and sport performance. Evidence from 24 new studies suggests that depression symptoms are well documented, especially in female athletes and solo-level sports athletes as well as competitive stress, overtraining, injury, and the shifting of career stages [1–5,9,12]. Physiological pathways that associate depression with deficient performance comprise impaired hypothalamic–pituitary–adrenal signaling disturbances, alterations in serotonin and dopaminergic activity, increased production of inflammatory cytokines as well as disturbed sleep [6,9,12,15]. Together, these changes compromise aerobic and anaerobic muscle power and slow recovery, prolong recovery periods and promote subjective fatigue judgments, thus impairing performance results [8,10,14]. Psychological and social factors also exert considerable influence on the risk of depression and its effects. Supporting others, adaptive mechanisms for coping, and psychological literacy promotion are protective; stigma, social pressure, and identity-based stress intensify vulnerability to depression [5,7,10,13]. Conclusions for practice reinforce the importance of multifaceted, interdisciplinary approaches

to athlete management. Regular mental health assessment, the provision of individualized training periodisation and mental health treatments, psychological intervention, optimization of sleep and policies within organisations that minimise stigma to decrease depressive symptoms while maintaining performance are also necessary to control for these depressive symptoms [6,8,16]. Notwithstanding limitations in methodology, such as differences in population study designs, variability in measurements and cross-sectional differences, present evidence shows the need to include mental health and its treatment in elite sport settings. Longitudinal, multi-disciplinary research is important in the future, to delineate the cause of these pathways, enhance interventions, and guarantee full mental and physical care to athletes. Finally, depressive symptoms and its mechanism in athletes are more than simply psychopathology but rather a complex biopsychosocial phenomenon, with a direct impact on the physiological functioning and athletic performance of athletes at elite level. It has to be tackled systematically if high performance athletes are to achieve their full potential (health, longevity, success).

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