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Review Article

The Impact of Digital Technologies, Recreation, and Nutrition on Stress Management and Mental Well-being in Athletes

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About Article

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ABSTRACT

Stress is a natural human experience that depending on its severity and duration, it can have both positive (eustress) and negative (distress) effects. Chronic and unmanaged stress has a negative impact on social mental and physical health whereas moderate stress may improve motivation and adaptability. A comprehensive strategy combining biological, psychological and social techniques is needed for effective stress management. While social support, resilience and psychological relief are all facilitated by recreational activities, stress responses, cognitive function, and emotional equilibrium are significantly influenced by nutrition. Digital interventions have also become widely available and scalable tools for stress management, prevention and monitoring. An integrative review of major database and other sources were conducted. The study included recent empirical, systematic, scoping, narrative reviews and other high-quality articles that is directly related to digital technologies, recreation, nutrition and mental health outcomes in athletes. A total of 46 studies met the inclusion criteria. The review revealed that impact may be positive or negative depending on certain factors. Stress detection, monitoring, recovery management and resilience are enhanced through digital technologies. Recreational activities also improve resilience, regulates emotions, reduce anxiety, stress and depression. Adequate nutrition lowers stress, anxiety, depression and enhance better mental well-being in athletes with nutrition knowledge and positive dietary attitudes enhancing mental resilience. This paper delves into the combined impact of digital technologies, recreation, and nutrition on stress management and mental well-being in athletes with impact ranging from mental resilience to self-regulation, autonomy and motivation and social connections. Furthermore, the use of nutrition, recreation with digital technologies fosters cognitive and emotional regulation as well as personalisation and preventive wellbeing system. This study was also able to establish that the combination of digital strategies, recreational and health produce an impact in Athletes well being. When taken as a whole, these tactics highlight how crucial a comprehensive framework is for improving mental health and stress management, especially for athletes and other high-risk groups.

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1. INTRODUCTION

Stress is a common human experience, a perceived difficulty and danger that the body reacts to. Moderate stress (eustress) can be inspiring, but excessive and protracted stress (distress) negatively impacts one's physical, mental and social health. Stress is emphasized in research from the behavioral sciences, psychology and medicine as a biological response as well as a psychosocial construct influenced by environmental factors and individual differences. Life will inevitably involve stress, which can have both beneficial and detrimental effects. Chronic and uncontrolled stress harms mental and physical health, whereas transient stress can promote motivation and growth. A multifaceted strategy that combines preventive interventions with biological, psychological and social tactics is necessary for effective management. Stress is both a physiological reaction and a psychological experience and how people evaluate and cope with it determines how it affects them (Antony *et al.*, 2025). Athletes frequently experience psychological distress and disruption which highlights the importance of sport-related mental health (Markser 2011; Jaiyeoba 2021). Jaiyeoba and Ogunsanya (2021) noted that elite athletes are subject to particular and severe pressures that can have a detrimental impact on their mental health and general well-being underscoring the need for more assistance from sports organisations.

Furthermore, no matter where you are or what you are doing, stress is a part of life. Although stress cannot be avoided, it can be controlled so that it does not control you. Stress is often brought on by life transitions like attending college, getting married, changing careers or becoming ill. It is important to note that even changes that cause stress can be good for you. For instance, moving away to college brings with it new challenges, friends and living situations that can lead to personal growth. Knowing yourself and carefully examining the sources of stress are crucial for this reason. It takes time to learn how to do this, but while stress is unavoidable, its negative effects, like depression or high blood pressure, can be reduced. Being conscious of how one perceive and respond to situations is crucial. This knowledge will assist the individual in creating stress-reduction coping mechanisms (Song *et al.*, 2025).

Stress refers to how people respond to events, situations, and changes in their lives on both physical and mental levels. Stress can affect people differently and for different reasons. Your response is determined by how you interpret a situation or event. You are likely to feel overwhelmed, oppressed or out of control if you have a negative perspective on a situation. The more common type of stress is called distress. The other type, known as good stress or eustress, arises from an optimistic perspective on a circumstance or event. Since it uses concentrated energy, eustress can help you overcome obstacles and act as a counterbalance to boredom. However, that energy can quickly transform into distress if something makes you feel that the situation is out of control or unmanageable (Nuetzel, 2025).

A positive stressor for one individual may be a negative stressor for another, so perception is frequently at play. Although the term stress is widely used in today's jargon and most people seem to understand what it means intuitively, it is challenging to define precisely because it is frequently used interchangeably with a number of other terms, including strain, pressure and anxiety. A broad range of physiological, emotional, behavioral and cognitive responses to environmental demands is collectively referred to as stress. We must constantly assess environmental threats, demands and challenges as we engage with the world around us and try to address any problems that may come up. Environmental requirements can occasionally be met with ease, like when you need to press a button on a key to unlock your car (Poluzzi *et al.*, 2025).

Sometimes, though, the demands of the environment can seem overwhelming and uncontrollable, like when one has to take three examinations in one day. This can lead to unpleasant emotional experiences, negative thought patterns and physical tension. Stress arises when an individual's perceived coping resources are not sufficient to meet the demands of their environment. Any situation or stimulus that induces stress is referred to as a stressor. However, what stresses one person out might not stress another out. For instance, someone who feels uneasy in social settings might not feel stressed when asked to attend a social gathering, but someone who believes they lack the social skills to blend in might. Stressors can be anything from minor inconveniences to major life transitions. Daily hassles are the occurrences or circumstances that we encounter regularly in our daily lives, like losing things, worrying about one's weight and having to wait for one's turn (Nuetzel, 2025).

Stress is a major contributing factor to emotional disorders. Cardiovascular disease, hypertension, immunosuppression, more frequent illnesses, sexual dysfunction, gastrointestinal disorders and recurrent headaches are among the major physical health issues linked to chronic high stress. Numerous behaviors and lifestyle decisions that may have detrimental effects on one's health are also linked to high levels of stress. People who are under a lot of stress are more likely to drink too much alcohol and use drugs and tobacco products more frequently, according to research. Ironically, drinking alcohol raises cortisol levels, which can lengthen the tension that stress reactions cause. The body's reaction to stress can alter how alcohol is processed, which can lessen its enjoyable effects and increase the desire for more. Chronic alcohol and tobacco use are also major contributors to several chronic health issues, such as liver and lung cancer, cirrhosis of the liver, emphysema, coronary heart disease and stroke (Tutkun, 2020).

Recognizing that abnormally low stress levels can also have detrimental effects is crucial. People who have too low arousal levels, for instance, typically exhibit boredom, poorer physical and cognitive function, procrastination and a lack of attention to detail. The Yerkes-Dodson Law, which was established by psychologists in the early 1900s, states that mild to moderate levels of arousal tend to be the most conducive to an organism's physiological and mental functioning. Research conducted over the past century has generally supported the idea that stress and anxiety are influenced by the type of task, even though the amount of stress and arousal needed for optimal functioning varies. Applying methods and approaches to lessen, manage or avoid the detrimental effects of stress on one's physical, mental and emotional health is therefore the process of stress management. Since stress is a normal

reaction to difficult circumstances, controlling it promotes equilibrium, effectiveness and well-being (Antony *et al.*, 2025). At the national level sports and physical education foster social and economic advancement improve public health and bring disparate communities together (Jaiyeoba & Oguntuase, 2019). Athletes face sport-specific stressors that interact with everyday life stressors, which impacts mental wellbeing and performance. Interventions used to manage stress in athletes include recreation/exercise, nutritional strategies and digital interventions. Therefore, understanding their independent and combined impact is essential to develop scalable, evidence-based supports for athlete mental health.

1.1. Research questions

1. What evidence exist on digital technologies, recreational or physical activities and nutritional interventions for stress management and mental wellbeing in athletes.

2. What are the combined impact of digital technologies, recreational/physical activities and nutritional interventions on stress management and mental wellbeing in athletes.

1.2. Conceptual clarifications

1.2.1. Stress management

The dynamic process through which people use behavioral and cognitive strategies to handle particular demands internal or external that are deemed to be burdensome or beyond their capacity is known as stress management. It is a collection of methods and psychotherapies designed to manage stress, particularly chronic stress, to enhance day-to-day functioning. It also describes programs that teach people skills like time management, relaxation, problem-solving and cognitive restructuring in order to lessen stress reactions and enhance adaptation. In order to prevent or lessen the adjustment to stressors in ways that preserve or enhance functioning and well-being, interventions and coping mechanisms are used.

1.2.2. Stress management in athletes

The term stress management describes the methods, approaches and interventions used to assist athletes in identifying, addressing and minimizing stressors that may have a detrimental impact on their general well-being, performance and health. Because athletes deal with psychological stress (pressure to succeed, expectations from coaches, fans and oneself) as well as physical stress (training competition injuries), stress management is essential for both mental and physical well-being. The use of mental skills training, relaxation techniques, healthy lifestyle practices and social support to control stress responses, prevent burnout and optimize performance and well-being is known as stress management in athletes. Other key aspects of stress management in athletes include: identifying stressors such as competitive pressure (winning or losing) fear of injury or re-injury high expectations from coaches, teammates fans and family balancing academics career or personal life with sport and overtraining and fatigue (Song *et al.*, 2025).

1.2.3. Mental Well-Being and Mental Health

The combination of feeling good and functioning effectively, which includes positive emotions, resilience, self-esteem and effective relationships, describes mental well-being. It is a multifaceted construct that includes self-acceptance, personal growth, purpose in life, positive relationships with others, environmental mastery and autonomy. Mental well-being is a state in which an individual recognizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully and can contribute to his or her community. Stable well-being is attained when people have the psychological, social and physical resources necessary to overcome their obstacles. According to WHO (2021), a state of complete physical, social and mental well-being and not merely the absence of disease or infirmity is what is meant by health.

Galderisi Heinz Kastrup Beezhold and Sartorius (2015) changed the definition of mental health in Omokhabi (2021) to include a dynamic state of internal equilibrium that enables people to use their abilities in a way that is acceptable to society. The claims of Cleverley *et al.* (2022) according to Ajiye (2025), mental health which includes social, emotional and psychological well-being affects how people react to stressful events and make informed decisions. It has an impact on people's emotions ideas and behaviours. Mental health involves emotions and social well-being. It influences our thoughts, feelings, and actions (Jaiyeoba, 2018). It also assists in determining how people cope with stress and make decisions. Mental health is essential throughout life, from birth through adulthood (Jaiyeoba, 2018). It also marks the equilibrium between a person's resource pool and the difficulties they face.

These differences are significant because they draw attention to the connection between mental health, which is a vital component of overall health and consequently overall wellbeing, which is defined as the capacity to function in society with purpose. Well-being and mental health are more important than ever in the increasingly complex world and new solutions and intervention models are being developed across all industries (Fisher & Shaikh, 2020). Overall mental health, mental coaching, personal development, and particular mental illnesses or difficulties are all included in mental wellbeing. These can vary from person to person and evolve (Poucher, 2023). Although research and support for the field have increased over time, most people deal with mental health issues daily.

1.3. Digital technologies

Digital technology includes gadgets like computers, tablets and smartphones as well as the wide range of digital activities people do nowadays like using social networking sites and the internet (Omokhabi 2021). While Obar and Wildman (2015) in Omokhabi *et al.* (2025) define social media as an internet-based tool that facilitates communication among users through an online community by allowing them to exchange ideas knowledge and other forms of expression the term digital technology use is broad and encompasses a variety of tools services and usage patterns that have grown and are rapidly changing people's lives (Omokhabi, 2023). The term digital technology use is broad and encompasses a variety of tools services and usage patterns that have grown and are rapidly changing people's lives (Omokhabi, 2023) These technologies are used extensively in human activities (Ojokheta & Omokhabi, 2023). Artificial Intelligence (AI) has become a

potent instrument in different fields in recent years such as education (Ojokheta & Omokhabi, 2023), healthcare (Omokhabi *et al*., 2025) and now sports. Technologies are evolving quickly which has significant implications for several sectors (Ajiye & Omokhabi, 2025. These tools are intended to supplement conventional mental health services by offering real-time support, encouraging self-care and boosting resilience as they facilitate personalised experiences tailored to the diverse needs and preferences of individuals (Ajiye *et al*., 2023). Thus, with present technological advancement, the construct of stress management and self-regulation has received a new approach as this affects both psychological and physiological indices of athletes during training, competition, injury recovery and psychological wellbeing (Jaiyeoba, 2022).

1.4. Recreation

Recreation is defined as the act of creating something a second time or as a way to play and unwind in order to replenish the mind, body and spirit. Recreation refers to those voluntarily chosen activities during non-work time which refresh the body or mind and make leisure time more interesting and enjoyable (Khasnabis *et al*., 2021; Wise, 2019). Recreational activities can be defined as activities that facilitate the refreshment of one's mind and body after work. Recreational activities can be communal or solitary, active or passive, healthy and useful for both the individual and society at large, and can be done indoors and outdoors. They include activities such as listening to music, gardening, hunting, swimming and traveling. Furthermore, recreational activities can also be defined as activities that are aimed at providing a refreshing break from normal routine. These activities are known to stimulate and rejuvenate the body and mind. They include sports of all kinds such as volleyball, basketball, swimming, fishing, hockey and football, among many others.

1.5. Nutrition

The terms nutrition, food and diet are often used interchangeably. Nutrition generally refers to the macro- and micro-nutrients essential for survival, but we do not simply eat nutrition (Rattan & Kaur, 2022). Biological/physiological nutrition is the processes of ingesting, absorbing, metabolising nutrients and using them for growth, repair, energy and homeostasis. From the Dietary/ behavioural dimension, nutrition is the food choices, meal patterns, cultural practices, and lifestyle that influence nutrient intake and utilisation. Macro and micronutrients are usually contained in our diet. Macronutrients, in the form of protein, carbohydrate, or fat, primarily provide energy to your body. The different macronutrients serve different energy pathways and functions in the body. Energy from macronutrients in food is measured in units called calories while micronutrients, known as vitamins and minerals, are required by the body in minute amounts. They protect and promote various bodily functions, including processing energy from macronutrients. Although critical to health, micronutrients do not supply energy.

2. LITERATURE REVIEW

2.1. Mental Well-Being in Athletes

The importance of an athlete's mental health for performance and long-term health is becoming more widely acknowledged. While playing sports fosters resiliency, self-control and positive emotions, athletes also deal with particular stressors that can disrupt their psychological equilibrium, such as rigorous training schedules, competitive pressure, injuries, identity issues and public expectations. Beyond the lack of mental illness, athletes' mental health includes emotional stability, cognitive function, social connectedness and life satisfaction. The capacity to control feelings like excitement, disappointment and anxiety during practice and competition is known as emotional well-being. Self-assurance, independence, fortitude and a feeling of direction in both life and sport are all components of psychological well-being. Relationship quality with teammates, coaches, family and supporters is a measure of social well-being and affects motivation and a sense of belonging (Ajiye & Ukpabi, 2025). Athletes' performance-based lifestyles pose several risks to their mental and physical health. Athletes are subject to particular stressors that can lead to poor health, such as intense and continuous pressure to perform at their best frequent travel, unstable positions or jobs and injury management (Purcell, 2022). Stress is known to have deleterious effects on human motivations and striving to accomplish life ambitions in conquering the environment, human performance, health and psycho-physiologically well-being (Jaiyeoba, 2017).

For example, Cognitive Functioning which is the ability to concentrate, make decisions and cope under pressure can make an athlete feel anxious. Performance pressure and expectations from oneself, coaches, sponsors and supporters can make people feel more anxious; Injury which are physical setbacks frequently result in depression, frustration or fear of getting hurt again; Overtraining and Burnout which is an excessive workload without sufficient recuperation lowers emotional stability and motivation. Thus, athletes are more likely than non-athlete populations to experience mental health issues and disorders because of stressors unique to the high-performance sporting environment. Negative social interactions or lack of social supports are potent stressors (Adelusi *et al*., 2023). These stressors include anxiety, depression and drug and alcohol use, among other mental health symptoms that are relatively common among athletes (Chang, 2020). For example, a study conducted by Poucher (2021) found a startling 41. 4% of the 186 Canadian Olympic and Paralympic athletes polled in 2021 showed signs of eating disorders, anxiety or depression. Stress and training are important predictors of anxiety and depression in athletes, according to the same study (Poucher *et al.* 2021). In contrast to depression, which can lower an athlete's motivation and energy and hinder their ability to perform at their peak, anxiety and stress have been shown to impair an athlete's focus, concentration and decision-making skills (Habay, 2022). Thus, when athletes perform poorly because of these mental health issues, they may feel trapped in a vicious cycle of declining mental health and poor performance. On the other hand, athletes with strong mental health may be able to handle the demands of training and competition, fostering resilience, drive and focus.

Identity crises can result from transitional difficulties, retirement from athletics and role changes which may require;

Social Support Systems: Resilience and well-being are promoted by resilient teammates, coaches and families. Psychological Skills Training (PST) has several methods to improve athletes' mental health, such as goal-setting, visualization, self-talk and relaxation techniques. Enhance concentration, lessen anxiety and promote emotional equilibrium with mindfulness and meditation.

• *Counseling and Sport Psychology Services:* Expert assistance for depression, anxiety, stress or poor performance.

• *Sleep and nutrition:* Proper recuperation techniques promote mental and physical well-being.

• *Balanced Identity:* To help athletes avoid crises after retirement, it is recommended that they cultivate identities and interests outside of sports.

• *Team Culture and Coaching Style:* Encouragement, open communication and supportive leadership all contribute to well-being (Hussey, 2019).

There are several advantages to athletes' mental health vis a vis increased consistency in performance under duress, increased ability to bounce back from setbacks and injuries, increased confidence drives and focus, improved communication between people both inside and outside of sports.

Therefore, mental health is essential for both life satisfaction and athletic success. It is more probable for athletes to succeed in both their personal and competitive lives if they maintain emotional stability, resilience and healthy social relationships. A comprehensive strategy that incorporates lifestyle management, psychological training, a positive team environment and expert mental health resources is needed to promote athlete well-being. Building resilience, balance and psychological resources that improve performance and quality of life are all important components of mental health for athletes (Ajiye & Ukpabi, 2025).

Athlete well-being has become a more popular topic of conversation in the world of high-performance sports. An athlete's overall well-being is influenced by several factors, including their physical, mental and social health. The Australian Institute of Sport defines athlete performance health as a condition of optimal physical, mental and social wellbeing associated with an athlete's sporting success. This definition will be used in this report as it goes beyond simply being free from illness or injury that prevents participation. Additionally, it has been acknowledged that athletes' physical and mental health are essential components of their identity as performers and individuals (Woodford & Bussey, 2021).

2.2. Digital Technologies in Stress Management and Mental Well-being

Digital technologies aid stress management in the following ways:

2.2.1. Wearables

Wearables have been shown by studies to enhance mental wellbeing of athletes. Emerging evidence shows that HRV biofeedback and wearables can reduce acute stress and anxiety markers and improve physiological indices through enhanced self regulated coping strategies development. Adebisi *et al.* (2025) stated that smart watches, fitness bands, biometric shirts, biosensors can be used to track heart rate variability, cardiovascular strain, muscle fatigue, sleep, cortisol levels, fatigue, hydration and muscular extension for athletes and that these devices track indicators such as skin conductance (a measure of stress), irregular heart rhythms, and sleep disturbances, enabling the detection of patterns that may signal burnout, anxiety, or mental fatigue. Studies have highlighted the value of wearable technology in gathering real-time biometric data including heart rate variability sleep patterns and Cortisol levels. These wearables when combined with AI algorithms can recognise patterns and give feedback to prevent injury or burn out and this significantly aids athletes wellbeing. By continuously monitoring athletes' through wearable devices, AI systems can detect early signs of fatigue or stress, predicting potential injuries before they occur (Rahmani *et al.*, 2024).

2.2.2. Digital Mental Health Applications

Through tele therapy apps and artificial intelligence (AI), digital technologies have improved mental health and stress management by providing individualized and easily accessible interventions. Also, applications like Headspace Calm and Moodfit can provide stress-reduction plans, breathing techniques, mood monitoring and guided meditation. These apps promote mindfulness, which dramatically lowers stress and improves relaxation (Firth, 2019).

More so, through the provision of creative, scalable and intuitive interventions, digital technologies have revolutionised stress management and mental health. Evidence demonstrates their efficacy in lowering stress, building resilience and fostering mental health; however, issues with access to privacy and evidence-based validation need to be addressed.

2.2.3. Hybrid Models

Hybrid models that combine professional assistance with digital tools have potential for improving stress management and mental health in the future. Digital platforms, machine learning, deep learning, and artificial intelligence are useful for mental-health screening and tracking in various subpopulations including athletes and a hybrid model of care combining face-to-face approaches with innovative digital technologies has unrealised potential in sport for prevention and early intervention of mental ill-health (Balcombe & De Leo, 2020). Within sports psychology, this framework can enable psychologist-in-the loop models where human expertise refines AI predictions through real-time feedback, while AI simultaneously enhances human decision-making with data-driven insights. Moreover, AI can support sport psychologists by automating tasks such as stress and mood tracking, communication monitoring, and injury surveillance. By analyzing biometric and emotional data, AI systems can contribute to building mental resilience and allow psychologists to manage athletes' stress more effectively. However, the necessity of human oversight, ethical issues and data privacy concerns continue to be crucial (Ajiye & Ukpabi, 2025). Thus, integration with conventional mental health care, inclusivity and ethical use are necessary for their efficacy.

2.3. Recreation in Stress Management and Mental Well-being

Regular participation in sports and recreational activities

is extremely important and beneficial for long-term health and wellbeing, as well as health benefits, physical benefits, physiological benefits, economic benefits and social benefits (Jaiyeoba, 2017). Recreational activities include sports, physical activity, hobbies, cultural engagement and outdoor pursuits, are essential for fostering mental health and stress reduction.

However, a lack of time, work or school obligations, restricted access to reasonably priced and safe recreational areas, which can pose obstacles to participation based on gender or culture and an excessive focus on sedentary recreation. Some of the issues impeding the benefits of recreation for stress management and mental health include excessive gaming or screen time, which can be detrimental to mental health. Recreation is therefore a potent non-pharmacological method of reducing stress and improving mental health. Recreational activities greatly enhance overall health by lowering physiological stress, fostering emotional stability and fortifying social ties. Policies that support leisure-integrated personal lifestyle choices and participation in recreational programs can promote long-term well-being and resilience. It is more than just recreation, it is a preventative and therapeutic tool for stress management, mental health promotion, emotional balance, social integration and personal development.

Evidence from literature demonstrate that physical activities are associated with better mental health and well-being in terms of reduced anxiety/depression, improved mood, improved wellbeing and social outcomes. Team sports usually produce better social and mental health outcomes through social support than individual sports however participation in recreational activities is beneficial in improving mental health. According to Adelusi *et al.* (2023), engagement in regular physical activity has been consistently associated with improved psychological wellbeing, reduced symptoms of anxiety and depression, and overall quality of life. Buttressing earlier submission, they further opined that physical activity participation serves not only as a means to maintain physical fitness but also to satisfy individuals' psychological needs for autonomy, competence, and relatedness which are essential for optimal functioning and wellbeing. Individuals who perceive that their basic psychological needs are met during recreational physical activities are more likely to experience higher motivation and positive affective outcomes (Adelusi *et al.*, 2023).

Overall, adults participating in team sport had more favorable health outcomes than those participating in individual sport, and those participating in sports more often generally report the greatest benefits; however, some evidence suggests that adults in elite sport may experience higher levels of psychological distress (Eather *et al.*, 2023). Empirical evidence further indicates that participation in recreational sport and leisure-based physical activity is associated with meaningful improvements in mental wellbeing among athletes, including reductions in depression, anxiety and stress and gains in life satisfaction and social connectedness. Team-based recreational activities tend to produce larger mental-health benefits than solitary exercise, likely because they combine physiological effects of exercise with psychosocial mechanisms such as social support, belonging, and identity (Eather *et al.*, 2023; Eime *et al.*, 2013). Studies have shown that physical activities and recreation improve mental health and wellbeing, self-esteem, self-efficacy, physical self-worth, body image satisfaction, resilience, social support, social connection, physical health, reduce pain, and fatigue (White *et al.*, 2024). According to Bayram *et al.* (2025) recreational activities can strengthen individuals' ability to cope with stress and deepen their social relationships.

The intense mental and physical demands placed on elite athletes are a unique aspect of a sporting career, and these may increase their susceptibility to certain mental health problems As the number of years of participation in sportive recreational activities increases, the recreational flow experience, recreational well-being and recreational participation intention also increase hence recreational sport activities increased participants' physical and psychological well-being and improved life satisfaction (Bayram *et al.*, 2025).

The evidence indicates that participation in sport is related to better mental health, including improved psychological well-being (for example, higher self-esteem and life satisfaction) and lower psychological ill-being i.e reduced levels of depression, anxiety, and stress (Eather *et al.*, 2023). Sport may be associated with improved psychosocial health in addition to improvements attributable to participation in physical activities (Eime *et al.*, 2013), Physical activity and exercise have significant positive effects in preventing or alleviating mental illness, including depressive symptoms and anxiety or stress-related disease. Similarly, those who play sports have a higher level of physical activity later in life and through sport, knowledge of nutrition, exercise, and health can be developed.

While it is well established that physical activity has a positive effect on mental health, a review has found that intense physical activity performed at the elite athlete level might instead compromise mental wellbeing, increasing symptoms of anxiety and depression through overtraining, injury and burnout (Rice *et al.*, 2016).

2.4. Nutrition in Stress Management and Mental Well-being in Athletes

A comprehensive strategy for maximizing athletes' performance and mental health can be achieved by combining dietary tactics with training and psychological support, as nutrition serves as more than just performance fuel for athletes; it is also a potent stress-reduction and mental health tool that promotes emotional equilibrium, resilience and recuperation. Individualization emerges as a cornerstone in preventing disordered eating among athletes. Jaiyeoba (2016) investigated the determinants of dietary habits and nutrient intake among athletes in Oyo State. The result indicated poor nutritional knowledge, lack of funds and lack of time. The study recommended a healthy diet, which is essential for stress reduction and mental health enhancement. This shows that nutrition is essential to athletes' wellbeing. Nutrition has demonstrable links to mood, energy, cognitive function and risk of disordered eating among athletes. Recent studies have shown that poor fueling (under eating), micronutrient deficiencies and inconsistent energy availability elevate risk of mood disturbance and anxiety as well as performance decrement. Also, better nutritional attitude/ knowledge is associated with better mental toughness and resilience indicating that as athletes' knowledge of nutrition

expands and their attitudes towards healthy eating become more positive, their mental toughness also appears to improve (Özsarı *et al.*, 2024). The study of Larsson *et al.* (2024) showed that athletes experiencing lower mental health or period of poor mental health reported decreased food intake more often than those with better mental health or those without period(s) of poor mental health. This implies that athletes who decreased their food intake experience lower mental well-being than athletes who increased their food intake. Research has shown a strong relationship between nutrition and mental health. Packed schedules and little rest time may make student-athletes more susceptible to mental health issues than the general population, but few athletes are fully aware of the effects that nutrition can have on their mental health (McCabe *et al.*, 2021). A balanced diet can alleviate athletes internalizing symptoms like anxiety, depression, mood disorders and social withdrawal. Moreover, diet and sleep are all associated with internalising symptoms. Diet appears to influence mental health partly via sleep quality and recovery process (Gao & Wang, 2024). Research suggests that an athlete's diet can impact their sleep, stress and overall well-being (Von Rosen *et al.*, 2019)

Dietary habits can influence mental health, where a balanced diet is associated with a reduced risk of depression and anxiety (Christensen *et al.*, 2021; McCabe *et al.*, 2021). Previous studies suggested that a healthy diet rich in fruits, vegetables, and protein intake has benefits for reducing internalising symptoms in both the general population and athletes (McCabe *et al.*, 2021; Gerber *et al.*, 2023). Also, poor dietary habits were associated with mental disorders in athletes. For instance, diets high in processed foods and sugars have been linked to increased risk of depression and anxiety (Christensen *et al.*, 2021). Alcohol consumption among athletes poses a significant dietary problem (Reardon *et al.*, 2021). Nutrition serves as a fundamental pillar of athletic performance, with athletes' dietary strategies especially those implemented before and after competition playing a critical role in recovery and physiological adaptation. Effective dietary can enhance the adaptive response to fatigue, promote muscle function and boost exercise tolerance (Malsagova *et al.*, 2021). Therefore, the monitoring of diets is important for athletes' improved competition performance

However, scientific evidence indicates that there are some issues in the dietary behaviours of athletes. Specifically, there is an imbalanced intake of vitamins, including insufficient Vitamin D and excessive levels of phosphorus, iron and zinc (Ersoy *et al.*, 2019). Elite athletes also demonstrate excessive consumption of vitamins, meat and sweets compared to non-elite athletes (Diehl *et al.*, 2013).

2.4.1. Macronutrients

Macronutrients, which include carbohydrates, proteins, and fats, play a critical role in athletic nutrition. Adequate carbohydrate intake is necessary to support energy production and replenish glycogen stores, thereby reducing the likelihood of restrictive eating behaviors. Macronutrients, micronutrients, encompassing vitamins and minerals, are paramount for energy metabolism and immune function (Amawi *et al.*, 2024).

In times of stress, carbohydrates lower cortisol secretion and supply glucose for brain function. Proteins that are high in amino acids, such as tyrosine and tryptophan, control the production of neurotransmitters such as dopamine and serotonin, which affect mood and stress reactions. Omega-3 fatty acids, in particular, are good fats that promote brain health and lower inflammation. Furthermore, micronutrients can support nervous system function, lessen fatigue and help regulate stress. B vitamins (B6, B9 and B12) are helpful in this regard. Magnesium enhances the quality of sleep and controls cortisol levels. Athletes who consume zinc and vitamin D report feeling happier and less anxious (Antony *et al.*, 2025). Lower risks of anxiety and depression are linked to diets high in fruits, vegetables, whole grains and lean proteins. Foods high in nutrients encourage steady energy and lessen mood fluctuations. A healthy diet rich in complex carbohydrates, omega-3 fatty acids and antioxidants improves memory, focus and reaction time, all of which are essential for successful athletic performance. Dietary sources of tryptophan and magnesium promote the synthesis of melatonin, which improves sleep, which is essential for healing and overall health. Foods high in antioxidants lessen the oxidative stress brought on by vigorous exercise, promoting both mental and physical healing (Malinowska *et al.*, 2024).

2.4.2. Hydration

Hydration is a key factor in preventing disordered eating among the active population. Even a slight dehydration raises cortisol levels and affects concentration, judgment and recuperation, all of which make athletes more stressed. Reduced stress and improved mental resilience are linked to gut microbiota diversity, which is enhanced by a diet high in fiber and probiotics.

2.4.3. Nutritional supplements

Sports Nutritional Supplements help replenish deficient nutrients and should only be considered when dietary intake falls short or specific deficiencies are identified (Amawi *et al.*, 2024). Consultation with qualified professionals is essential to ensure safe and appropriate usage

Theoretical foundations for the adoption of Digital technologies, Recreation and Nutrition for stress management in Athletes

The theory that explains the effect of Digital Technologies, Nutrition and Recreation on stress management is the Biopsychosocial model and it is explained below:

2.5. The Biopsychosocial Model

The Biopsychosocial Model was originally propounded by Engel (1977), who argued that health and illness cannot be understood solely through biological mechanisms, but through the combined influence of biological, psychological, and social processes (Engel, 1977). Engel criticized the reductionism of the biomedical model and proposed a more holistic, patient-centered approach. However, subsequent scholars, including Romano *et al.* (2004), and Melchert (2015) further expanded and operationalized the model in clinical and behavioral health contexts.

The model is based on the assumption that human health, functioning, and well-being arise from the dynamic interaction of biological, psychological, and social domains (Engel, 1977;

Borrell-Carrio*et al.*, 2004). The BPS model guides holistic assessment of athlete well-being by integrating physiology, cognition, social environments, and behavior (Melchert, 2015). It supports interventions involving nutrition, psychological training, technological management, and recreational balance.

The biological factors include genetics, neurochemistry, hormonal regulation such as cortisol or serotonin, nutritional status, physical activity levels, and sleep patterns. Engel (1977) emphasized that biological processes cannot be evaluated in isolation from social and psychological influences. Therefore, in athletes' nutritional quality directly influences physiological readiness, cognitive performance, and emotional regulation as consistent with the biological emphasis of the BPS model (Melchert, 2015).

The psychological factors will include thoughts, beliefs, emotions, coping skills, motivation, and stress appraisal. Psychological processes influence how individuals interpret stressors and respond to challenges. In athletes, performance pressure, self-efficacy, and cognitive appraisal of stress are central psychological factors that shape mental well-being, aligning with Engel's (1977) emphasis on cognition and emotion in health outcomes.

Social factors influence include interpersonal relationships, coaching environments, team culture, digital technology use, socioeconomic conditions, and recreational engagement. Social factors serve as external inputs that shape stress, motivation, and help-seeking behaviour (Borrell-Carrio *et al.*, 2004). Digital tools (wearables, apps, social media), team support, and recreational activities influence social connectedness and coping strategies among athletes, illustrating the social dimension of the BPS framework (Melchert, 2015). The BPS Model Connects Digital Technologies, Nutrition, and Recreation to Athlete Mental Health.

Digital Technologies (Social & Psychological factor) i.e digital monitoring systems, performance-tracking apps, and social media shape psychological stress, cognitive load, motivation, and perceived competence. Their influence aligns with the BPS model's assertion that social and technological environments affect mental health (Borrell-Carrio *et al.*, 2004). Nutrition (Biological factor) influences energy metabolism, immune function, neurotransmitter synthesis, and cognitive clarity, all of which affect mood and stress regulation which is consistent with the model's biological component (Melchert, 2015). Recreation (Psychological & Social factor) and non-competitive physical activity improve mood, stimulate endorphin release, enhance social connectedness, and reduce stress demonstrating how behavior and environment jointly shape well-being (Engel, 1977).

This Biopsychosocial Model have the following key principles which includes;

• *Holism:* The model views health as an interaction of biological, psychological, and social processes, rather than isolated mechanisms (Engel, 1977).

• *Interactionism:* Factors in the three domains continually influence each other. This principle is emphasized in later refinements of the model (Borrell-Carrio *et al.*, 2004).

• *Individual Differences:* Each person's health profile is shaped by unique combinations of biopsychosocial influences (Melchert, 2015).

• *Context Matters:* Environmental, cultural, and technological contexts play essential roles in mental health (Borrell-Carrio *et al.*, 2004).

This theory is based on the believe that there is an Interconnected biopsychosocial system. The implication of this for this study is that nutrition, digital technologies and recreation are all connected to mental health outcomes in athletes.

However, Borrell-Carrio *et al.* (2004) stated that measuring interactions among all three domains can be complex which serve as a limitation of the theory.

3. METHODOLOGY

An integrative review of major database, peer review journal, articles, official publication and other electronic database like Scopus, PubMed/PMC, Web of science, Google Scholar and other publishers' sites was conducted. Primary search combined terms related to athletes: mental health/stress, athletes wellbeing, exercise/recreation/physical activity, nutrition/diet/sports nutrition, Artificial intelligence in sports/Athletes, stress management, predictive analytics/sport analytics, technology-based strategies/digital stress management. These keywords were at some instances joined with and, OR before the search. The search yielded a lot of publications from which the researcher purposively selected relevant studies.

3.1. Inclusion and Exclusion Criteria

The inclusion and exclusion criteria of the study is as follows;

• *Inclusion:* Studies included must be an empirical study published in peer review article or official publication or any other relevant electronic source in English language and having the Keywords stated earlier and must be a recent study from 2010 till date. Priority was given to more recent studies over older ones. This review also include systematic reviews, scoping reviews and high-quality narrative reviews that directly examined athletes' wellbeing in any of the three dimensions (Recreation, Nutrition and digital) or sports participation and reported mental-health or stress outcomes. The selected studies must also contribute to the understanding of the topic under review.

• *Exclusion:* The study will exclude all articles or journals that does not satisfy the inclusion criteria.

Search strategy

3.2. Search strategy includes

Identification of related studies through electronic search of major databases and other sources which yielded over one thousand studies i.e n= 1301. The duplicates removed are 652. The more recent studies were given preference over older ones. A total of 649 publication were left after removing the duplicates.

Screening of the publications abstract and titles for quality and relevance: The 649 publication left was therefore reduced to 424 after screening and the exclusion of 225 studies. A total of 424 publications were assessed for eligibility and 378 studies were further excluded because they did not focus on athletes, had methodological weaknesses, not directly related to mental health or wellbeing outcomes, did not examine

nutrition, recreation or digital technologies or have mental well-being outcomes, not peer review and not English language publication with corresponding values of n= 231, 53, 27, 35, 14 & 18 respectively. The studies remaining and included are 46, hence n=46.

Two reviewers screened the titles/abstracts for relevance, and full texts were reviewed for study design, population, interventions, outcomes, and quality. The two reviewers then removed duplicates and articles that were not relevant to the study. They further assessed each of the remaining studies for relevance and studies recommended were included while others were excluded. Key information was extracted from the study and refined in the researchers language. The researcher therefore synthesized narratively by domain due to heterogeneity in interventions and outcomes.

3.3. Expected outcomes

This study aims to provide insight into the impact of Digital Technologies, Recreation and Nutrition on Stress Management and Mental Well-being in Athletes. This study will aid stress regulation, enhance wellbeing and reveal the synergistic effect of digital technologies, recreation and nutrition on stress management. This study will enlighten stakeholders on the effective ways of managing stress for optimal output. This study will reveal interventions for increased self-awareness and coping strategies, that will reduce performance-based burnout. This study will provide an evidence-based framework for sports management.

3.4. Implications

This study will be relevant to sport psychologist, policy makers, technology developers and other stakeholders. This study synthesizes empirical evidence on digital technologies, recreational or physical activities and nutritional interventions for stress management and mental wellbeing in athletes. This study will reveal the combined impact of digital technologies, recreational/physical activities and nutritional interventions on stress management and mental wellbeing in athletes.

4. RESULTS AND DISCUSSION

The synthesis of findings on the impact of digital technologies, recreation and nutrition is presented below;

4.1. Impact of Digital Technologies on Stress Management and Mental Health of Athletes

The impact of digital technologies on stress management and mental health of athletes is as follows;

4.1.1. Digital interventions can enhance psychological skills and stress regulation

Several studies show that well-designed digital tools can positively influence stress management and mental wellbeing when they incorporate evidence-based psychological skills. For instance, Bordo *et al.* (2025) ran a pilot randomized controlled blended intervention using the Perform-UP Tennis app, which combined breathing exercises, nature based guided visualizations, and in-person support. Results showed significant improvements in self-confidence, cognitive anxiety, arousal control, and internal state awareness in tennis players. The authors conclude that integrating digital tools (app-based) with psychological skills (relaxation, mindfulness) is feasible and beneficial in athlete populations. Geiger *et al.* (2024) undertook a cross-sectional study among elite athlete and the study showed high acceptance of e-mental-health interventions and willingness to use digital tools to support mental well-being. This implies that digital tools can be used to support mental health of athletes and indicates readiness to adopt digital supports for wellbeing. Findings implies that digital mental-skills tools (apps, guided visuals, breathing training) can improve athletes' emotional regulation and awareness which are key mechanisms for stress management when implemented thoughtfully.

4.1.2. Wearable devices provide useful physiological insights for stress monitoring

A consistent body of work shows that wearables especially HRV, sleep, and strain sensors can act as indicators of stress, recovery, and training adaptation. For instance, Lindstrom *et al.* (2024) conducted an observational study among elite swimmers and found out that Wearable-derived HRV, resting heart rate, and exercise strain correlated with psychological stress and energy deficiency. This study supports use of wearables for monitoring stress in athletes. This study links wearable device metrics to lab-based measures of psychological stress. Addleman *et al.* (2024) conducted a review and found that in sport contexts HRV metrics via wearable devices are reliable indicators of stress, recovery, and training adaptation in athletes. Parpa *et al.* (2025) embarked on a study among elite female soccer players and found HRV and smartphone-based monitoring detected physiological stress changes related to infection and training loads. De Vries *et al.* (2023) in their study found out that wearable sleep/HRV is more useful as predictors of resilience than direct stress indicators. This suggests longer-term protective value. Park *et al.* (2024) explores how wearables can be used in young athletes to track physiology stress and inform training. There's a clear association (not causation) between more autonomous motivational profiles and higher physical activity in wearable-monitor users (Friel & Garber, 2020). This implies that wearables can indirectly promote wellbeing through increased activity. Wearables function as early warning systems, allowing athletes/coaches to identify stress buildup, maladaptation, or overtraining supporting proactive stress management.

4.1.3. Digital Platforms can also create or amplify psychological stress

While digital tools can be beneficial, several studies highlight risks, especially when usage is excessive, poorly regulated, or features promote compulsive engagement. For example, Collins *et al.* (2025) conducted a systematic review on mobile app use and mental health in elite athletes and found mixed or negative effects vis a vis increased stress, anxiety, and mental fatigue were reported. They note that significant negative effects potentially hindering athletic performance include increased stress, anxiety, and mental fatigue (Collins *et al.*, 2025). The authors caution that app usage should be integrated

strategically into training, to minimize harm and maximize benefit. Similarly, Chen *et al.* (2024) highlighted the dark side of consumer health and fitness apps, calorie tracking and physical activity tracking which can provoke negative psychological effects, particularly when feedback is rigid or users feel pressure from tracking. This suggests that digital tools are not universally beneficial and their design can either support or undermine mental wellbeing. Fiedler *et al.* (2024) in their study reported App-specific effects i.e Instagram use predicted greater calm/positive valence in some analyses; TikTok/longer use often negatively associated with sleep/recovery/mood and importantly performance level moderated effects (negative associations stronger in lower-level athletes). Athletes on low performance levels showed lower mental well-being when using social media longer, yet in national and international athletes the strength of these relationships was weaker or even reversed. Fiedler *et al.* (2023) in their study found that mental health in 12–19 year-old athletes was decreased when they showed prolonged usage times and addiction to digital media.
The implication of the findings above is that digital tools can exacerbate stress when they encourage compulsive tracking, upward social comparison, or overstimulation. The psychological impact depends on app type, usage patterns, and athlete characteristics.

4.1.4. Digital Social Support and Connectedness Influence Stress and Resilience

Digital communication spaces (e.g., online athlete communities) can moderate the impact of stressors. Zhang and Wang (2025) study was conducted on online social support and athlete resilience and the study reported that online social support (OSS) moderates the relationship between stressors and suicidal ideation and that OSS is linked to higher psychological resilience among sports students and gender differences were explored as well. The study used survey-based models and mediation/moderation analyses. Hence, digital communities can buffer stress and enhance resilience, offering continuous emotional and informational support, complementing physical team environments.

4.1.5. Adoption, Engagement, and Impact Vary Widely Among Athletes

The effectiveness of digital technologies depends heavily on user characteristics, preferences, motivation, and athletic level. Jakowski (2022) in their study found out that high uptake of fitness apps and wearables and self-tracking can support recovery management but usage, engagement and impact vary. Fiedler *et al.* (2024) found that performance level moderates digital media effects that is negative effects is stronger for lower-level athletes. Digital interventions are not one-size-fits-all. Differences in motivation, competitiveness, age, sport type, and performance level shape how athletes respond to digital tools

4.2. Impact of Recreation on Stress Management and Mental Health of Athletes

The impact of Recreation on stress management and mental health of athletes is discussed under the following subheadings:

4.2.1. Recreational Physical activity reduces stress, anxiety, and depression

A consistent body of research shows that regular physical activity is protection against psychological distress across athlete and general populations. For instance, Singh *et al.* (2023) reported that physical activity interventions significantly improved symptoms of distress, anxiety, and depression in adult populations. Rasheed (2023) looked at physical activity and mental health, noting that athletes who maintained higher levels of physical activity reported lower stress, anxiety, and depression, even during pandemic constraints. The review argues that physical activity in recreational contexts (e.g., home-based exercises, online training) served as a coping strategy to manage stress and maintain well-being. Systematic/narrative reviews by Martín-Rodríguez (2024) highlight mechanisms by which physical activity and team sport participation benefit mental health vis a vis neurochemical effects, improved emotion regulation, resilience and social functioning. Pasquerella *et al.* (2025) conducted a study among 44 adolescent athletes which showed that chronic participation in strategic sports reduced stress over time, acute exercise sessions reduced anxiety and depressive symptoms. Karakitsiou *et al.* (2025) embarked on a Bibliometric and Narrative Review and found out that team sports improve psychological empowerment, self-efficacy, and resilience, contributing to lower stress and improved mental well-being. Also, the study showed that participation in sports and team sports can lead to significant changes in mental health, which are primarily positive. Physical activity reliably improves psychological outcomes, functioning as a buffer against stress and negative mood states.

4.2.2. Recreational exercise improves Mental Health through Psychological, Biological, and Social Mechanisms

Several studies identify specific mechanisms through which recreation supports mental well-being.
In a recent systematic review, White *et al.* (2024) synthesized mediators and moderators of the physical activities, and mental health link. The study found strong evidence for mechanisms including affect, regulation, self-esteem, self-efficacy, resilience, and social support, social connection, body image satisfaction, health and well-being, physical self-worth, physical health, pain and fatigue. These mediators suggest why physical activities works that is engaging in exercise improves mood, builds self-efficacy, fosters social connections, and reduces fatigue all of which buffer stress. These reviews support exercise as protection against stress and low mood when integrated appropriately. Eather *et al.* (2023) conducted a Systematic Review of 29 studies and found that Sport participation, especially team sports, was linked to improved mental health, higher life satisfaction, and lower stress and depression and that social interaction is a key mediator. Eime *et al.* (2013) conducted a systematic Review of 11 studies which revealed that team-based sport participation reduces psychological distress and enhances self-esteem, social benefits (belonging, peer support) mediate improvements in well-being. Martín-Rodríguez (2024) found recreation enhances neural functioning, emotion regulation, and neurochemical pathways that reduce stress. This implies that recreation enhances mental

health through interconnected biopsychosocial mechanisms, improving resilience and emotional capacity to manage stress. Team Sport participation provides unique social and emotional Benefits

4.2.3. Team sports appear consistently more beneficial than individual activity for stress management, mental health, and social connectedness.

According to Eather *et al.* (2023, Team sports linked to higher life satisfaction and lower stress and depression, with social interaction as a critical mediator. Eime *et al.* (2013) also found team-based sports reduce psychological distress through belonging and peer support. Also, Karakitsiou *et al.* (2025) team sports enhance self-efficacy, resilience, and psychological empowerment. Zuckerman *et al.* (2021) in their study confirmed improved social health outcomes with team sport participation. Jugl *et al.* (2023) examined psychological outcomes, including self-esteem and mental well-being, which significantly improved with participation in sports programs. The study of Khan *et al.* (2022) found that participating in team sports offer mental health benefits for both genders, whereas non-team sports might be more advantageous for boys compared to girls. Therefore, Team sports offer enhanced social bonds, collective identity, and emotional support, making them especially effective for stress management and psychological wellbeing.

4.2.4. Recreational activity as a coping strategy and source of resilience

Recreational activities help athletes cope with stress and develop long-term psychological resources. For instance, Rasheed (2023) found recreational physical activities (online workouts, home exercise) acted as a stress-coping mechanism during COVID lockdowns. Pasquerella *et al.* (2025) found strategic and regular participation in sport promoted long-term stress reduction. Martín-Rodríguez (2024) found recreation supports long-term mental health via improved resilience, emotional stability, and social functioning. Recreation builds psychological endurance, helping athletes withstand pressure, regulate emotions, and maintain wellbeing under high training or competitive stress.

4.3. Impact of Nutrition on Stress Management and Mental Health of Athletes

Nutrition has the following impacts on the mental health of athletes:

4.3.1. Healthy dietary patterns protect against stress, anxiety, and depression

A consistent theme across studies is that balanced, high-quality diets are associated with better mental health among athletes. For instance, Gao and Wang (2024) conducted a cross-sectional study among 758 young adult athletes and found that better dietary patterns are associated with lower internalizing symptoms (anxiety, depression), with sleep quality mediating the relationship. Ramírez-Goerke *et al.* (2023) revealed that athletes who cooked their own meals exhibited higher anxiety, whereas greater water intake and whole grain consumption were linked to lower anxiety and that more frequent and intense training, particularly weight training, was also associated with reduced anxiety. Gerber *et al.* (2023) in their study among prospective cohort, adolescent elite athletes found that higher protein consumption predicted lower depressive symptoms, suggesting macronutrient intake may influence mental health in athletes indicating that higher protein consumption in athletes was a prospective predictor of lower depressive symptom severity at follow-up. Halioua *et al.* (2024) conducted a cross-sectional study among female athletes which revealed that low energy availability and poor dietary practices were linked to depression, anxiety, and eating disorder risk thereby highlighting the importance of nutrition for mental health. Keskin *et al.* (2020) in their cross-sectional study found out that weight-class athletes' eating habits and macronutrient consumption were significantly associated with depression, anxiety, and stress scores, emphasizing diet-stress relationships. Therefore, Healthy dietary patterns (adequate macronutrients, hydration, whole foods) are protection against stress and internalizing symptoms, likely through effects on energy balance, neurochemical regulation, and sleep.

4.3.2. Poor Nutrition and low energy availability increase vulnerability to psychological distress

Several studies highlight that inadequate intake, poor diet quality, and low energy availability predispose athletes to worse mental health outcomes. Larsson *et al.* (2024) found that prospective cohort, adolescent athletes with poorer mental health tended to reduce food intake and this lower intake was linked to decreased mental well-being over time. Christensen *et al.* (2021) in their cross-sectional study among female collegiate athletes, examined diet quality and mental health and found limited association between better diet and reduced stress or depressive symptoms, suggesting other factors may moderate the relationship. De Souza *et al.* (2019) found that aggressive behaviours, alcohol use, and fatigue is significantly associated with psychological distress and stress in both sexes while nutrition/unhealthy diet and lower alcohol use is associated with psychological distress in female athletes. Halioua *et al.* (2024) found that low energy availability is associated with depression, anxiety, and disordered eating risk. This implies that insufficient nutrition undermines psychological resilience and contributes to stress, either directly or through fatigue, hormonal disruption, and energy imbalance.

4.3.3. Nutrition knowledge, attitudes, and education influence stress and resilience

Beyond actual diet, what athletes know and believe about nutrition significantly impacts their stress levels and mental well-being. For instance, Tutkun (2020), in his cross-sectional study among 420 university athletes reported that poor nutritional knowledge was associated with higher stress levels thereby highlighting the need for tailored nutrition strategies as part of stress management. This implies that athletes with better nutrition awareness reported lower perceived stress. Özsarı *et al.* (2024) found that athletes positive attitudes and higher knowledge about nutrition predicted greater mental toughness and resilience in athletes. This implies that positive attitudes to healthy nutrition associated with greater mental toughness. McCabe *et al.* (2021) found out that staff perceive

nutrition and mental health as linked, but integration across programs is inconsistent. Sánchez-Díaz *et al.* (2020) also found nutrition education interventions (team-level) improve dietary habits, nutritional knowledge and can influence fitness markers in team-sport athletes and many studies recommend embedding education into training programs for lasting behavior change. Therefore, Nutrition literacy strengthens resilience and stress coping, while poor knowledge increases vulnerability. However, Educational-based interventions are promising but underutilized.

4.3.4. Targeted nutritional strategies and micronutrient support can enhance Mental Well-Being

Evidence suggests that specific nutrients, supplementation, and professionally guided dietary strategies may support psychological and stress outcomes in athletes. Malinowska *et al.* (2024) conducted an exploratory review and identified nutritional strategies (omega-3s, magnesium, hydration) that may reduce stress and support psychological well-being in athletes. They focused specifically on nutrition approaches to improve mental health in athletes (particularly in contexts of depression and disordered eating). They argue for tailored nutrition therapy, guided by professionals and adapted to individual athlete needs, as a way to mitigate psychiatric symptoms in athletes. Their conclusion emphasizes that a holistic approach, integrating high-quality and balanced diets, is critical for both performance and wellbeing. The systematic review of Ghazzawi *et al.* (2023), showed that adequate micronutrient status (vitamins, minerals) is important for health and performance and that no single micronutrient dominates but deficiencies (iron, vitamin D, B-vitamins) can impair mood, cognition, recovery and increase susceptibility to stress/illness. The review emphasised assessment and targeted supplementation when needed. Gerber *et al.* (2023) also found that specific macronutrient (protein) intake has prospective mental health benefits. Findings above implies that micronutrient and targeted nutritional strategies may bolster psychological health, particularly when addressing deficiencies, but this requires individualized, professional guidance.

4.4. Combined impact of Nutrition, Recreation and digital technologies on mental health of athletes

The combined impact of use of digital technologies, Recreation and Nutrition on the mental health of athletes are discussed below:

4.4.1. Holistic lifestyle integration and psychological/ physiological resilience

When athletes combine healthy nutrition, balanced recreation and constructive use of digital technologies like wearables, monitoring apps, virtual training, they can build psychological resilience which gives them the capacity to adapt to stress, recover from fatigue and sustain wellbeing. This is supported by evidence in literature that balanced diet quality including adequate micronutrients, omega-3 fatty acids, low ultra-processed intake supports neutral health, mood regulation, cognitive performance which is key to mental resilience (Christensen *et al.*, 2021) that is diet quality predicted fewer symptoms of depression/anxiety. This implies that high quality diet is positively associated with reduced depression and anxiety in athletes. In addition, recreational and leisure activities provide recovery from competitive stress, enhances enjoyment and buffer against burnout indicating that sports participation improves psychological and social well-being and reduce distress (Eime *et al.*, 2013). Athletes report that these tools help them monitor sleep and recovery-related behaviours and can support recovery self-management that is increasing awareness and prompting behavioral adjustments (Jakowski, 2022). Digital health tools such as mood tracking or recovery monitoring apps increase self-awareness and accountability. These three factors when combined fosters an integrated wellbeing ecosystem where physical, mental and technological supports reinforce one another that is nutrition fuels the body, recreation restores balance and technology maintains self-awareness.

4.4.2. Self regulation, Autonomy and Motivation

Nutrition planning, recreational participation and technology assisted feedback promotes self determination and self regulation. Digital health technologies and flexible recreation enhance self-regulation while good nutrition supports sustained motivation and performance. Nutrition-related behaviors are associated with mental health outcomes in athletes. De Souza *et al.* (2019) found that unhealthy dietary habits, inadequate attention to nutrition, and higher alcohol use were linked to greater psychological distress among collegiate femaAthletes with higher diet quality had significantly lower scores of depression, anxiety, and stress, suggesting that diet quality may be an important factor associated with mental health in collegiate athletes (Christensen *et al.* 2021). Self-monitoring technologies such as nutrition trackers, wearables enhance autonomy and perceived control which are linked to increased motivation and reduced anxiety and other negative effects (Maher *et al.*, 2017; Friel & Garber, 2020; Ryan *et al.*, 2019) while results suggest that using a wearable is a positive experience for users with little risk of negative psychological consequences (Ryan *et al.*, 2019). Sleep monitoring may be a possible approach to raise the athlete's awareness and to detect dysfunctional sleep indices at an early stage and self-tracking technologies are possible approaches to support recovery self-management activities for athletes (Jakowski, 2022). This implies that wearables and mobile health applications strengthen athletes' self-monitoring and intrinsic motivation. As the experience and frequency of participation in recreational sports activities increased, the levels of well-being elevated (Bayram *et al.*, 2025). This implies that recreational participation promotes enjoyment and autonomy, offsetting the pressure of stress in elite competition. Hence, the recreational sports environment provides autonomy and a supportive mechanism which is less rigid and more playful thereby meeting the basic psychological needs of autonomy, competence and relatedness. Athletes who maintain nutritional discipline while allowing for flexible enjoyable recreation report greater life satisfaction and self-efficacy. Together the three creates a positive feedback loop, digital self-regulation tools reinforce nutritional habits and recreational engagement thereby enhancing intricate motivation and wellbeing. When

technology, recreation and nutrition jointly support autonomy, athletes develop adaptive motivation and lower burnout.

4.4.3. Social connectedness and community support

Social connections formed through shared meals, team recreation and digital networks contribute to belongingness and social support which is germane for psychological health. Team based recreation and club participation increase social integration, reduce loneliness and improve emotional wellbeing that is sport participation enhances social connectedness and belonging (Eime *et al.*, 2013) while digital platforms such as virtual group workout environments and online social support communities can extend athletes' networks beyond physical space. Empirical research among sports-specialty shows that online peer communities provide emotional and informational support and enhance resilience under stress (Zhang & Wang, 2025). Digital platforms like online athletes communities, virtual group workouts extend these networks beyond physical space, providing continuous emotional and information support. Sánchez-Díaz *et al.* (2020) found that nutrition education (both online and face-to-face) improves eating habits and nutrition knowledge among team-sport athletes. This emphasized the importance of team-based nutrition education and collaborative strategies to improve dietary adherence and support group performance outcomes. This implies that shared nutrition initiatives like team cooking sessions, dietary challenges, foster collective efficacy and cohesion. These nutrition programmes implemented within teams increase cohesion and trust. Therefore, the integration of digital tools, recreation and nutrition creates a social ecosystem or community cohesion that buffer against isolation and mental distress.

4.4.4. Cognitive functioning and emotional regulation

Nutrition fuels optimal brain function, recreation regulated mood and stress and digital feedback helps athletes monitor and adjust together these enhanced cognitive performance and emotional balance. Nutrition and recreation affect neurochemical balance while digital biofeedback enables real time stress regulation. Nutrition influences neurotransmitter synthesis and brain energy metabolism, directly affecting concentration and mood stability and links micronutrients and brain function in athletes while leisure time physical activity lowers stress and depressive symptoms. Ghazzawi *et al.* (2023) findings suggest that vitamins and minerals are crucial for an athlete's health and physical performance, and no single micronutrient is more important than others. Micronutrients are necessary for optimal metabolic body's functions such as energy production, muscle growth, and recovery, which are all important for sport performance (Ghazzawi *et al.*, 2023). Consistent physical activity contributes to stress reduction, physical activity decreases cortisol levels, exercise stimulates endorphin production and endorphin increase fosters a sense of well being (Martín-Rodríguez, 2024). Recreation facilities endorphin release and stress relief, improving emotional regulation. In addition, Heart-rate variability apps allow real-time tracking of stress and sleep, promoting early intervention before emotional fatigue escalates, early detection using wearable HRV and sleep metrics could therefore enable readiness feedback or just-in-time interventions to prevent escalation of emotional fatigue (de Vries *et al.*, 2023). Biofeedback and app based mindfulness training reduce anxiety and improves focus on athletes. These combined effect improve focus, decision making and psychological readiness. They enhance cognitive clarity and emotional balance which is vital for consistent performance.

4.4.5. Personalisation and preventive wellbeing system

Digital technologies enable personalisation tailoring nutrition, recreation and recovery to each athletes physiological and psychological profile, turning wellbeing from reactive to preventive. AI based nutrition apps and wearable sensors allow for individualised dietary adjustments which is linked to mood and performance metrics. According to Lundstrom *et al.* (2023), Wearable tech metrics (HR, training load) can be used to detect energy deficiency and psychological stress in elite swimmers and the data could allow personalized monitoring and preventive interventions. Park *et al.* (2024) also believe wearables have the potential for monitoring training, recovery, and health, thereby preventing mental health issues. Jakowski (2022) stated that self-tracking via smartphone apps for athletes' recovery and sleep, enables personalized monitoring and management, supporting preventive wellbeing. Wearable and data-driven nutrition strategies may help optimize fueling and recovery and personalized nutrition approaches may reduce fatigue via better energy and hydration management (Burke *et al.*, 2019). Wearables based recovery tracking helps tailor training and recreation to psychological readiness. Also integrated digital platforms combining nutrition, recreation and mental health tracking improve early detection of stress-related decline. Combining monitoring of training load, recovery, and wellbeing helps detect fatigue and reduce the risk of overtraining/burnout (Temm*et al.*, 2022). Recreational programmes informed by digital data like recovery load, optimise rest and enjoyment while minimising burnout. A digital integrative athlete care merging psychological and physiological monitoring for long term well being is essential to athletes survival. These systems shift athlete mental health care from reactive to preventive and data-driven.

These three when combined builds resilience, lowers stress, enhances autonomy, improves internal drive, improves belongingness and support, improves focus and emotional control and enables proactive well being.

4.5. Discussion of findings

The study reviewed findings on the impact of digital technologies, recreation and Nutrition on stress management and mental health of athletes. The review revealed that the adoption of digital technologies for stress management and mental wellbeing in athletes can produce both positive and negative impacts as indicated in the studies reviewed. Research has shown that wearables helps to monitor stress and has been accepted by athletes for mental wellbeing monitoring. This acceptance shows that digital technologies have impacted athletes wellbeing to a considerable extent. Wearables also detect stress both physiological and psychological and was

found to predict mental resilience than stress indicators. Fitness apps also support recovery management. The use of mental health apps correlates positively and negatively based on usage. Findings implies that wearables and mental health apps are valid and increasingly used tools for monitoring stress in athletes. Athletes are receptive to digital interventions, including e-mental-health platforms and impact may either be positive or negative based on usage. Digital technologies have a dual impact on stress and mental health in athletes, that is it is positive when tools are structured, evidence-based, blended with psychological skills, or used for physiological monitoring and Negative when apps encourage obsessive tracking, promote social comparison, or are used excessively. Benefits is conditional and depend heavily on athlete motivation, performance level, and app design. Ultimately, the literature suggests that digital technologies are powerful but double-edged, requiring careful integration into sport psychology and training systems to maximize benefits and limit harms. However, evidence is mainly observational and more experimental and longitudinal studies are needed to test interventions using digital feedback for stress management.

Strong evidence supports that recreational sport participation enhances mental well-being and reduces stress. Team-based and socially interactive sports provide the greatest psychological benefit. Structured, chronic participation offers long-term protection against stress, while acute exercise also offers immediate mental health benefits.

Regular physical activity through exercise routines and especially through team sports participation reduces stress, anxiety, and depression. Benefits occur through affect regulation, improved self-esteem, resilience, and social bonding. Team sports offer unique advantages through social support, belonging, and psychological empowerment. Recreational participation acts as a coping strategy that enhances emotional resilience, especially during challenging circumstances. Recreation is therefore a multidimensional protective factor, operating through biological, psychological, and social processes that collectively enhance athletes' mental well-being. Nutrition plays a multifaceted role in stress management and mental health among athletes.

Healthy diets and adequate macronutrient intake protect against stress, anxiety, and depression. Poor diet quality, low energy availability, and nutrient deficiencies significantly worsen psychological resilience and mood. Nutrition knowledge and positive dietary attitudes enhance mental toughness and reduce perceived stress. Targeted nutritional strategies (omega-3s, hydration, micronutrients) provide additional pathways for psychological support. However, integration of nutrition into mental health programs is inconsistent, despite evidence for strong benefits. Overall, nutrition is a critical but often overlooked pillar in athletes' psychological well-being, influencing stress regulation through biological, psychological, and behavioral pathways. This implies that athletes that are knowledgeable about nutritional strategies are more likely to implement it and have less mental health issues. Athletes also need better diet for psychological resilience. There is some evidence of indirect effects via sleep quality and recovery, but more longitudinal and intervention studies are needed.

Human biology requires a certain amount of physical activity/recreational activities, healthy diet and frequent monitoring through technology to maintain good health and wellbeing. Studies and reviews indicate that the greatest promise lies in an integrated approach where nutrition, recreational/exercise and digital tools are combined. A plan that includes nutritional adequacy, regular recreation and digital tools for monitoring and coaching will go a long way in improving mental health outcomes of athletes. The combined effect is depicted with the example of an athlete that went swimming to relax her muscles, used biofeedback wrist sensors, mindfulness and performance tracking app to track her performance after taking food rich in Macro and micro nutrients to boost her muscle growth and vitality through diet. Bordo *et al.* (2025) study supports the idea that combining digital psychological and recreational interventions works in athletes. Nutrition apps help athletes monitor their dietary intake, learn about nutritional needs, and potentially correct deficits. Better nutrition supports physiological recovery, energy balance, and brain function, which can buffer stress. Recreational physical activity, as shown in many studies, directly reduces stress and improves affect, self-esteem, resilience, and other mental health mediators. Improved nutrition may enhance the benefits of recreational physical activities (e.g., better recovery, greater capacity for exercise), and physical activities may amplify the psychological benefits of good nutrition (e.g., via improved mood, self-efficacy). Digital delivery (via apps) enables self-monitoring, feedback, and engagement in both domains (nutrition and exercise), potentially increasing adherence and integration into daily routines.

From the studies, no single study examined the combined impact of the three variables used in these study, but some examined the impact of two of the variable thereby showing existing gap in literature. There is a lack of randomized controlled trials that explicitly combine digital nutrition tools and recreational physical activity (or psychological skills) in athlete samples, measuring stress and mental wellbeing as primary outcomes. More work is needed to identify mediators (e.g., self-efficacy, recovery, sleep) by which combined digital nutrition, recreation interventions influence stress and mental health in athletes. There is need for more longitudinal research that is long-term follow-up is needed to assess whether benefits (or harms) persist, especially across competitive seasons.

5. CONCLUSION

This study has shown that when three interventions merge, they create an improved mental health package for athletes. Adequate diet, energy availability, and nutrition knowledge reduce stress and support resilience. Wearables and e-mental health tools are effective for monitoring and potentially improving mental well-being, though intervention studies are limited. Participation in sport, particularly team-based, strongly promotes mental health, reduces stress, and enhances resilience. These interventions will be effective if there is; collaboration between digital tools and sport psychologist on the quantity of usage, routine screening for energy availability, eating-disorder risk and targeted nutrition education for athletes, the persistent use of digital applications with regular recreational activities

and therapeutic nutritional screening, guidance and adoption and Athletes' literacy training in mental health interventions use.

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