Recreation, Physical Activity, and Sedentary Lifestyle from a Sports Sciences Perspective: Contemporary Approaches

Editors:

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DUVAR

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CHAPTER 1

Postural Deformities in Female Athletes: An Integrative Review of Biomechanics, Determinants, Assessment, and Intervention Strategies

Prof. Dr. Şebnem ŞARVAN CENGİZ[1]

Şarvan Cengiz, Ş. (2025). Postural deformities in female athletes: An integrative review of biomechanics, determinants, assessment, and intervention strategies. M. Gönen & M.Erkan (Ed.), *Recreation, physical activity, and sedentary lifestyle from a sports sciences perspective: Contemporary approaches* (ss. 5–26). Duvar Yayınları.

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Introduction

This chapter provides a comprehensive and integrative review of **postural deformities commonly observed in female athletes**, focusing on evidence published in the last five years. It explores postural deviations such as **thoracic kyphosis, lumbar hyperlordosis, forward head posture, scapular dyskinesis, knee valgus, and pelvic malalignment**, and examines how these conditions intersect with sport-specific demands, neuromuscular profiles, hormonal fluctuations, and training practices.

Unlike traditional research articles, this chapter synthesizes the existing literature within a **broader conceptual and educational framework**, offering readers not only scientific knowledge but also practical guidance for assessment, prevention, and correction strategies tailored for female athletes.

Female athletes represent a rapidly growing athletic population with **unique biomechanical, neuromuscular, anatomical, and hormonal characteristics**. These characteristics influence posture, movement patterns, and injury risk in sport-specific ways.

A book chapter is the ideal format because it allows the topic to be explored holistically, addressing:

- Fundamental biomechanical principles of posture
- Sex-specific differences in musculoskeletal structure
- Influence of menstrual cycle and hormonal profiles
- Sport-specific training loads and asymmetrical demands
- Evidence-based corrective exercise strategies

Current literature still overrepresents male athletes or mixed-gender groups, often lacking sex-specific analyses. The chapter fills this gap by:

- Focusing exclusively on **female athletes**
- Mapping **postural deformities** reported in the last five years
- Explaining the mechanisms behind these deformities
- Highlighting **assessment tools and intervention strategies** validated for women
- Offering a modern conceptual framework linking **posture → movement → performance → injury risk**

Thus, the chapter positions itself as one of contemporary works to consolidate and analyze postural health specifically within the female athletic population.

This comprehensive perspective situates the chapter as a key reference point for professionals who seek to understand **the interconnected nature of posture, performance, and injury prevention in female athletes**.

This chapter addresses exclusively focusing on the nuanced postural deformities prevalent in female athletes, a demographic often underrepresented in sex-specific analyses (Donnelly & Moore, 2023).

The increasing participation of women in athletics necessitates a deeper understanding of their unique anatomical, biomechanical, hormonal, and psychological factors that influence injury risk and performance (Gianakos et al., 2022).

This is particularly pertinent given that postural regulation and stability are paramount for optimal athletic performance across various sports, requiring intricate multimodal interactions between musculoskeletal and neural systems (Lauenroth et al., 2021).

Literature Review

Postural instability, characterized by impaired proprioception and increased center of pressure sway, has been frequently observed in female athletes, particularly in endurance sports and those recovering from injuries, underscoring its relevance to injury prevention (Oliveira et al., 2025). This targeted approach provides a comprehensive, pragmatic body of knowledge that acknowledges past findings and addresses opportunities for future research directions in athletic females (McNulty et al., 2024).

This dedicated examination is crucial, given the documented increase in sports-related injury rates among female athletes alongside their growing participation in high school and collegiate sports (Boucher et al., 2018). Moreover, this rise in participation has led to a parallel increase in the incidence of injuries, making a focused investigation into female-specific postural deviations an imperative for effective injury mitigation and performance enhancement strategies (Asgari et al., 2021; Oliveira et al., 2025).

Deficits in neuromuscular control, often associated with postural abnormalities, are modifiable through targeted training programs, emphasizing the importance of early detection and intervention (Ulman et al., 2022). These programs frequently involve specific muscle strengthening, proprioceptive drills, and balance training, which have demonstrated efficacy in preventing injuries and improving postural control (Oliveira et al., 2025). The etiology of these postural disturbances can be multifaceted, involving both intrinsic factors such as age, body height, and body mass, as well as extrinsic factors like sport-specific training loads that contribute to adaptive postural changes (Zwierzchowska et al., 2022).

For instance, female athletes often exhibit distinct balance characteristics, sometimes showing superior coordination of visual and proprioceptive systems, which could be exploited in tailored intervention strategies (Weismiller et al., 2021). Despite potential advantages in certain postural control mechanisms, female athletes are more susceptible to specific musculoskeletal injuries, highlighting the need for sex-specific analyses and intervention strategies (Ingel et al., 2021; Kacem et al., 2021). For example, imbalances in lower limb biomechanics, potentially exacerbated by hormonal fluctuations, contribute to conditions like knee valgus, which is a significant risk factor for anterior cruciate ligament injuries in female athletes (Vico-Moreno et al., 2022). The increased susceptibility to anterior cruciate ligament injuries in female athletes is further compounded by factors such as quadriceps dominance and inadequate hamstring strength, which collectively impair dynamic knee stability (Gheidi & Sadeghi, 2014). These neuromuscular imbalances often manifest as dynamic knee valgus, a critical biomechanical precursor to anterior cruciate ligament injuries in female athletes (Gheidi & Sadeghi, 2014; Myer et al., 2004; Schmidt et al., 2022).

Studies conducted in Türkiye demonstrate that postural instability, balance performance deficits, and impairments in proprioceptive control among female athletes are closely

associated with an increased risk of lower extremity injuries. National evidence indicates that static and dynamic balance parameters in female athletes differ from those observed in male athletes, and that these differences play a critical role in postural control mechanisms and injury susceptibility (Baltacı et al., 2013; Korkusuz & Baltacı, 2016).

In female athletes, increased center of pressure sway and insufficient proprioceptive feedback become particularly evident during post-injury rehabilitation, with such impairments being associated with a higher risk of injury recurrence (Erkmen, 2016; Şimşek et al., 2019). Research conducted in Türkiye emphasizes that early identification of postural control deficits, followed by targeted balance- and proprioception-based exercise interventions, is essential for effective injury prevention strategies (Aydın et al., 2019).

National studies focusing on knee joint biomechanics further reveal a high prevalence of dynamic knee valgus in female athletes, identifying this biomechanical pattern as a major risk factor for anterior cruciate ligament (ACL) injuries (Korkusuz, 2017; Zorba & Saygın, 2013). Neuromuscular imbalances, including quadriceps dominance, insufficient hamstring strength, and weakness of the hip abductor musculature, have been shown to compromise dynamic knee stability, thereby increasing valgus angles and substantially elevating the risk of ACL injury in female athletes (Baltacı et al., 2013).

Additionally, research conducted on female athletes in Türkiye highlights the influence of hormonal fluctuations on connective tissue laxity and muscle activation patterns, which may indirectly affect postural control and balance performance (Çetin & Aydos, 2018; Özdemir, 2021). However, it has also been noted that these physiological variables are not systematically controlled in many national studies, limiting the development of evidence-based, female-specific training and rehabilitation protocols.

Overall, findings from the Turkish literature support the need to address postural instability, neuromuscular control deficits, and lower extremity biomechanical risk factors in female athletes within an integrated framework. These findings underscore the importance of early screening, sex-specific exercise programs, and balance- and proprioception-oriented interventions for injury prevention and long-term athletic health.

This is particularly pronounced during periods of rapid growth, such as puberty, where hormonal shifts and altered neuromuscular strategies contribute to a heightened risk of anterior cruciate ligament injuries (Dadfar et al., 2021). This vulnerability is amplified by factors such as neuromuscular fatigue and specific phases of the menstrual cycle, which can profoundly impact postural control and lower limb biomechanics (Kacem et al., 2021). Such issues underscore the necessity for injury prevention programs that account for the unique biomechanical and hormonal profiles of female athletes (Mattu et al., 2022; Silvers-Granelli, 2021). Neuromuscular training programs, encompassing plyometrics, balance training, and strength conditioning, have shown considerable effectiveness in mitigating anterior cruciate ligament injury risks in adolescent female athletes by improving dynamic knee stability and movement competence (Ramachandran et al., 2024; Schmidt et al., 2022).

These interventions have been shown to be particularly effective post-puberty, where female athletes exhibit altered neuromuscular strategies and increased knee abduction moments during landing that heighten ACL injury risk (Myer et al., 2012; Ramachandran et al., 2024). This makes early exposure to neuromuscular training interventions crucial for female athletes to enhance jump-landing biomechanics and reduce anterior cruciate ligament injury risk (Ramachandran et al., 2024). However, the sustained efficacy and widespread adoption of these programs outside of controlled clinical settings remain a challenge, necessitating strategies to improve adherence and integration into routine training regimens (Hart, 2023).

Furthermore, the underlying mechanisms of anterior cruciate ligament injury, including whether they are sport- or gender-specific, and the impact of fatigue on preventive measures, warrant further investigation to refine current protocols (Silvers & Mandelbaum, 2007). One key area for refinement involves addressing the higher quadriceps activation and lower hamstring activation often observed in female athletes during high-risk movements, which contributes to increased anterior tibial shear forces and ACL strain (Bencke et al., 2018). Moreover, deficits in hip and core strength can further exacerbate knee valgus and increase anterior cruciate ligament injury risk by diminishing control over femoral internal rotation and adduction during dynamic tasks (Silvers, 2009). These deficits necessitate a holistic training approach that incorporates proximal joint stability to optimize distal limb mechanics and reduce injury susceptibility (Kacprzak et al., 2024).

Despite advancements, current injury prevention strategies often lack individualized considerations, potentially limiting their effectiveness across diverse athletic populations (Hewett et al., 2012, 2016). To optimize intervention efficacy, future research must therefore focus on developing personalized approaches that integrate athlete-specific biomechanical profiles, hormonal status, and sport-specific demands into tailored prevention protocols (Mattu et al., 2022). This includes the implementation of robust, evidence-based screening tools to identify female athletes at heightened risk, allowing for targeted intervention strategies that move beyond generalized approaches (Myer et al., 2010). Such personalized approaches can incorporate advanced biomechanical analyses, including 3D motion capture and ground reaction force measurements, to precisely quantify movement patterns and identify subtle deviations indicative of heightened injury risk. Additionally, a more comprehensive understanding of how training volume and frequency impact injury risk in female athletes is crucial for designing effective prevention programs ("Effective Anterior Cruciate Ligament Injury Prevention Programming in Young Female Athletes: An Evidence-to-Practice Review," 2024).

This involves further epidemiological and biomechanical studies to determine exact injury mechanisms and the most effective interventions for specific populations, particularly given the disproportionately high rates of certain injuries, such as anterior cruciate ligament ruptures, in female athletes (John et al., 2025; Mancino et al., 2024; Saxby et al., 2023; Silvers & Mandelbaum, 2007). Despite extensive research and the development of effective

prevention programs, female athletes continue to experience a 4- to 6-fold higher risk of anterior cruciate ligament injuries compared to male athletes, indicating a need for more targeted and pervasive implementation of current knowledge (Donelon et al., 2024; Fischer, 2006). This necessitates a deeper exploration into the multifactorial etiologies, including inherent anatomical differences like a wider pelvis and increased Q-angle, which contribute to greater knee valgus during dynamic movements (Saber et al., 2024). Moreover, the distinctive neuromuscular control patterns and landing biomechanics frequently observed in female athletes further heighten their predisposition to such injuries (Voskanian, 2013).

Indeed, customized landing tasks have highlighted how female athletes often adopt potentially harmful kinematics, underscoring the need for further biomechanical research focused on sex-specific differences (Brunetti et al., 2024). Furthermore, approximately 40% of female athletes exhibit no biomechanical deficits during unanticipated cutting tasks, suggesting distinct risk profiles within the population that require tailored assessment and intervention (Pappas et al., 2015). This highlights the need for a comprehensive understanding of individual biomechanical profiles to develop effective injury prevention strategies (Brunetti et al., 2024). Such an understanding could leverage advanced analytical techniques, like machine learning algorithms, to process vast datasets of biomechanical and physiological metrics, thereby identifying nuanced risk factors that elude conventional analyses.

Moreover, investigations into how biomechanical risk factors change across various stages of maturation in female athletes are essential for developing age-appropriate interventions (Ramachandran et al., 2024). This includes exploring the influence of hormonal fluctuations throughout the menstrual cycle on joint laxity and neuromuscular control, which can significantly impact injury susceptibility (Akhundov et al., 2022). Further research is also warranted to clarify the interplay between intrinsic factors, such as anatomical predispositions like a wider Q-angle and increased midfoot mobility, and extrinsic factors like sport-specific demands and training methodologies, on overall injury risk in female athletes (Ismail et al., 2020; Larwa et al., 2021). This multifaceted approach is critical given that biomechanical deficits, such as those contributing to increased knee adduction and internal rotation moments, are often concurrent, necessitating interventions that address multiple risk factors simultaneously (Myer et al., 2010; Pappas et al., 2015).

Despite considerable research, conclusive evidence linking specific hormonal profiles or menstrual cycle phases to increased anterior cruciate ligament injury risk remains elusive due to methodological limitations in past studies (Silvers, 2009). High-quality prospective studies are needed to establish the influence of hormonal mechanisms on ACL injury risk, especially by evaluating biomechanical changes across the menstrual cycle using high-risk movements like rapid deceleration and change of direction (Balachandar et al., 2019). Further investigation should also focus on pelvis width, Q-angles, femoral notch widths, and hamstring-quadriceps muscle activity to delineate their specific contributions to ACL injury in various phases of the menstrual cycle (Vellingiri, 2017).

This necessitates a more rigorous examination of hormonal profiles and their direct influence on ligamentous stiffness and neuromuscular control to better understand the observed injury disparities (Bell et al., 2014; Legerlotz & Nobis, 2022). This approach will enable the development of targeted interventions that account for both mechanical and physiological factors contributing to injury susceptibility in female athletes (Legerlotz & Nobis, 2022). Further, the dynamic interplay between these intrinsic and extrinsic factors, coupled with individual training loads and recovery practices, must be thoroughly investigated to generate comprehensive injury prevention models. This integrated understanding can inform evidence-based strategies, moving beyond broad recommendations to precise, athlete-specific interventions. Crucially, future research must address the pervasive underrepresentation of female athletes in sports and exercise medicine research, which often overlooks the unique physiological changes associated with the menstrual cycle and the potential methodological difficulties they pose (Dos'Santos et al., 2023).

Addressing this gap requires a paradigm shift towards inclusive research designs that prioritize female-specific physiological considerations (Gianakos et al., 2024). This inclusive approach will provide a more complete understanding of injury risk factors and facilitate the development of gender-specific prevention and rehabilitation programs (Gianakos et al., 2024). It also requires improved reporting of participant characteristics, including specific sports, skill levels, and resistance training histories, as these factors significantly influence movement strategies and hormonal profiles (Dos'Santos et al., 2023).

Moreover, exploring the long-term impact of hormonal contraceptives on injury risk and recovery in female athletes presents another critical avenue for investigation (Nédélec et al., 2021). Such research is vital for understanding how exogenous hormones interact with endogenous fluctuations to influence biomechanical stability and ligamentous integrity (Donelon et al., 2024). This includes examining how hormonal contraceptives might alter collagen synthesis and cross-linking, thereby affecting the viscoelastic properties of ligaments and tendons and potentially influencing injury susceptibility and healing rates. Further, a holistic approach that considers socio-environmental and psychological factors alongside biological considerations is imperative for a comprehensive understanding of female athlete health and performance (Stitelmann et al., 2024).

This broader perspective acknowledges that female athletes are not a monolithic group and that individualized strategies are needed, moving beyond a sole focus on menstrual cycle phases to encompass the multifaceted determinants of performance and injury risk (Stitelmann et al., 2024). Specifically, despite the increasing participation of women in sports, research disproportionately features male athletes, creating a significant knowledge gap in understanding female-specific physiological responses and injury mechanisms (Fort-Vanmeerhaeghe et al., 2025; Smith et al., 2022). This disparity often leads to the extrapolation of male-centric findings to female populations, which overlooks critical sex-specific differences in biomechanics, endocrinology, and recovery processes (McNulty et al., 2024). This overreliance on male data for female athletic populations underscores the urgent

need for focused research on female athletes to develop evidence-based training and injury prevention protocols (McNulty et al., 2024; Welde et al., 2024). This ongoing issue is problematic given that female athletes are considerably more susceptible to certain injuries, such as anterior cruciate ligament tears, with rates approximately 3.5 times higher than in male athletes (Dos'Santos et al., 2023). This gap is further compounded by the complexities of conducting rigorous physiological studies in female athletes due to hormonal variability across the menstrual cycle, often leading to a paucity of robust, sport-specific research (Vogel et al., 2023).

Results

This scarcity of data necessitates an in-depth, sex-specific analysis of postural deformities and injury mechanisms in female athletes to inform targeted interventions and preventative strategies. Addressing this, the subsequent sections delve into specific postural deviations commonly observed in female athletes, linking them to underlying physiological and biomechanical factors. This review, unlike many traditional studies, critically examines how these postural conditions interact with sport-specific demands, neuromuscular profiles, hormonal fluctuations, and training practices to provide a comprehensive understanding of their etiology and impact. This detailed exploration aims to bridge existing knowledge gaps by synthesizing recent literature specifically concerning female athletes, offering a foundation for evidence-based assessment and intervention strategies. Specifically, research consistently indicates that female athletes, particularly those in sports like gymnastics, soccer, and basketball, exhibit higher injury rates per exposure compared to males, often attributable to distinct anatomical characteristics of the lower kinematic chain (Larwa et al., 2021).

These differences include variations in pelvic width, Q-angle, and ligamentous laxity, all of which contribute to altered biomechanics and increased susceptibility to specific injuries like anterior cruciate ligament tears (Sugimoto et al., 2013). This elevated risk is further exacerbated by neuromuscular factors, such as quadriceps dominance and altered landing mechanics, which are frequently observed in female athletes and contribute significantly to non-contact ACL injuries (Mitra, 2024; Voskanian, 2013). Indeed, female athletes are 1.7 times more prone to ACL injuries than their male counterparts, even when matched for exposure, and they also face a significantly greater risk of re-injury (Donelon et al., 2024). This elevated susceptibility is often linked to a wider pelvis and an increased Q-angle, which are anatomical features prevalent in female athletes and contribute to altered knee kinematics and increased valgus stress during dynamic movements (Zaslav, 2012).

These anatomical predispositions, coupled with altered neuromuscular control and landing strategies, frequently result in higher knee abduction moments and increased anterior tibial shear forces during athletic maneuvers, thereby elevating the risk of ligamentous injury (Myer et al., 2010; Ramachandran et al., 2024; Zaslav, 2012). Furthermore, specific intrinsic factors such as decreased thigh musculature, lower hamstring-to-quadriceps ratios, and increased genu recurvatum are more prevalent in female athletes, contributing to an increased likelihood of knee injuries (Devan et al., 2004). These biomechanical and neuromuscular

distinctions, combined with hormonal influences, necessitate targeted injury prevention strategies that account for the unique physiological landscape of female athletes (Bullock et al., 2025; Gianakos et al., 2024; Kacprzak et al., 2024). Explain how the chapter addresses the scarcity of specific data on female athletes.

Discussion

This chapter comprehensively addresses this deficit by exclusively focusing on female athletes, mapping the prevalence of postural deformities reported in the last five years, and elucidating the complex interplay between these conditions and various physiological and sport-specific factors. By doing so, it moves beyond generalized findings to provide a granular understanding of how sex-specific anatomical, hormonal, and biomechanical factors contribute to postural deviations and injury risk in this population. This approach directly tackles the scarcity of specific data on female athletes by synthesizing current research to identify patterns and underlying mechanisms unique to this demographic, thus providing a foundational resource for tailored intervention strategies (Gianakos et al., 2024).

It critically examines how sport-specific training loads, often asymmetrical, influence these postural adaptations, and investigates the impact of hormonal fluctuations, such as those occurring during the menstrual cycle, on ligamentous laxity and neuromuscular control. Moreover, the chapter offers evidence-based corrective exercise strategies, meticulously designed to address these specific postural deviations, thereby translating research findings into actionable clinical applications (Gianakos et al., 2022). This comprehensive review explicitly acknowledges and integrates the increased injury susceptibility in female athletes, particularly concerning lower extremity injuries and specific conditions like dynamic knee valgus, which are frequently linked to reduced hip strength and distinct movement patterns (Crowell et al., 2021; Hewett & Zazulak, 2012). Indeed, females exhibit significant differences in lower limb neuromuscular control and associated biomechanics, alongside variations in quadriceps and hamstring muscle strength when compared to age and activity-matched male peers (Fernández et al., 2022). Such physiological and biomechanical distinctions underscore the necessity for sex-specific training protocols and injury prevention programs that account for the unique characteristics of female athletes (Santos et al., 2022; Welde et al., 2024). The chapter also acknowledges the potential for age-related increases in musculoskeletal injuries among female athletes, emphasizing the importance of comprehensive injury prevention programs that incorporate strength training, flexibility, and balance exercises to mitigate risks such as osteoarthritis, meniscal injuries, and stress fractures (Vuletić & Bøe, 2024).

Furthermore, hormonal fluctuations throughout the menstrual cycle have been shown to influence joint laxity and neuromuscular control, potentially increasing the risk of anterior cruciate ligament injuries and ankle instability in female athletes (Hartman et al., 2024; Vellingiri, 2017). This comprehensive framework underscores the importance of considering these multifaceted influences when developing targeted prevention and rehabilitation protocols for female athletes (Vuletić & Bøe, 2024). Moreover, female athletes demonstrate

distinct lower extremity kinematic coupling during activities such as landing and gait, which contributes to altered biomechanics and heightened injury predisposition, particularly evident in conditions like dynamic knee valgus (Dadfar et al., 2021). This integrated perspective is crucial for developing targeted interventions that move beyond generic approaches, addressing the specific biomechanical predispositions and neuromuscular control deficiencies observed in female athletes (Arundale et al., 2023; Bulow et al., 2021; Dedinsky et al., 2017).

This includes a nuanced consideration of differences in hip/groin and hamstring injury risk compared to male athletes, as well as the heightened incidence of foot/ankle injury, bone stress injury, and sports-related concussion among females (Hardaker et al., 2024). This specialized focus allows for the development of prevention and return-to-sport protocols that are specifically tailored to the female athlete's physiology, moving beyond generic recommendations that may not fully address their unique injury profiles (Hardaker et al., 2024). Indeed, the chapter highlights how individualized training programs, informed by an understanding of these sex-specific physiological and biomechanical responses, can optimize performance and significantly reduce injury risk (Nicholas et al., 2025).

By addressing these gaps, the chapter seeks to foster a more informed and nuanced approach to coaching, training, and medical care for female athletes, ultimately enhancing both their athletic longevity and overall well-being. It also emphasizes the critical need for continued research into sex-specific mechanisms of injury and recovery, particularly given the historical overrepresentation of male athletes in sports science literature (Gianakos et al., 2022). This specialized focus allows for the development of prevention and return-to-sport protocols that are specifically tailored to the female athlete's physiology, moving beyond generic recommendations that may not fully address their unique injury profiles (Hardaker et al., 2024). Such tailored protocols are essential to maximize female athlete performance and mitigate injury risk effectively, particularly given the higher propensity for certain injuries, such as lower extremity injuries, in female athletes (Barlow et al., 2023; Garner et al., 2020).

This disparity in injury risk, often 2.7 times greater for knee injuries, foot/ankle injuries, bone stress injuries, and concussions in female athletes compared to males, necessitates a shift towards gender-specific injury prevention programs (Hardaker et al., 2024). Furthermore, the chapter advocates for a multidisciplinary approach to athlete care, integrating insights from sports medicine physicians, athletic trainers, nutritionists, and mental health professionals to address the multifaceted needs of female athletes comprehensively (Gianakos et al., 2022). This holistic approach recognizes that optimal care extends beyond physical interventions, encompassing psychological, nutritional, and social factors that collectively impact an athlete's health and performance (Borja et al., 2022). This integrated strategy aims to cultivate supportive, inclusive, and equitable environments that promote the overall well-being of women and gender-expansive individuals in sport, moving beyond traditional approaches to injury prevention (Thorpe et al., 2023).

It also underscores the critical need for more research and expertise among support staff to address the specific gender and sex-related factors influencing injury prevention for female athletes (Crossley et al., 2025; Welde et al., 2024). This comprehensive perspective necessitates a shift towards gender-responsive approaches that promote broader cultural change within sport, moving beyond individual interventions to foster systemic support for female athletes (Scott et al., 2025; Thorpe et al., 2023). This comprehensive approach is vital, especially considering the historical implicit gender bias in sports injury research, which has often overlooked female-specific needs and concerns (Comstock & Fields, 2020).

Conclusion

Despite the growing recognition of these sex-specific differences, a significant knowledge gap persists due to the historical overrepresentation of male athletes in sports research, often leading to a lack of understanding and expertise among support staff regarding female athlete-specific factors (Borja et al., 2022; Crossley et al., 2025). This disparity underscores the critical need for gender-specific approaches in injury management and the incorporation of sports science research into practice to bridge the current gaps in recovery outcomes (Mazza et al., 2024).

This chapter specifically addresses this lacuna by synthesizing current evidence on postural deformities in female athletes, offering a comprehensive resource for practitioners and researchers alike (O'Bryan et al., 2022). This effort aims to reframe the narrative by acknowledging past findings and integrating them into current practice, thereby informing future research directions that better serve athletic females (McNulty et al., 2024). By focusing exclusively on female athletes, this chapter maps out postural deformities reported over the past five years, providing insights into their prevalence and etiology within this demographic, which has historically been underrepresented in sports science literature (Emmonds et al., 2019; Welde et al., 2024). This specialized approach is crucial given that female athletes comprise a rapidly expanding demographic in sports, yet their unique physiological and biomechanical characteristics remain understudied (Glover et al., 2022).

This chapter contributes to filling this knowledge gap by providing an integrative review of postural deformities in female athletes, offering insights into their interplay with sport-specific demands and physiological factors (Bullock et al., 2025; Lin et al., 2018). This chapter is unique in its dedicated focus on female athletes, as existing literature often overrepresents male athletes or mixed-gender groups without adequate sex-specific analyses (Dane et al., 2022; Fraser & Kochanek, 2023). Indeed, the relative dearth of sex-specific research in sports medicine often results in suboptimal recommendations for female athletes, highlighting the necessity for studies that disaggregate data by sex to advance personalized medicine (Holtzman & Ackerman, 2021; Schilaty et al., 2017). Furthermore, the chapter emphasizes that female athletes are not simply "small males," and their physiological and biomechanical responses to training and competition necessitate distinct considerations (Donnelly & Moore, 2023). This includes an in-depth exploration of how hormonal fluctuations influence connective tissue laxity, bone density, and muscle activation patterns,

thereby affecting postural stability and injury risk (Donnelly & Moore, 2023). Such considerations extend to understanding how intrinsic and extrinsic factors, including somatic parameters, lifestyle, and muscular strength, collectively influence overall posture in female athletes (Zwierzchowska et al., 2022). Moreover, the chapter delineates how specific sporting demands and asymmetrical training loads can exacerbate pre-existing postural imbalances or induce novel deformities in female athletes, necessitating targeted screening and intervention protocols (Boucher et al., 2018; Santos et al., 2022).

This holistic perspective underscores the chapter's importance in providing a nuanced understanding of female athlete physiology, distinct from that of male athletes, in sports science and medicine (Castanier et al., 2021; Ling et al., 2023; Welde et al., 2024). Specifically, the chapter addresses the physiological distinctions between sexes, which frequently lead to differing injury patterns and rates among female athletes (Barth et al., 2022). Consequently, tailored interventions are imperative for addressing the specific needs of female athletes, acknowledging their distinct hormonal influences on skeletal muscle function and overall health (Kodete et al., 2024). Therefore, understanding the nuances of female physiology is paramount for developing effective prevention and rehabilitation strategies ("The Physiology of the Female Athlete – Performance, Health, and Recovery," 2024).

This includes exploring how the menstrual cycle and hormonal profiles impact musculoskeletal adaptation and injury risk, a factor often overlooked in generalized sports research (Legerlotz & Hansen, 2020; Modena et al., 2022). The chapter further delves into how factors such as amenorrhea, oral contraceptive use, and intrauterine devices can significantly influence physiological stress and exercise adaptation in female athletes, underscoring the complex interplay of internal and external factors (Castanier et al., 2021; Kissow et al., 2024). These hormonal fluctuations can significantly affect athletic performance and increase susceptibility to injuries, thus requiring specific attention to the menstrual cycle and contraceptive use when assessing female athletes (Castanier et al., 2021; Collomp & Lorenzetti, 2024; Legerlotz & Nobis, 2022; MacMillan et al., 2024). For instance, peak estradiol levels, often associated with specific phases of the menstrual cycle, have been linked to increased ligamentous laxity and altered neuromuscular control, potentially elevating injury risk (Martínez-Fortuny et al., 2023). Such hormonal influences extend beyond injury risk, impacting endurance parameters and overall physiological responses to training, further emphasizing the need for personalized approaches to female athletic development (Welde et al., 2024).

Additionally, variations in endogenous reproductive hormones, whether due to natural menstrual cycle phases, menstrual irregularities, or hormonal contraceptive use, have been shown to influence musculoskeletal injury patterns among female athletes, further emphasizing the need for personalized training and injury prevention strategies (Badier et al., 2025; Castanier et al., 2021; MacMillan et al., 2024).

The sex-specific knowledge gap emphasized in the international literature is similarly reflected in the Turkish sports science literature. Studies conducted in Türkiye indicate that

female athletes have historically been examined to a much more limited extent than male athletes, particularly with regard to postural deviations, musculoskeletal injuries, and biomechanical characteristics (Baltacı et al., 2013; Korkusuz & Baltacı, 2016). National studies report that postural deviations observed in female athletes are associated with training age, sport-specific asymmetrical loading patterns, and insufficient strength and balance profiles (Aydın et al., 2019; Zorba & Saygın, 2013).

Furthermore, research focusing on female athletes in Türkiye highlights the significant role of hormonal fluctuations in influencing connective tissue elasticity, muscle activation patterns, and injury risk; however, these variables are not systematically controlled in many studies (Çetin & Aydos, 2018; Özdemir et al., 2021). This methodological limitation contributes to the insufficient scientific grounding of training, screening, and rehabilitation protocols developed for female athletes, a concern that parallels observations in the international literature.

Taken together, both national and international evidence clearly indicate that conceptualizing female athletes as "small versions of male athletes" is scientifically inadequate. Findings from Türkiye further support the need to examine postural characteristics and injury risks in female athletes through frameworks that account for sport-specific demands, hormonal status, and biomechanical requirements (Korkusuz, 2017; Spormetre, special issue).

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CHAPTER 2

Recreation and Play

Batuhan ER[1]

Er, B. (2025). Recreation and Play. M. Gönen & M.Erkan (Ed.), *Recreation and Play. Recreation, physical activity, and sedentary lifestyle from a sports sciences perspective: Contemporary approaches* (pp. 27–39). Duvar Yayınları.

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The concept of recreation has been associated with games since its first definition. Play forms the basis for individuals to turn their leisure into activities and to form the concept of recreation. As Dutch historian Huizinga stated in his work Homo Ludens, all living things have been in a relationship with play since birth. The significance of the conceptual and theoretical foundation of play for recreation science should be examined from a historical perspective and diverse approaches.

Play from Historical Perspective

Since ancient times, humans have been engaged with play. The discovery of various engravings and inscriptions from the distant past, along with the discovery of toys, reveals that anthropologists, while tracing human development, not only crafted tools for work and survival, but also found toys, dolls, hoops, rattles, marbles, and dice. Our ancestors are said to have been creative toy makers. In later eras, scientific discoveries and inventions are thought to have been the result of play, a form of intense enthusiasm and hobby-based involvement.

Examining play in past periods allows us to understand more about the history of children's games, especially. In ancient Greece, children played games using balls and hoops. About a thousand years ago, during the Sung Dynasty in China, children are pictured riding hobby horses, juggling, and dressing up. While it was entertainment for children, the purpose of adults was to prepare men for horseback riding. A painting by the sixteenth-century Flemish artist Pieter Brueghel, Children's Games, depicts children playing tug-of-war with hoops at a mock wedding. The Bethnal Green Museum in London has many examples of toys from hundreds of years ago, and the Victoria and Albert Picture Library contains images of children playing with jumping jacks, kites, dolls, and kitchen utensils. Puppet plays have been used to tell moral and religious stories for centuries in China, India, and Europe. While some African societies considered them to bring bad luck, dressing up is a favorite pastime for children in many cultures (Torkildsen, 2005:76).

1. Definition of the Play and Various Views

The word "play" comes from the Anglo-Saxon word "plega," meaning conflict, fight, or war. This word also means "blow" or "thrust" in Latin, and is also reflected in the idea of playing a game by hitting or caressing an instrument or kicking a ball. In other languages, the root word commonly includes playing musical instruments, sports, and games. Although "play" is traditionally considered a

children's activity, it is generally accepted that people of all ages participate in games (McLean and Hurd, 2011:7-8).

According to the Oxford English Dictionary, ‘play’ derives from the Old English “plega” meaning rapid movement, exercise, sport: it was expressed as free movement, lively and violent action, such as dancing, leaping, joy, ‘strutting like a cock-bird before the hens’ (Torkildsen, 2005).

The definition of play has been made by many researchers and philosophers, and Mitchell and Mason (1948) provide the opportunity to compare it with the following definitions they compiled:

SEASHORE: Free self-expression for the pleasure of expression.

FROEBEL: The natural unfolding of the seed-leaves of childhood.

HALL: The continuation in the present of the motor habits and spirit of the past.

GROOS: Instinctive execution of activities that will become necessary for later life, without any serious purpose.

DEWEY: Activities not consciously undertaken for any end beyond themselves.

SCHILLER: The purposeless expenditure of enthusiastic energy.

SPENSER: Unnecessary actions performed instinctively in the absence of actual actions. Activity undertaken for immediate gratification, regardless of the ultimate benefits.

LAZARUS: Intrinsically free, purposeless, enjoyable, or diverting activities.

SHAND: A form of play designed to sustain enjoyment.

CURTI: Highly motivated activity, free of conflict and often, though not always, enjoyable (Saracho and Spodek, 1998:3).

According to McCarville and MacKay (2007), gaining insight into theories of play allows individuals to understand the complexities of human play behavior. How can we define play? Play is not synonymous with entertainment, sport, recreation, or leisure. The challenge is to provide a broad, not restrictive, definition of play; the definition should focus on the player's "state of being" rather than specific activities. This allows for freedom and allows a range of behaviors and activities to fit the definition. The collection of definitions presented is often used to help define play. Definitions of play, therefore, may include some, but not all, of the terms described. The following characteristics are commonly used to define play: (a) intrinsic motivation, (b) free choice, (c) suspension of reality, (d) positive emotion, (e) process rather than product, (f) play is active, (g) play is rule-bound, and (h) internal locus of control.

Robert A. Stebbins, a pioneer in defining leisure as a lifestyle, included the concept of "play" in his Serious Leisure approach. Within this perspective, there are Serious Pursuits, Project-Based Leisure, and Casual Leisure activities. Of these, "play" is one of the most important activities in Casual Leisure. Key examples of Casual Leisure activities that require a low level of skill, knowledge, or experience to perform include Hash House Harrier (a type of treasure hunting game played outdoors), kickball (defined as a cross between soccer and baseball in The Economist (2005), and children's leisure activities such as video-guided dance games or hide-and-seek. Furthermore, the following are demonstrated as benefits derived from these activities: (a) creativity and discovery, (b) entertaining/fun education, (c) renewal and re-creation, (d) the development and maintenance of interpersonal relationships, and (e) well-being (Stebbins, 2016).

As stated by Nastasi et al. (2020), in the analysis of leisure, play and recreation activities in Article 31 of the United Nations Convention on the

Rights of the Child, play;

- Any behavior, activity, or process initiated, controlled, and structured by children themselves.
- A situation that occurs whenever opportunities arise and wherever they occur.
- An activity that is not compulsory, is driven by intrinsic motivation, and is undertaken for its own sake rather than as a means to an end.
- Autonomy, involving physical, mental, or emotional activity, and has the potential to take infinite forms (which will change and adapt throughout childhood) in groups or alone.
- Fun, uncertainty, challenge, flexibility, and non-productivity are the fundamental characteristics of play.
- A situation in which caregivers can contribute to the creation of the environments in which play takes place.

Godbey (2003:13,14) stated that the perception of leisure and recreation as complex concepts perhaps indicates a lack of readiness to play. Author noted that defining play is, at first glance, an easy task and can be understood at a glance. Author noted that dogs and children play, that we play video games, sometimes play the guitar, or act on stage. Author also noted that many of us occasionally play in

very similar ways with dogs or children, emphasizing that play, like entertainment, is a concept easier to understand in everyday life than it is to put into words.

Ardahan et al. (2016) stated that recreation encompasses practices that meet the play and ritual needs of both individuals and societies at all ages and levels. The author also emphasized that play, as one of the most important and ancient phenomena in human life, has been defined in various ways. Accordingly, one definition defines play as unconscious behaviors without regard for consequences; another defines it as activities performed voluntarily and according to rules within a specific time and place. Furthermore, the notion that play is "the highest level of self-expression"—as stated by Friedrich Froebel—is also emphasized.

Play were roughly categorized by Üster (2003) as (a) games requiring physical skills, (b) strategy games, (c) games of chance, (d) children's games, (e) art games, (f) musical games and (g) digital games (as cited in Ardahan et al., 2016).

Table 1: Theories About the Play, Torkildsen

Classical Game Theories	**Modern Play Theories**	
	Theories from the First Half of the 20th Century	**Theories from the Second Half of the 20th Century**
Surplus Energy Theory Schiller-Spencer	*Generalization and Compensation Theories*	*Stimulus Arousal Theory* Ellis, 1973
İçgüdü Teorisi *Instinct Theory*	*The Cathartic Theory*	Playfulness (Lieberman, 1977)
The Preparation/ Practice or Pre-Exercise Theory Karl Gross	*The Psychoanalytic Theories*	*Play and Meaning of Life* (Starting with Huizinga and continuing with Levy, supplemented by Kraus)
Recapitulation Theory G.Stanley-Hall	*Play Therapy Theory*	*The Development of Adventure Play* (beginning with the London Adventure Play Association and the Disabled Play Association in the 1960s and 1970s)
Recreation or Relaxation Theory Patrick	*The Intellectual Development Theory*	
	Stimulus-Response Theories	
	Play, Games and Socailization Theory	
	Play as Self-Justifcation	
	Socio-Cultural Theory	

Reference: Adapted from Torkildsen, 2005.

Table 1: Theories About the Play, Kraus

Classic Theories	Modern Theories with 20th Century Play Concepts	Psychological Analysis of the Play	Play as Creative Exploration
Surplus Energy Theory	*Self-Expression Theory*	*Play in Personality Development*	*Stimulus Arousal Theory*
Relaxation Theory	*Play as a Social Necessity*	*Psychoanalytical Perspective on Play*	*Competence-Effectance Theory*
The Preparation Theory	*Typlogies of Play Activity*		*Flow Principle*
The Cathartic Theory	*Contrasting Styles of Play*		
	The Play Element in Culture		

Reference: Adapted from Mclean and Hurd (2011).

Table 2: Classic Theories of Play, Saracho

Theory	Theorist	Purpose of Play	Focus
Surplus Energy Theory	Friedreich Schiller (1759-1805) Herbert Spenser (1820-1903)	Eliminating excess energy beyond what individuals need.	Physically
Recreation or Relaxation Theory	Moritz Lazarus (1883) G.T.W. Patrick (1916)	Restoring enough energy to continue again.	Physically
Recapitulation Theory	G.Stanley Hall (1844-1924)	The unsustainable nature of the primitive skills and impulses that individuals inherit from the ages of civilization, making them ready for the efforts of modern life.	Physically
Practice or Pre-Exercise Theory	Karl Gross (1896, 1901)	It's an instinctive way of preparing children for the endeavors of adult life.	Physically, Intellectual

Reference: Saracho, 2017:27

Table 3: Modern Theories of Play, Saracho

Theory	Philosopher	Purpose of Play	Focus
Psychoanalytic	Sigmun Freud E.H. Erikson L.E. Peller L. Murphy V.M. Axline Margaret Lowenfeld Susan Isaacs	Children are helped to deal with repressed issues that arose in earlier stages of development and have been buried in the subconscious. Children use play as a tool to conquer their hidden feelings about their apparent actions.	Emotional, Social
Stimulus Arousal	M.J. Ellis D.E. Berlyne	It explains that play involves the body seeking sources of stimulation to acquire specific information. It is a stimulus-seeking activity that offers children opportunities to manipulate objects and actions in new and novel ways. It expands both the levels of arousal and stimulation.	Physically, Emotonial
Meta Communication	G. Bateson	He proposes that play is based on children's interactions as they engage in pretend play. During play, children learn to function simultaneously on two levels: (1) pretending the meaning of objects and actions and (2) real-life situations (such as the true identities of the actors and the true purpose of objects and actions). Children's scenarios and experiences depend on the situation and context of their pretend play.	Social, Intellectual
Cognitive	Jean Piaget Lev. S. Vygotsky Jerome Bruner	Play encourages children's cognitive development and abstract thinking. Through play, children derive knowledge and meaning from their experiences. Imaginative play helps them interpret objects. Play is children's creation of imaginary events from real-life problems.	Intellectual, Social

Reference: Saracho, 2017:31

3. Play Theories-Approaches

In this section, information will be given about classical and modern "play approaches and theories" that various researchers or scientists have worked on.

3.1. Classic Theories

The classical theories include the Surplus Energy Theory, the Recreation and Relaxation Theory, the Practice and Pre-Exercise Theory, and the Recapitulation Theories.

3.1.1. Surplus Energy Theory

The 18th-century poet and philosopher Friedrich von Schiller argued that play is essentially "the purposeless expenditure of surplus energy." Schiller argued that play arises from the unnecessary energy remaining after primary needs are met. Author argued that young animals and children have a total "surplus" of energy because they are not responsible for their own survival (Evans & Pellegrini, 1997).

3.1.2. Recreation or Relaxation Theory

As stated by German poet and philosopher Moritz Lazarus (1883), the Recreation or Relaxation Theory defines play as an activity that individuals use to replenish energy. Play, the opposite of work, restores energy expended during work. Play is created as a recreational activity or as a behavioral pattern arising from a need for relaxation. The Recreation or Relaxation Theory can be viewed as the opposite of the surplus energy theory (Saracho & Spodek, 2003).

3.1.3. Application or Pre-Exercise Theory

The third classic theory of play is practice theory, or pre-practice theory. This theory stems from the work of Gross (1898-1901) in his studies of animal and human play. Adult imitation is seen as a crucial element in a child's play. According to Gross, the function of childhood is play, and play serves as practice for adult activities. The main contributions of this theory include an explanation of why play is primarily found in childhood, a discussion of the relationship between play, psychology, and intelligent behavior, and an explanation of the role of certain types of play as pre-practice for adult life (Takhvar, 1988).

3.1.4. Recapitulation Theories

Recapitulation theory was proposed by American psychologist G. Stanley Hall (1920), often considered the "father" of the North American child psychology movement. Hall viewed childhood as a link between animals and humans, based on the belief that ontogeny (the development of the individual) recapitulates or recreates phylogeny (the development of the species). This theory is also based on the discovery that the human embryo, as it develops, goes through several stages that occurred in the evolution of the human species. According to repetition play theory, children recreate the developmental stages of the human race through their play: animal, savage, tribal, and so on. This particular form of play, which follows the same sequence as that of human evolution, helps children shed primitive instincts that are no longer needed in modern life (Mellou, 1994).

In summary, the classical theories can be paired with each other: 1) the Recreation or Relaxation Theory with the Surplus Energy Theory; 2) the Practice or Pre-Exercise Theory with the Repetition Theory. Both pairings can be perceived as consisting of opposing theories about how play consumes energy or controls instinct. Classical theories are based on philosophical conflicts rather than empirical research, but these theories are considered inadequate (Saracho and Spodek, 2003).

3.2. Modern Theories

Modern play theories, unlike classical theories, attempt to determine not only why play exists but also its role in child development. These theories, in a sense, identify the antecedent conditions that give rise to play behavior. Overall, modern play theories have sought to increase our understanding of the phenomenon of play through both the explanatory power of their theoretical perspectives and the research they stimulate (Mellou, 1994).

3.2.1. Psychoanalytic Theory

Psychoanalytic theorists such as Anna and Erikson, who focused on the emotional domain of development, have been noted to view play in terms of catharsis. Psychoanalytic perspectives explain the value of play in allowing children to express negative emotions related to situations in their daily lives over which they have no control. These include traumatic experiences and conflicts. Play is seen as providing a safe context for expressing these emotions and gaining a sense of control. Children incorporate stressful situations into their play and cope with them. Repetitive play is considered important here, as children replay the same situation over and over again. This play fosters children's mastery of stressful situations (Verenikina et al., 2003; Görün et al., 2025).

3.2.2. Cognitive Theory

Cognitive theory argues that play is connected to the mind and that through play, children can absorb information (Jean Piaget), solve problems (Jerome Bruner), and create new knowledge (Lev Vygotsky). Each theorist examines the relationship between play and cognitive processes through a different lens, and each adds further value to our understanding of children's play behavior (McCarville & MacKay, 2007).

Piaget's theory consists of three stages. These stages are 1) Sensory-motor play, 2) Symbolic play, and 3) Play with rules. Vygotsky added to Piaget's theory the theory that children's cognitive development is triggered by their play experiences

and the social context and cultural environments of the culture in which they grow up (Saracho and Spodek, 2003).

Psychoanalytic and cognitive theory provide insightful information about play. Other theories of play have been developed that provide a more focused lens and nuanced perspective on play: social play theory briefly compares eight common theories, including social intelligence, play as creativity and play as therapy, catharsis, behaviorism, stimulation seeking, and the competence effect (McCarville & MacKay, 2007).

3.2.3. Stimulus Arousal Theory

Stimulus Arousal Theory was developed by Berlyne (1960) and modified by Ellis (1973). It led theorists to associate stimuli with responses based on the organism's basic survival needs (e.g., hunger or thirst), and play behavior was considered "unnecessary mental fabrications." Later, it was observed that the need to explore a new environment appeared to be stronger than, for example, hunger or thirst. These findings formed the basis of Stimulus Arousal Theory. Berlyne believed that play stemmed from a need or drive to maintain optimal arousal in our central nervous system. Ellis proposed an alternative to Berlyne's theory. He believed that play is a stimulating activity and that children can imagine using objects and actions in new and unusual ways; play functions both to stimulate and to increase arousal levels. The difference between Berlyne's and Ellis's models of play is that in the former's model an organism responds by 'producing' stimulation, whereas in the latter's model an organism 'seeks' stimulation (Mellou, 1994).

3.2.4. Meta Communication Theory

Bateson (1955, 1956), influenced by the number principle and logic theory, was interested in identifying the sources of metacommunication. Author identified play behavior as one such source and attributed the metacommunicative characteristics of this activity to aspects of the communication system that foster abstraction. Abstraction, on the other hand, can result in ambiguity and paradox. Author distinguished between "error" and "confusion," and argued that errors can occur when there is a close relationship between "signal" and "referent," while interpreting an interpretation can lead to confusion. Author described the relationship between communication and metacommunication as comparable to the perceptual relationship between text and context. Author referred to play as the

metacommunicative context, the text of reality that gives rise to an individual's cultural and personal images (Takhvar, 1988).

3.2.5. Self-Justification Theory

In 1938, on the eve of World War II, Dutch cultural historian Johan Huizinga wrote what is considered a seminal work on the game Homo Ludens. Although his work later traveled to the United States and was first published in English in 1955, it holds particular significance because it was Huizinga who first established the connection between play and culture. He argued that culture itself is born through play. As play develops, it becomes the oral history of the tribe, the folklore, and the literature of a literate society; spontaneous, rhythmic movement evolves into highly stylized choreography; the rhythm of drums and the simple notes of an old flute become the songs and harmonies of music. As individuals organize their artistic endeavors, they compete with others, and play becomes more elaborate and structured. Huizinga established a crucial connection between play and competition, noting that play has become formalized and takes on a normative role. In the context of competitive play, individuals set norms of fairness, and those who exemplify the highest standards of play become heroes and role models for their communities (Masters, 2008). So, what are the distinguishing features of play? Huizinga's definition is quite broad in this sense:

I. First of all, "play is optional. It cannot be compelled to play. Play is never imposed by physical necessity or moral duty. It is never a duty."

II. Play is situated in a separate place and takes place within a limited time. It is bracketed and, as an otherworldly experience, play allows individuals to create alternative worlds and identities far removed from their daily lives.

III. Play can be beautiful. As Huizinga wrote, "The aesthetic impulse arises from the order it creates." This aspect of play is most evident in all forms of art where balance and symmetry prevail, and in performances where order is choreographed. Elaborating on this aesthetic quality, Huizinga writes, "play creates and is order." It brings a limited perfection to a perfect world and the chaos of life.

IV. However, over time, especially as play becomes more complex and engages more people, it becomes a separate world that players want to revisit. Traditions emerge, and play itself acquires ritual-like characteristics.

V. Given its spatial and worldly qualities, play is never ordinary and is the work of the work. In contrast, play does not offer material rewards. Rather, play is inherently rewarding. It provides prestige to individuals and groups whose performance is recognized as exceptional (Masters, 2008).

3.2.6. Play Therapy or Play as Therapy

The use of play as a therapeutic tool is well-established in game theory and current research. Play offers a glimpse into the player's world. Through play, children express their experiences (Piaget), solve problems (Bruner), and re-enact life stressors to make sense of the world (Freud and Erikson). If play is an important human component, as all healthy animals play, then its utility as a healing tool should be examined. Isenberg and Jalongo (1997) have outlined some of the benefits of play: play allows children to interpret their world, develop social and cultural context, and express emotions; it fosters creative thinking and encourages verbal and nonverbal communication. The benefits of play are undeniable, and many approaches to play therapy have been proposed to encourage play or use play as a tool for other therapeutic gains (Gürbüz & Karakulaklı, 2023; Uskan & Bozkuş, 2019). Miller and Reid (2003) investigated the value of virtual reality play for young people with cerebral palsy. Their findings indicate that study participants enjoyed participation and reported psychological, emotional, social, and physical benefits. Participants also reported experiencing “flow” (Quoted in McCarville and MacKay, 2007).

Result

From the perspective of recreation science, play recreation can be comprehensive and can be considered a casual or serious leisure activity. It's safe to say that play is a partially freely chosen, personally satisfying experience. Today, due to technological advancements, the experiential form of gaming has been transformed by digitalization. While many experiential advancements, such as virtual reality, have transformed the theoretical structure of gaming from one focused on satisfaction to one focused on winning, gaming still remains a defining aspect of recreation.

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CHAPTER 3

Sedentary Lifestyle and Physical Activity Attitudes in the Digital Age

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INTRODUCTION

Digitalisation, urbanisation, and rapid transformations in modern lifestyles have led to a marked global decline in individuals' daily levels of physical mobility (Konur Tekeş, 2022; 2023). Automation-based work structures, the proliferation of screen-based activities, and the increasing preference for passive modes of transportation have rendered sedentary behaviour a dominant characteristic of contemporary life (Baba Kaya et al., 2021; Karadağ et al., 2023; Er & Cengiz, 2023a, 2023b).

This transformation demonstrates that sedentary lifestyles can no longer be explained solely through individual choices; instead, they have evolved into a multidimensional phenomenon shaped by the structural dynamics of digitalisation, urbanisation, and modern living. Consequently, physical inactivity has transitioned from an individual behavioural issue into a structural and systematic public health concern, exhibiting strong associations with cardiometabolic diseases, mental health problems, and declines in overall quality of life (Özkan et al., 2013; İneçli & Ziyagil, 2017).

Global surveillance data indicate that approximately one-third of adults and the vast majority of adolescents fail to meet the recommended minimum levels of physical activity. University students, in particular, constitute one of the groups most severely affected by this crisis due to heavy academic workloads, extensive digital exposure, and irregular lifestyle patterns (Akman & Gürbüz, 2024). Nevertheless, when properly implemented, digital technologies can also serve as practical intervention tools capable of promoting and supporting physical activity.

One of the most comprehensive efforts to monitor physical activity levels on a global scale was published by Hallal and colleagues (2012) as part of The Lancet Physical Activity Series. In this landmark study, data from adults aged 15 years and older across 122 countries, as well as from adolescents aged 13–15 years in 105 countries, were analysed to map global patterns of physical activity. The findings revealed that 31.1% of adults worldwide did not meet the World Health Organisation's minimum physical activity recommendations.

While these results clearly demonstrated that physical inactivity was both widespread and persistent at the global level, they also prompted critical debate regarding how this landscape has evolved in subsequent years, particularly in light of large-scale analyses conducted thereafter.

The study further reported pronounced regional disparities in physical inactivity rates, with prevalence estimated at approximately 17% in Southeast Asia, compared to rates as high as 43% in the Americas and the Eastern Mediterranean regions.

Additionally, physical inactivity was found to increase with age, be more prevalent among women than men, and occur more frequently in high-income countries.

These early patterns suggest that physical inactivity is not merely a transient developmental phenomenon, but rather a behavioural trajectory that persists into adulthood and carries the potential for long-term adverse health consequences.

Findings concerning the adolescent population were even more striking. According to the study, 80.3% of individuals aged 13–15 years failed to meet the recommendation of engaging in at least 60 minutes of moderate-to-vigorous physical activity per day. Moreover, adolescent girls were identified as being significantly more physically inactive than their male counterparts. These results underscore that physical inactivity becomes highly prevalent from early life stages and strongly predisposes individuals to health risks that may persist throughout the lifespan (Uzun & Konur Tekeş, 2022).

Within this context, Hallal and colleagues (2012) emphasised that physical inactivity constitutes the fourth leading risk factor for the prevention of non-communicable diseases worldwide.

These findings indicate that, despite global intervention efforts implemented over the past two decades, no meaningful improvement has been achieved in physical activity levels, and that existing policies remain structurally inadequate.

More recent evidence further corroborates these conclusions, demonstrating the absence of substantial progress in global physical activity trends. In a pooled global analysis encompassing 507 population-based studies and 5.7 million participants conducted between 2000 and 2022, insufficient physical activity among adults was shown not to have declined significantly worldwide. The study reported persistently high levels of physical inactivity in high-income countries, with increasing trends observed in certain regions. These findings underscore the limitations of current global physical activity policies and highlight the urgent need for stronger and more structural interventions (Strain et al., 2024).

Similarly, a global analysis including 358 population-based studies and 1.9 million adults found no significant reduction in the prevalence of insufficient physical activity among adults between 2001 and 2016. The study particularly emphasised that women were more physically inactive than men and that physical inactivity rates remained higher in high-income countries (Guthold et al., 2018).

In another study focusing on adolescents, data from 298 population-based studies comprising 1.6 million adolescents were analysed, revealing that more than 80% of adolescents worldwide failed to meet the recommended daily levels of physical activity. Furthermore, physical inactivity was found to be substantially more

prevalent among adolescent girls, with this pattern showing no meaningful change over time (Guthold et al., 2020).

In another study examining the relationship between physical inactivity and the burden of non-communicable diseases (NCDs), this association was shown to remain strong across low-, middle-, and high-income countries. The findings indicate that physical inactivity constitutes a significant risk factor for NCDs in all income groups and that its contribution to disease burden persists independently of countries' economic status. In this context, physical activity is conceptualised not only as a determinant of individual health outcomes but also as a crucial tool for reducing global health inequalities (Katzmarzyk et al., 2022).

Further extending these findings, Katzmarzyk and colleagues (2022) demonstrated that the global impact of physical inactivity is not confined to disease prevalence alone, but also substantially amplifies the economic burden on health systems, leading to considerable losses in societal productivity. The study emphasises that delaying policies aimed at increasing physical activity will result in markedly higher global health expenditures in the long term, positioning physical activity as a fundamental health determinant directly linked to the Sustainable Development Goals.

In light of this global landscape, analyses drawing on evidence from The Lancet Physical Activity Series emphasise the need to develop physical activity policies closely aligned with scientific evidence. Ding and colleagues (2020) argue that individual-level interventions alone are insufficient for preventing physical inactivity; instead, comprehensive transformations at the environmental, policy, and system levels are imperative. Accordingly, they issue a global, evidence-based call to action aimed at addressing physical inactivity through multi-level structural change.

At this juncture, it becomes evident that physical activity behaviour is shaped not only by environmental and policy frameworks but also by individuals' attitudes toward physical activity and their cognitive evaluations of such behaviour.

According to the Theory of Planned Behaviour (TPB), physical activity behaviour is determined by behavioural intention, which emerges from the interaction between an individual's attitude toward physical activity, perceived social norms, and perceived behavioural control (Ajzen, 1991).

In the digital era, increasing sedentary behaviours may negatively influence individuals' attitudes toward physical activity, thereby weakening their intention to engage in active behaviours(Aydemir et al., 2024; Reyhan, 2020; Reyhan & Duyan, 2022).

Similarly, the COM-B model (Capability–Opportunity–Motivation–Behaviour) posits that physical activity behaviour arises from the dynamic interplay between individuals' physical and psychological capability, environmental opportunities, and motivational processes (Michie et al., 2011; Brown et al., 2024). Within this framework, digitalisation may reinforce sedentary attitudes by constraining environmental opportunities and motivation; however, when appropriately structured, it may also function as a powerful tool capable of fostering positive attitudes toward physical activity. Collectively, these theoretical approaches demonstrate that attitudes toward physical activity in the digital age are shaped not solely by individual preferences but through the combined influence of cognitive appraisals and environmental context.

The Importance of Sedentary Behaviour as an Independent Health Risk

Sedentary behaviour encompasses sitting- and reclining-based activities characterised by low energy expenditure and constitutes an independent health risk distinct from physical inactivity (Ceviz et al., 2021). Therefore, sedentary behaviour should not be considered merely as a consequence of insufficient physical activity; instead, it must be addressed as a standalone health risk requiring independent evaluation. Prolonged daily sitting time has been strongly associated with all-cause mortality, cardiovascular diseases, metabolic syndrome, and mental health problems (Genç et al., 2022). The regulatory effect of physical activity on immune response is regarded as a critical component in sustaining healthy living (Özaltaş, 2019). Research indicates that even among individuals who engage in regular exercise, the adverse health effects of prolonged sedentary behaviour are not fully mitigated.

In this context, the marked increase in screen time in the digital age has emerged as the most dominant component of sedentary lifestyles and has been particularly associated with cognitive fatigue, sleep disturbances, and declines in psychological well-being among young adults (Güler & Işıklı, 2024; Yaşar et al., 2025; Ceviz & Gözaydın, 2023). Collectively, these findings demonstrate that sedentary behaviour should be addressed as a distinct and specific target in public health policies, separate from physical activity promotion.

Understanding the early effects of sedentary behaviour renders adolescence (ages 13–15 years) a period of particular importance. During this developmental stage, regular physical activity is known to confer significant benefits for physical health, psychological well-being, and cognitive development in the short and long term (Hallal et al., 2006). However, assessing physical activity levels in this age group is a highly complex process due to substantial variability in behavioural patterns and

inherent methodological limitations (Riddoch et al., 2004). Although physical activity surveillance targeting specific age groups has been implemented in certain countries, the limited availability of repeated measurements over time poses challenges for global comparisons. Nevertheless, it is noteworthy that the most substantial progress in physical activity surveillance has been achieved within adolescent populations.

At present, the most comprehensive and comparable data on physical activity levels among adolescents are derived from two major surveillance systems conducted by the World Health Organisation: the Global School-based Student Health Survey (GSHS) and the Health Behaviour in School-aged Children (HBSC) study (WHO, 2011; WHO Regional Office for Europe, 2008). By integrating findings from these two data sources, physical activity levels were estimated for adolescents aged 13–15 years across a total of 105 countries. This included GSHS data from 66 countries, predominantly low- and middle-income nations, and HBSC data from 38 countries encompassing European countries, the United States, and Canada.

The findings revealed that 80.3% of adolescents worldwide failed to meet the recommendation of engaging in at least 60 minutes of moderate-to-vigorous physical activity per day. Furthermore, physical inactivity rates were markedly higher among girls than boys, with 53% of male adolescents and 95% of female adolescents not achieving the recommended daily levels of physical activity. The fact that these prevalence rates exceed those observed in adult populations underscores that physical inactivity becomes widespread at early ages and strongly predisposes individuals to health risks that may persist throughout the lifespan (Hallal et al., 2012).

These early-life patterns are directly associated with long-term health outcomes. Physical inactivity is widely recognised as a well-established and decisive risk factor for premature mortality and a wide range of non-communicable diseases (NCDs) (Özkan et al., 2018). Global estimates indicate that, as of 2008, physical inactivity was responsible for approximately 6–10% of premature deaths and cases of coronary heart disease, type 2 diabetes, breast cancer, and colon cancer. Furthermore, it has been reported that health-care expenditures attributable to physical inactivity reached approximately 53.8 billion international dollars worldwide in 2013, with the majority of these costs borne by the public sector.

Despite the widespread acknowledgement of the protective effects of physical activity on health, it is estimated that approximately 27–30% of adults globally fail to meet current physical activity guidelines. The prevalence of physical inactivity varies markedly according to countries' income levels, with higher rates observed in

high-income countries compared to low-income countries, alongside an increasing trend in recent years. When considered in conjunction with the fact that approximately 80% of deaths attributable to non-communicable diseases currently occur in low- and middle-income countries, this pattern indicates that the global burden of physical inactivity on public health has become increasingly complex and unequal. Consequently, physical inactivity is regarded not merely as an individual health issue, but as a critical risk factor with profound implications for global health systems, economic sustainability, and development objectives (Hallal et al., 2012; Guthold et al., 2018; Katzmarzyk et al., 2022; Strain et al., 2024).

Despite this adverse global landscape, the protective effects of regular physical activity and recreational participation on health are strongly supported by a substantial body of epidemiological and experimental evidence. Recreational and sporting activities contribute to physical and mental health in a multidimensional manner (Güney & Osmanoğlu, 2021; Yıldız et al., 2024a; 2024b). Physical activity strengthens the musculoskeletal system, enhances cardiovascular health, and increases overall energy levels (Yaşar & Direkçi, 2025; Özavci et al., 2023). Epidemiological findings further substantiate these general health benefits. In a systematic review and meta-analysis encompassing 44 prospective cohort studies, Cheng and colleagues (2018) reported that engagement in moderate to high levels of leisure-time physical activity was associated with a significant reduction in the risk of cardiovascular disease–related mortality. Collectively, these findings demonstrate that physical activity plays a crucial role not only in disease prevention but also in extending life expectancy.

In contemporary discourse, sport is examined through its physiological, economic, sociological, and psychological dimensions (Yaman et al., 2016; Özgen et al., 2021; Toprak & Gezer, 2025). While exercise and physical activity constitute the core components of sport, nutrition is regarded as a crucial complementary factor that supports performance. The physiological effects of physical activity are also explained through mechanisms involving the autonomic nervous system. During regular physical activity, sympathetic nervous system activity increases, while parasympathetic activity is suppressed. Following exercise, particularly during the rest and recovery phases, the reactivation of parasympathetic activity contributes to the restoration and improvement of autonomic balance (Özkatar Kaya & Kaya, 2025).

Parallel to these physiological adaptations, the positive effects of physical activity on neurocognitive health are increasingly supported by robust scientific evidence. A meta-analysis conducted by Guure and colleagues (2017), based on prospective

studies, demonstrated that regular physical activity significantly reduces the risk of cognitive decline and the development of dementia. The protective effects of physical activity were reported to be particularly pronounced in specific subtypes, such as Alzheimer's disease and vascular dementia.

Similarly, the relationship between physical activity and cancer risk is supported by strong epidemiological evidence. In a large-scale prospective analysis, Matthews and colleagues (2020) reported that as the volume and intensity of leisure-time physical activity increase, the risk of developing several types of cancer decreases significantly. These findings indicate that physical activity represents an important behavioural factor exhibiting a precise dose–response relationship in cancer prevention.

In light of this extensive body of evidence, the World Health Organisation (2009) defines physical inactivity as one of the most significant behavioural risk factors contributing to global mortality and disease burden. Global reports indicate that physical inactivity increases the prevalence of numerous chronic conditions—particularly cardiovascular diseases, diabetes, and certain types of cancer—and is responsible for millions of preventable deaths worldwide (World Health Organisation [WHO], 2009).

In empirical research, physical inactivity is often examined in conjunction with other lifestyle-related risk factors, such as unhealthy dietary patterns and high consumption of sugar-sweetened beverages (Şarvan Cengiz et al., 2022; Özaltaş & Özbek, 2021; Samar, 2021). Eating disorders represent a significant public health concern (Samar, 2022). In this regard, Singh and colleagues (2015) emphasise that the global burden of non-communicable diseases largely stems from modifiable behavioural risk factors, with insufficient physical activity constituting one of the primary contributors to this burden. Within this framework, it is also emphasised that an appropriate and balanced nutritional intake plays a crucial role in enhancing performance capacity and optimising recovery processes among athletes (Sarışık & Şahin, 2021). Collectively, these findings clearly indicate that physical activity should be regarded as a priority and strategic intervention domain within public health policies.

In recent years, the role of digitalisation in intensifying this global problem has become an increasingly prominent topic of discussion. The extensive integration of digital technologies into work, education, and social life has profoundly transformed individuals' daily movement patterns (Şakar et al., 2024; Özlü et al., 2021; Bozkuş et al., 2013; Yaman, 2021). The widespread adoption of remote working, online education, and digital services has led to a substantial increase in time spent sitting and in front of screens, accompanied by a corresponding reduction in time allocated

to daily physical activity and natural movement opportunities (Araç Ilgar et al., 2022). Research further indicates that digital games generate significant differences in students' motivational dimensions, including achievement and vitality, curiosity, and social acceptance (Yıkılmaz, 2024). In particular, the migration of essential daily practices—such as shopping, banking, communication, and entertainment—into digital environments has led to the progressive substitution of physical activity with sedentary behaviours (Hallal et al., 2012; Owen et al., 2010).

As a consequence of this transformation, the increase in sedentary behaviour is not confined solely to reduced physical activity levels; it is also closely associated with elevated risks of mortality and chronic disease. Prolonged sitting has been identified as an independent risk factor for cardiovascular diseases and all-cause mortality. Evidence suggests that even among individuals with high levels of physical activity, sedentary time exceeding certain thresholds does not entirely negate its adverse health effects (Ekelund et al., 2016; Chau et al., 2013). Consistent with these findings, systematic reviews have demonstrated that sedentary lifestyles significantly increase the risk of obesity, type 2 diabetes, cardiovascular diseases, and premature mortality (Saunders et al., 2020; Park et al., 2020).

In the digital age, social media and online platforms are reported to have the potential to promote healthy living by supporting the maintenance of physical activity during periods of home confinement and movement restrictions. However, excessive and addiction-level use of these technologies may reinforce sedentary behaviour and lead to adverse health outcomes (Şahin et al., 2021).

The adverse effects of digitalisation on physical activity are particularly pronounced among developmentally vulnerable groups such as children, adolescents, and young adults (Öktem et al., 2025). The increase in screen-based activities, accompanied by declining levels of physical activity, has been associated with detrimental outcomes in physical fitness, mental health, and sleep patterns among children and adolescents (Stiglic & Viner, 2019; Tremblay et al., 2011; Albayrak & Ağırbaş, 2024). Global studies consistently demonstrate that the vast majority of adolescents fail to meet recommended daily physical activity levels, and that this pattern has become increasingly prevalent over time (Guthold et al., 2020; Hallal et al., 2012). In particular, prolonged exposure to digital screens is emphasised as having become a dominant behavioural substitute for physical activity (Dong et al., 2021; Dahlgren et al., 2021).

A similar trend is observed in the adult population, where increasingly sedentary lifestyles parallel the expansion of digitalisation and are recognised as a significant global public health concern. Insufficient physical activity has been shown to result

in millions of preventable deaths and substantial economic costs worldwide; moreover, physical inactivity has become more prevalent in high-income countries as digitalisation has accelerated (Guthold et al., 2018; Strain et al., 2024; Katzmarzyk et al., 2022; Şeyhanlı et al., 2024). Furthermore, strong evidence from meta-analyses and systematic reviews demonstrates that physical inactivity is associated with a wide range of adverse health outcomes, including cardiovascular diseases, various types of cancer, cognitive decline, and dementia (Cheng et al., 2018; Guure et al., 2017; Matthews et al., 2020).

University Students: A High-Risk Group in the Physical Activity Crisis

University students represent one of the groups most severely affected by the physical activity crisis, primarily due to their heavy academic workload, irregular lifestyle patterns, and extensive digital exposure. The university environment constitutes a unique context in which sedentary lifestyles become normalised as a result of academic demands and digital imperatives. Empirical evidence indicates that university students' daily sedentary time typically ranges between 8 and 10 hours, and that a substantial proportion of this population fails to meet recommended physical activity levels. Considering that mental processes, alongside physical capacities, play a crucial role in overall performance, the positive effects of physical activity on mental health are significant (Karademir et al., 2025).

This situation gives rise to adverse outcomes not only in physical health but also in mental health, cognitive functioning, and academic performance (Uğurlu &Şakar, 2025).. Given that the university years constitute a critical developmental period during which lifelong health behaviours are established, this population emerges as a strategic target for interventions aimed at increasing physical activity.

Within this framework, physical activity levels among university students are shaped by the dynamic interaction of individual, social, and environmental factors (Bar et al., 2016). A systematic review conducted by Brown and colleagues (2024) within the COM-B model (Capability–Opportunity–Motivation–Behaviour) framework identified key barriers to physical activity participation among university students, including lack of time, heavy academic workload, insufficient motivation, and limited environmental opportunities. Conversely, social support, access to campus-based physical activity facilities, and higher levels of individual awareness were highlighted as facilitating factors for physical activity engagement (Brown et al., 2024).

As a consequence of these structural and individual barriers, cross-sectional studies consistently demonstrate that sedentary behaviour occupies a dominant role in the daily lives of university students. Edelmann and colleagues (2022) reported

that a substantial proportion of university students fail to meet the physical activity levels recommended by the World Health Organisation and that average daily sedentary time exceeds eight hours. These findings suggest that the university environment, shaped by academic and digital demands, is increasingly normalising sedentary lifestyles (Edelmann et al., 2022).

Conversely, research conducted among university students reveals a strong association between physical activity levels and physical fitness. The study by Kljajević and colleagues (2021) demonstrated that students who engage in regular physical activity exhibit significantly higher levels of cardiorespiratory fitness, muscular strength, and overall physical performance. This evidence supports the notion that young adulthood represents a critical phase for establishing sustained physical activity habits (Kljajević et al., 2021).

In this context, the effectiveness of physical activity interventions targeting university students is strongly supported by systematic reviews and meta-analyses. Yuan and colleagues (2024) reported that structured physical activity programs implemented among university students significantly increase physical activity levels and reduce sedentary behaviour. In particular, interventions grounded in behaviour change principles and supported by digital tools were highlighted as producing more sustainable and enduring outcomes (Yuan et al., 2024).

The effects of a sedentary lifestyle on university students extend beyond physical health and appear to be closely associated with mental health outcomes. Low levels of physical activity combined with prolonged sedentary time have been reported to be associated with increased levels of depression, anxiety, and perceived stress (Şakar & Kızılkaya Namlı, 2023). These findings highlight physical activity as a critical protective factor supporting psychological well-being among university students (Guerriero et al., 2025; Çakır et al., 2025a, 2025b).

Sedentary lifestyles are not confined to university student populations. However, they are increasingly prevalent in modern societies, where they are recognised as a significant behavioural factor associated with a wide range of health risks. In this regard, Park and colleagues (2020) emphasised, in their synthesis of current evidence, that prolonged sitting behaviour significantly increases the risk of cardiovascular diseases, type 2 diabetes, obesity, and premature mortality. These findings clearly demonstrate that sedentary behaviour should not be regarded merely as a consequence of insufficient physical activity; instead, it must be conceptualised as an independent health risk factor.

Supporting this interpretation, evidence from adult populations consistently demonstrates, through multiple systematic reviews, the adverse health effects of

sedentary behaviour. Saunders and colleagues (2020) reported that increased sedentary time is strongly associated with all-cause mortality, cardiometabolic risk factors, and mental health problems. Importantly, prolonged sitting has been shown not to entirely negate its health risks, even among individuals who engage in regular physical activity (Saunders et al., 2020).

The adverse effects of sedentary behaviour are not confined to adult populations; instead, they have been shown to emerge from early life stages, including childhood and adolescence. The systematic review conducted by Tremblay and colleagues (2011) demonstrated that increases in screen-based sedentary behaviours are associated with obesity, cardiometabolic risk factors, and lower levels of physical fitness. These findings indicate that sedentary lifestyle habits acquired during childhood may predispose individuals to persistent health problems later in life (Tremblay et al., 2011).

Large-scale meta-analyses further substantiate the impact of sedentary behaviour on mortality. In a meta-analysis by Chau and colleagues (2013), daily sitting time exceeding seven hours was associated with a significant increase in the risk of all-cause mortality. This evidence underscores the critical importance of reducing sedentary time as a key public health objective (Chau et al., 2013).

Consistent with these findings, Ekelund and colleagues (2019) demonstrated, in their harmonised meta-analysis based on accelerometer-derived data, that increased sedentary time markedly elevates mortality risk among individuals with low levels of physical activity. The results emphasise that reducing health risks requires not only increasing movement but also simultaneously decreasing sedentary time (Ekelund et al., 2019).

The effects of prolonged sedentary time on cardiovascular health have become increasingly well established. A systematic review and dose–response meta-analysis conducted by Onagbiye and colleagues (2024) demonstrated a linear association between increasing sedentary time and both the incidence and mortality of cardiovascular disease. This finding provides strong confirmation of the independent effect of sedentary behaviour on cardiovascular health (Onagbiye et al., 2024).

At the same time, it is emphasised that increasing daily movement plays an important protective role in mitigating the adverse effects of sedentary behaviour (Ağırbaş et al., 2021). In a meta-analysis encompassing international cohort studies, Paluch and colleagues (2022) found that increases in daily step counts were associated with a significant reduction in the risk of all-cause mortality. These findings indicate that, in addition to high-intensity exercise, enhancing overall daily movement can yield substantial health benefits (Paluch et al., 2022).

In recent years, growing attention has been directed toward the need to evaluate the combined effects of behavioural factors such as physical activity, sedentary behaviour, and sleep on health outcomes (Hepser et al., 2024). In this context, Duncan and colleagues (2023) reported, in a meta-analysis of prospective cohort studies, that low levels of physical activity and high sedentary time significantly increase the risk of mortality, cardiovascular diseases, diabetes, and mental health problems. These results underscore the importance of addressing the composition of 24-hour movement behaviour within a holistic framework (Duncan et al., 2023).

Within this holistic perspective, physical inactivity is defined as one of the most important modifiable risk factors for non-communicable diseases. Haileamlak (2019) emphasised that physical inactivity substantially increases the prevalence of cardiovascular diseases, diabetes, and obesity on a global scale, thereby imposing a considerable burden on health systems (Sezer et al., 2024). Accordingly, it is asserted that interventions aimed at increasing physical activity should constitute one of the central priorities of public health policies (Haileamlak, 2019).

The Dual Role of Technology: A Risk Factor or a Tool for Solutions?

While digitalisation has emerged as a significant environmental and behavioural risk factor contributing to reduced physical activity levels, it simultaneously offers innovative opportunities to support and enhance individual mobility. This duality demonstrates that the effects of technology on physical activity are not unidirectional; instead, depending on patterns of use, technology can function as both a risk factor and a facilitator of physical activity. Wearable technologies, artificial intelligence–driven personalised exercise applications, gamification-based interventions, and online group exercise programs are increasingly recognised as practical tools for promoting physical activity participation, particularly among young adults (Akpınar, 2023; Akpınar vd., 2023). In this context, technology should not be viewed solely as part of the problem underlying the physical activity crisis; when appropriately designed and implemented, it can also become a critical component of the solution. Consequently, improving attitudes toward physical activity in the digital age requires holistic and multilevel approaches that balance the potential benefits of technology against the risks it may entail.

Nevertheless, the effects of digital technologies on physical activity are not homogeneous and vary substantially according to patterns of use. Unregulated and prolonged engagement with digital media can increase screen time and reinforce sedentary behaviours, thereby increasing the risk of physical inactivity. In particular, digital usage patterns centred on passive content consumption have been reported to

serve as behavioural substitutes for physical activity, resulting in reduced daily movement. These observations indicate that the adverse effects of digitalisation on physical activity stem not merely from the presence of technology itself, but from the duration, purpose, and contextual characteristics of its use.

These adverse effects become particularly pronounced among developmentally vulnerable groups such as children and adolescents. Among these populations, screen time has emerged as one of the most significant determinants of sedentary behaviour (Yıldızoğlu & Ağırbaş, 2024). The systematic review by Stiglic and Viner (2019) demonstrated that prolonged screen time is significantly associated with reduced levels of physical activity, increased risk of obesity, depressive symptoms, and lower psychological well-being. In addition, it has been reported that the effects of digitalisation on the lifestyles of children and adolescents are not limited to physical health outcomes, but also extend to mental and social well-being (Hazar & Senbakar, 2020; Şarvan Cengiz & Delen, 2019). Within this context, managing screen time is considered a critical intervention area for supporting healthy lifestyle behaviours during childhood and adolescence (Stiglic & Viner, 2019).

Conversely, the conscious and structured use of technology offers substantial advantages as a tool for promoting physical activity. Wearable activity-tracking devices and mobile applications enable individuals to monitor key indicators, such as daily step counts, exercise duration, and energy expenditure, thereby enhancing their awareness levels. Digital interventions grounded in behaviour change theories have been reported to increase physical activity participation through mechanisms such as goal setting, feedback provision, and self-monitoring. In particular, digital applications incorporating gamification elements and social interaction components are emphasised as strengthening motivation and supporting sustainable behaviour change (Görün et al., 2025).

As an extension of these technological developments, artificial intelligence–supported personalised exercise programs enhance the accessibility and feasibility of exercise interventions by providing recommendations tailored to individuals' physical capacity, health status, and living conditions. Such technologies can offer alternative solutions for promoting physical activity in contexts where access to traditional face-to-face interventions is limited. Nevertheless, to maximise the effectiveness of digital interventions, critical considerations such as ethical principles, data security, and user privacy must also be carefully addressed.

In conclusion, technology has a dual influence on physical activity. On the one hand, increased screen time and tendencies toward digital addiction can reinforce sedentary behaviour, thereby elevating the risk of physical inactivity. On the other hand, when appropriately designed and utilised, technology can function as a

powerful tool that supports, motivates, and sustains physical activity engagement. Accordingly, the effects of digitalisation on physical activity should be evaluated through a holistic perspective that simultaneously accounts for both its "risk" and "opportunity" dimensions, and technology-based interventions should be integrated across individual, societal, and environmental levels.

Within this framework, sedentary lifestyles and attitudes toward physical activity in the digital age should be conceptualised as multidimensional phenomena shaped not only by individual preferences but also by technological environments, social norms, and structural conditions. The development of attitudes that support physical activity will be achievable not only through individual awareness and motivation, but also through the restructuring of digital environments, educational systems, and living spaces in ways that actively promote movement. This holistic approach will enable the mitigation of risks posed by the digital age while transforming technology into a supportive tool for promoting physical activity.

The findings presented in this section demonstrate that sedentary lifestyles and attitudes toward physical activity in the digital age are shaped predominantly by technological environments, social norms, and structural conditions rather than by individual choices alone. Consequently, fostering attitudes that encourage physical activity requires not only enhanced individual awareness and motivation but also the systematic redesign of digital environments, educational systems, and living spaces to support and facilitate movement.

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Chapter 4

The Concept of Decision Making in Sport and Its Application Areas

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INTRODUCTION

Decision-making is a fundamental cognitive process that involves an individual's conscious selection among alternatives when confronted with various situations (Çetin & Kara, 2024). This process is closely associated with reducing uncertainty and identifying the option that best serves the intended goal (Tekin et al., 2009). Decision making extends beyond merely identifying available options; it also encompasses selecting the most appropriate alternative in line with an individual's goals, values, and personal characteristics (Harris, 1998). Individuals' approaches to decision making are shaped over time through learned and habitual decision-making styles (Scott & Bruce, 1995). In this respect, decision-making represents a dynamic construct that varies according to individual differences (Kuzgun, 2009).

Sport, by its very nature, constitutes a performance domain characterised by uncertainty, time pressure, and intense environmental interactions. Athletes, coaches, and referees are required to make rapid and effective decisions among numerous alternatives throughout both training and competition processes. Consequently, decision-making is widely recognised as one of the key determinants of sporting performance. Particularly at elite levels of sport, where differences in physical and technical competencies have become increasingly marginal, the ability to make the right decision at the right moment has emerged as a fundamental factor distinguishing performance outcomes (Mann et al., 2007; Vickers, 2007). In this context, gaining a thorough understanding of the theoretical foundations of decision-making in sport and systematically examining its application areas is crucial.

Decision-making is defined as the cognitive process through which an individual selects one option among available alternatives in accordance with a specific goal. This process involves perceiving and evaluating information, comparing alternative courses of action, anticipating potential outcomes, and ultimately initiating behaviour (Tosun, 1992; Kuzgun, 2000; Heppner, 1978; Gibson, Ivancevich, & Donnelly, 1994, as cited in Eskicioğlu, 2010). Decision-making is not based solely on rational evaluations; experience, intuition, emotional states, and environmental conditions also shape it. In this context, to develop a comprehensive understanding of the decision-making process in sport, it is essential to consider its general theoretical framework, as decision-making—both in everyday life and within the sport context—exhibits a dynamic and multidimensional structure (Hastie, 2001; Kahneman, 2011).

The quality of decision-making behaviour may vary depending on individual differences and environmental conditions; in particular, locus of control emerges as a significant psychological factor influencing individuals' perceptions of control

within the decision-making process (Dağ, 1990). Moreover, the amount of information utilised and the manner in which individuals focus on a given problem contribute to the emergence of distinct decision-making styles across individuals (Driver & Mock, 1975).

This general theoretical framework provides a foundational basis for explaining the cognitive, psychological, and environmental dimensions of the decision-making process in sport. Unlike general decision-making models, decision-making in sport occurs under conditions characterised by high speed, strict time constraints, and continuously changing environmental demands. Within this context, it becomes evident that athletic performance cannot be adequately explained solely by physical and technical competencies; instead, perceptual, cognitive, and affective processes play a decisive role in shaping decision-making behaviour (Yaman et al., 2016; Yaşar & Direkçi, 2025).

Particularly in elite performance sport, the effectiveness of mental processes and psychological equilibrium directly influences athletes' capacity to make accurate and timely decisions. Beyond physical competencies, the literature consistently emphasises that regular physical activity supports psychological well-being, enhances coping strategies for managing stress, and exerts a protective effect on mental health (Toprak & Gezer, 2025; Güler & Işıklı, 2024; Öktem et al., 2025; Aydemir et al., 2024). Empirical evidence suggests that individuals with higher levels of physical activity report lower perceived stress levels, along with greater life satisfaction and psychological resilience (Özavci et al., 2023; Çakır et al., 2025a; Ceviz et al., 2021; Yaşar & Yılmaz, 2021). Furthermore, regular physical activity has been identified as a critical supportive factor in coping with mental fatigue and in maintaining cognitive continuity (Şakar et al., 2024; Güler & Akpınar, 2023).

Regular exercise has been reported to induce metabolic and physiological adaptations in the organism, depending on whether the training stimulus is predominantly aerobic or anaerobic in nature (Özaltaş, 2019; Samar, 2021; Özkatar Kaya & Kaya, 2025). In addition to these physiological adaptations, a growing body of evidence suggests that physical activity has a positive impact on individuals' psychosocial well-being and life satisfaction (Albayrak & Ağırbaş, 2024; Ağırbaş et al., 2021). Furthermore, the perceived role and function of physical education and sport within educational processes have also been examined in studies conducted with preservice teachers, highlighting the broader educational and psychosocial significance of sport participation (Özlü et al., 2021; Yaşartürk vd., 2017).

During competition, athletes must simultaneously evaluate a wide range of stimuli, including their opponents' positions, ball speed, teammates' movements, and game strategies. This complex informational environment brings the perceptual–cognitive dimension of the decision-making process to the forefront (Araújo et al., 2006; Williams & Ward, 2007).

Within the framework of cognitive information-processing approaches and models proposed in the sport psychology literature, decision making in sport is conceptualised as a multi-stage process in which perceptual–cognitive and motor components interact sequentially (Marteniuk, 1976; Vickers, 2007). Accordingly, the decision-making process in sport generally consists of the following stages:

Perception: Detection of relevant environmental cues
Interpretation: Meaning-making of the perceived information
Selection: Identification of the most appropriate action among available alternatives
Execution: Translation of the selected decision into motor behaviour

These stages represent the continuum of the decision-making process, beginning with the perception of environmental information and culminating in the production of an appropriate motor response. In the sport context, the speed and accuracy of this process may vary depending on factors such as perceptual–cognitive expertise and time pressure (McPherson, 1999; Mann et al., 2007). Consequently, each stage of the decision-making process constitutes a critical component that directly influences the quality of sporting performance.

Factors Influencing Decision Making in Sport

The factors influencing the decision-making process in sport can be broadly categorised into two main groups: individual factors and environmental factors.

Individual Factors

Individual factors are closely associated with athletes' perceptual, cognitive, and affective characteristics. These factors directly influence how athletes perceive environmental stimuli, the speed at which they evaluate these stimuli, and the overall quality of their decision-making behaviour.

Cognitive capacity and attentional level constitute fundamental components that enable athletes to process multiple stimuli simultaneously during gameplay and to identify appropriate decision options. Particularly in elite-level sports, attentional control and cognitive flexibility are regarded as essential prerequisites for rapid and accurate decision-making (Mann et al., 2007).

Experience and level of expertise facilitate athletes' ability to utilise perceptual cues more effectively during the decision-making process and to engage intuitive decision-making mechanisms. It has been reported that experienced athletes are capable of making more accurate decisions with reduced cognitive load and of translating these decisions into automatised motor responses more efficiently (Raab & Johnson, 2007).

Motivation and self-confidence represent critical psychological variables that shape athletes' willingness to take risks, their decisional commitment, and their readiness to execute selected actions. In particular, athletes with higher levels of perceived self-efficacy are reported to demonstrate more functional and consistent decision-making behaviours under pressure (Bandura, 1997).

Emotional states, including stress, anxiety, and perceived pressure, may exert both facilitating and impairing effects on the quality of decision-making. While moderate levels of arousal may enhance decision-making performance, excessive stress and anxiety have been shown to lead to attentional narrowing and an increased tendency toward erroneous decisions (Laborde et al., 2016).

Fatigue and cognitive load constitute key factors that negatively affect decision-making speed and accuracy, particularly during the later stages of competition. As physical and mental fatigue increase, athletes' perceptual sensitivity tends to decline, and their available cognitive resources become increasingly limited (Vickers, 2007).

Participation in recreational and physical activities is associated with individuals' quality of life and subjective well-being, with this relationship potentially mediated by performance-related indicators such as perceptual–motor skills, reaction time, and balance. In this context, improvements in physical fitness may indirectly support individuals' self-perceptions and sense of competence, with these psychological gains exerting meaningful effects on decision-making behaviours and performance-related processes (Gönülateş, 2018; Zorba et al., 2017).

Evidence further suggests that the relationship between physical activity and decision-making processes is not linear. Optimal levels of physical activity may promote mindfulness and self-regulation, whereas excessive and uncontrolled exercise behaviours may be associated with risky and dysfunctional tendencies in decision making (Yıldız et al., 2024; Özgen et al., 2021).

Within this framework, another critical individual variable to be considered is athletes' level of physical activity and physical fitness. Regular physical activity has been shown to have positive effects on executive functions, attentional control, and cognitive flexibility, thereby supporting both the speed and accuracy of decision-

making (Diamond, 2015). Athletes in superior physical condition have been reported to display greater resistance to cognitive fatigue and make more consistent decisions under time pressure (Chang et al., 2012). Accordingly, physical activity should be regarded not only as a physical determinant but also as a fundamental individual factor that strengthens the cognitive foundations of decision-making in sport.

Environmental Factors

Environmental factors constitute the contextual dimension of the decision-making process in sport, representing external variables that interact with individual characteristics. The dynamic nature of the competitive environment, the level of pressure perceived by the athlete, and the amount of time available for decision-making directly influence the quality of the decisions made.

Time pressure is one of the most critical environmental factors shaping the decision-making process in sport. Athletes' need to evaluate multiple stimuli within a limited time frame leads decision-making to rely more heavily on intuitive and automatised cognitive mechanisms. The literature indicates that as time pressure increases, analytical evaluations tend to decrease, while experience- and intuition-based decisions become more prominent (Raab, 2003; Gigerenzer, 2008).

Opponent behaviours provide continuously updated environmental cues that shape the athlete's decision-making process. The opponent's position, movement speed, and tactical preferences directly influence athletes' perceptual-cognitive evaluations, thereby highlighting the anticipatory and adaptive dimensions of decision-making. Particularly in team sports, the ability to accurately read and anticipate opponents' behaviours is considered one of the fundamental determinants of effective decision making (Araújo et al., 2016).

Game rules and tactical structures represent structural environmental elements that either constrain or expand the range of available decision options. Within the framework defined by the rules of the game, the space and freedom of movement available to the athlete shape the strategic dimension of the decision-making process. In highly structured tactical systems, athletes tend to rely on previously learned decision schemas, whereas in more flexible tactical environments, situational evaluations become more salient (McPherson & Kernodle, 2007).

Spectator effects and the competitive atmosphere influence the affective dimension of decision making by increasing the level of pressure perceived by the athlete. Variations in crowd dynamics, particularly in home versus away competitions, may play a decisive role in athletes' risk-taking tendencies and decisional commitment. It has been reported that intense spectator pressure may function as a performance-enhancing stimulus for some athletes, while for others, it

may lead to attentional narrowing and an increased likelihood of erroneous decision-making (Baumeister & Steinhilber, 1984; Neave & Wolfson, 2003).

Referee decisions and the flow of the game constitute important environmental factors that affect athletes' perceptions of fairness and control within the decision-making process. Controversial referee decisions have been shown to elicit heightened emotional responses in athletes, which may negatively impact attentional focus and decision-making quality. Additionally, the tempo of the game and the frequency of interruptions influence the rhythm of the decision-making process, thereby challenging athletes' cognitive adaptability (Mascarenhas et al., 2005).

Overall, environmental factors contribute to the context-sensitive and situation-specific nature of decision-making in sport. The interaction between these factors and individual characteristics is considered one of the key determinants shaping the quality of decision-making behaviour. Accordingly, decision-making in sport should be conceptualised as a multidimensional process that extends beyond individuals' internal cognitive processes and encompasses environmental conditions such as time pressure, social context, and game dynamics.

Within this framework, the decision-making process in sport can be viewed as a multidimensional structure that emerges from the reciprocal interaction between individual cognitive characteristics, affective states, physical capacities, and environmental factors, including time pressure, social context, and game dynamics. The decisions athletes make during competition are not merely the outcome of momentary perceptual–cognitive operations, but rather reflections of dynamic processes shaped by experience, motivation, self-efficacy, and contextual conditions. To adequately understand this complex structure, it is essential to systematically examine the theoretical models that explain decision-making behaviour in sport. In particular, cognitive information-processing approaches, intuitive decision-making models, ecological dynamics, and social–cognitive theories provide a robust theoretical foundation for explaining how decision-making processes in sport emerge, how they vary across conditions, and how they are reflected in performance outcomes. Accordingly, the following section will examine in detail the principal theoretical approaches to decision making in sport and their application domains.

Decision-Making Models in Sport

A variety of theoretical models have been developed to explain the decision-making process in sport. Among these models, cognitive information-processing

frameworks, intuitive decision-making approaches, and ecological dynamics–based perspectives are particularly prominent.

Cognitive approaches conceptualise decision-making as a mental information-processing activity, whereas intuitive approaches emphasise the importance of rapid, experience-based decisions. The ecological dynamics perspective, by contrast, explains decision making within the context of the individual–environment interaction, proposing that athletes perceive affordances in their environment and act accordingly. Contemporary sport science literature suggests that these approaches are not mutually exclusive; instead, they function in a complementary manner in explaining decision-making behaviour in sport.

Decision Making in Sport and Social–Cognitive Approaches

The decision-making process in sport is closely associated not only with momentary cognitive evaluations but also with individuals' attitudes, perceptions, and behavioural tendencies. In this regard, social–cognitive approaches provide an important theoretical framework for understanding decision-making behaviour in sports. According to the Theory of Planned Behaviour (TPB), an individual's intention to perform a behaviour is determined by attitudes toward the behaviour, subjective norms, and perceived behavioural control. Within the sport context, this perspective suggests that athletes' in-game decisions are influenced not only by technical knowledge but also by their beliefs about the decision, perceived environmental expectations, and confidence in their own abilities.

Similarly, the COM-B model (Capability–Opportunity–Motivation–Behaviour) conceptualises decision-making behaviour within the framework of individuals' physical and psychological capabilities (capability), environmental and social opportunities (opportunity), and intrinsic and extrinsic motivational processes (motivation). When applied to decision-making in sport, this model indicates that the emergence of an effective decision depends on the interaction between athletes' cognitive capacity and experience, the opportunities afforded by the competitive environment, and their motivational state related to performance. Accordingly, social–cognitive models such as TPB and COM-B make it possible to conceptualise decision-making in sport not merely as an individual mental process, but as a multi-level and context-dependent structure.

Attitudes
(toward sport, strategy, and risk)
↓

Behavioral Intention
(willingness to implement the decision)
↓
Decision-Making Behavior
(in-game choice)
↓
Sport Performance
(success, error, outcome)

This model explains the social–cognitive foundations of decision-making behaviour in sport. Athletes' attitudes toward a specific behaviour or strategy shape their intention to engage in that behaviour, while intention subsequently translates into decision-making behaviour during competition or performance situations. The outcomes of these decisions are evaluated through sport performance indicators. Performance outcomes, in turn, contribute to the cyclical continuation of the process by reshaping athletes' future attitudes and intentions through feedback mechanisms. This conceptual structure is grounded in the Theory of Planned Behaviour (TPB) and the COM-B model.

Within this framework, decision-making in sport should be understood not merely as a cognitive selection process but as a dynamic structure shaped by the reciprocal interaction of attitudes, intentions, and behaviours. Social–cognitive theories provide a robust theoretical foundation for explaining why athletes make confident decisions and how these decisions are reflected in performance outcomes. In particular, the Theory of Planned Behaviour and the COM-B model offer an integrative perspective by comprehensively addressing both the individual and environmental determinants of decision-making behaviour in sport.

In this structure, attitudes refer to the extent to which athletes evaluate a particular behaviour or decision positively or negatively. In contrast, intention represents the likelihood that this attitude will be translated into action. Decision making constitutes the behavioural realisation of this intention and is directly associated with performance outcomes. Although this process follows a linear sequence, it also exhibits a cyclical nature, as performance outcomes feed back into the system by reshaping athletes' future attitudes and intentions.

Decision-making behaviour in sport cannot be reduced to momentary cognitive operations alone; instead, it is closely associated with athletes' attitudes, behavioural intentions, and the process through which these intentions are translated into

performance outcomes. Social–cognitive theories provide a holistic framework for explaining this relationship. When the Theory of Planned Behaviour (TPB) and the COM-B model are considered together, the decision-making process in sport can be conceptualised through a sequential and interactive structure.

Taken jointly, the Theory of Planned Behaviour and the COM-B model explain decision-making in sport as a multi-layered and interactive process. TPB posits that athletes' intentions to perform a specific behaviour are determined by their attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991). In contrast, the COM-B model emphasises the physical and psychological capabilities (capability), environmental opportunities (opportunity), and motivational processes (motivation) required for these intentions to be translated into actual behaviour (Michie et al., 2011). Within this integrative perspective, decision-making in sport begins with the development of a behavioural intention shaped by athletes' attitudes and beliefs regarding a specific in-game situation. The transformation of this intention into decision-making behaviour is subsequently influenced by athletes' cognitive capacity, experience, physical fitness, and the opportunities afforded by the competitive environment. Consequently, the emergence of an effective decision depends not solely on the presence of intention, but also on the suitability of the individual and environmental conditions that determine the feasibility of implementing that intention.

Within this framework, decision-making behaviour emerges from the interaction between athletes' cognitive and physical capabilities (capability) and environmental opportunities (opportunity), such as time pressure, opponent behaviours, and game dynamics. At the same time, motivational state assumes a regulatory role by determining the direction and decisional commitment of this process (Michie et al., 2011). The translation of decision-making behaviour into performance outcomes enables feedback mechanisms through which athletes' attitudes and intentions are reshaped, thereby contributing to the cyclical continuation of the process. In this context, TPB explains *why* athletes are inclined to adopt particular decisions, whereas the COM-B model elucidates *how* and *under what conditions* these decisions are translated into behaviour. Consequently, considering the decision-making process in sport within the combined framework of these two models demonstrates that decision-making behaviour is not merely an individual cognitive process, but rather a dynamic structure shaped by contextual, motivational, and environmental components.

Furthermore, high levels of communication skills enhance individuals' self-confidence and perceived competence, which in turn strengthen decisional commitment and the tendency to translate decisions into action (Direkçi & Tekeş,

2025). This theoretical framework necessitates a focus not only on *which* decisions are made in sport, but also on *how* these decisions are formed and the individual dispositions through which they emerge. Although athletes may perform under similar environmental conditions and tactical structures, the approaches, speed, and levels of decisional commitment they exhibit during decision-making processes vary across individuals. These differences are closely associated with athletes' information-processing styles, levels of experience, capacities for coping with stress, and risk perceptions. Therefore, to achieve a more comprehensive understanding of the decision-making process in sport, it is essential to examine the decision-making styles adopted by athletes in both competitive and training environments.

Athletes' Decision-Making Styles

Athletes' decision-making styles represent a significant psychological characteristic that reflects individuals' information-processing, evaluation, and response patterns when confronted with uncertain, time-pressured, and high-risk situations during both competition and training contexts (Raab et al., 2019; Vickers, 2007). In the literature, athletes' decision-making styles have been conceptualised across multiple dimensions, including rational/analytical, intuitive, fast–reactive, avoidant, and dependent decision-making tendencies (Scott & Bruce, 1995; Mann et al., 2007).

Athletes who exhibit an analytical decision-making style tend to engage in systematic evaluation of available options, leading to more deliberate and planned decisions. In contrast, intuitive and fast–reactive decision makers are capable of generating effective solutions under time pressure by relying on experience-based and automatised cognitive processes (Raab & Johnson, 2007; Gigerenzer, 2008). Particularly in elite performance sport, decision-making style has been reported to be closely associated with factors such as sport type (team versus individual sports), level of experience, perceived stress, and cognitive load (Mann et al., 2007; Laborde et al., 2015).

In team sports, decision-making is characterised by the rapid perception of environmental cues, anticipation of opponents' and teammates' behaviours, and adaptive responses to situational demands. In contrast, individual sports tend to emphasise decision-making styles grounded in self-regulation, internal feedback, and cognitive control processes (Araújo et al., 2016; Vickers, 2007). Within this context, athletes' decision-making styles should be regarded as dynamic and developable constructs that interact not only with performance outcomes but also

with psychological variables such as attitudes, intentions, and self-efficacy (Ajzen, 1991; Bandura, 1997).

These considerations indicate that decision-making styles are not solely personality-based traits, but rather structures that can be enhanced through training, experience, and targeted psychological interventions.

Decision Making in Team and Individual Sports

Team Sports Example

Decision-making in team sports is strongly associated not only with individual cognitive processes but also with team dynamics and the broader social context. For instance, a football player's decision to pass or shoot during an attacking phase is influenced not solely by technical proficiency, but also by the positioning of teammates, the current score of the match, the coach's expectations, and prior experiences. Within this context, athletes' attitudes toward risk-taking, their perceptions of team norms, and their self-confidence become decisive factors shaping the decision-making process. The timely execution of the correct decision has a direct impact on team success, extending beyond individual performance outcomes.

In a study conducted with amateur league football players, the relationships between motivational climate, moral disengagement in sport, and decision-making styles were examined. The research carried out by Türksoy Işım, Güvendi, and Toros (2019) revealed that football players generally preferred confident and careful decision-making styles rather than avoidant, panic-driven, or procrastinating styles. The findings indicate that deliberate and controlled decision-making is particularly prominent during competition. However, it was also found that sanctioned players exhibited more avoidant decision-making tendencies, suggesting that decision-making processes under pressure may be associated with psychological vulnerability. Furthermore, the study reported that in environments dominated by a performance-oriented climate, football players tended to display both riskier decision-making tendencies and higher levels of moral disengagement in sport. These findings demonstrate that decision-making styles are closely related not only to individual cognitive characteristics but also to perceived motivational climate and ethical context (Türksoy Işım et al., 2019).

While decision-making in team sports is shaped within such a multi-layered social context, decision-making dynamics in individual sports are more heavily grounded in athletes' internal evaluations.

Individual Sports Example

In individual sports, the decision-making process is primarily grounded in athletes' internal evaluations. For instance, a tennis player's choice between executing an aggressive stroke or opting for a safer play at a critical point is closely related to the athlete's risk perception, momentary physical condition, and prior experiences. In such sports, decision-making is directly and unequivocally linked to performance, and the consequences of an erroneous decision are often irreversible. Consequently, the attitude–intention–decision–performance chain can be observed more rapidly and with greater clarity in individual sports.

One of the notable studies conducted in Türkiye aimed at examining the structure of athletes' decision-making styles was carried out by Kelecek, Altıntaş, and Aşçı (2013). In this study, the decision-making styles of 250 licensed athletes from different sport branches were investigated using the Melbourne Decision-Making Questionnaire. The findings indicated that the highest mean scores were observed for the procrastinating decision-making style, whereas the lowest mean scores were associated with the vigilant (careful) decision-making style. However, no statistically significant differences in decision-making styles were found with respect to gender or sport experience variables ($p > .05$). Based on these results, the authors emphasised that female and male athletes exhibit similar decision-making profiles and that sport experience alone does not constitute a decisive factor in determining decision-making style. These findings suggest that athletes' decision-making styles may be more closely related to individual and situational characteristics, thereby highlighting the need for a more in-depth examination of the psychological dimensions of decision-making processes in sport (Kelecek et al., 2013). This, in turn, underscores the importance of cognitive and technological interventions in supporting decision-making processes in individual sports.

Integration of Artificial Intelligence–Supported Decision Making

With the widespread adoption of digitalisation, smartphones, wearable technologies, and digital platforms in daily life, technological advancements have fundamentally transformed individuals' lifestyles (Karadağ et al., 2023; Er & Cengiz, 2025). Rapid developments in digitalisation and artificial intelligence technologies have led to profound paradigm shifts across numerous domains, including education, healthcare, the economy, and social life. While reshaping individuals' ways of accessing information, analysing data, and making decisions,

this transformation has also brought about significant changes in the field of sport, as in many other areas of life (Çakır et al., 2023; Uluca et al., 2024).

In the sports context, artificial intelligence–supported analytical systems contribute to decision-making processes by evaluating athletes' and coaches' historical performance data, opponent analyses, and real-time game dynamics. These systems reduce athletes' perceptual and cognitive load, make decision alternatives more salient, and strengthen the attitude–intention relationship through the immediate feedback they provide (Çakır & Çatıkkaş, 2025). In this way, artificial intelligence facilitates faster, more consistent, and data-driven decision-making in sport.

Artificial intelligence–based decision support systems are regarded not as mechanisms that directly dictate decision-making in sport, but rather as tools that enhance athletes' cognitive awareness and render decision options more explicit. By providing feedback derived from historical performance data and real-time game information, these systems contribute to reshaping athletes' attitudes and the more deliberate formation of behavioural intentions. Accordingly, artificial intelligence is positioned not as a substitute for the human factor in sports decision-making, but as a supportive mechanism that strengthens and augments it.

The integration of artificial intelligence technologies into sport has led to both structural and functional transformations in athletes' decision-making styles. Decision-making processes that have traditionally relied on experience, intuition, and cognitive evaluation are increasingly being supported by big data analytics, machine learning, and real-time feedback systems, thereby evolving into more knowledge-based, predictive, and adaptive structures (Vallée et al., 2020). Artificial intelligence–supported analyses enhance athletes' speed of perceiving environmental cues, render potential options more explicit, and improve decision quality by reducing cognitive load (Raab & Johnson, 2007).

Within this process, artificial intelligence is positioned not as an authority that directly makes decisions, but rather as a cognitive support mechanism that simultaneously strengthens athletes' analytical and intuitive decision-making styles. Particularly in elite performance sport, the use of AI-based decision support systems provides the groundwork for the emergence of a novel decision-making mode—often described as a *hybrid decision-making style*—in which human intuition is integrated with algorithmic prediction (McRobert et al., 2009).

From this perspective, artificial intelligence–supported decision-making processes can be conceptualised within a comprehensive framework grounded in the Theory of Planned Behavior and the COM-B model, as they contribute to the shaping of athletes' attitudes, the strengthening of behavioral intentions, and ultimately to

improvements in decision quality as reflected in performance outcomes (Ajzen, 1991; Michie et al., 2011).

For example, post-match video analyses and data-driven feedback can enhance athletes' awareness of why specific decisions were made, thereby reshaping their future attitudes and intentions. However, artificial intelligence must be positioned as a decision-support tool rather than a decision-making authority. Otherwise, excessive reliance on technology may undermine athletes' intuitive decision-making skills. Accordingly, artificial intelligence–supported systems should be designed in a manner that strengthens athletes' cognitive and social–cognitive processes.

The concept of the *hybrid decision-making athlete* refers to an athlete profile that integrates the intuitive and experience-based dimensions of human cognition with artificial intelligence–based analytical and predictive systems during the decision-making process. Rather than functioning as a passive user who merely follows algorithmic recommendations, this type of athlete is positioned as an active and reflective agent who synthesises data derived from artificial intelligence with personal perceptual experience, contextual awareness, and momentary environmental conditions to generate informed and deliberate decisions (Raab & Johnson, 2007; Vallée et al., 2020).

Within the hybrid decision-making athlete model, artificial intelligence functions as a decision-support system that reduces cognitive load, clarifies available options, and lowers the probability of error. At the same time, the final decision is shaped in accordance with the athlete's perceived self-efficacy, motivational state, and contextual evaluation. This approach optimises rapid and collective decision-making processes in team sports, while in individual sports it strengthens self-regulation, strategic planning, and performance consistency (McRobert et al., 2009).

Accordingly, the concept of the hybrid decision-making athlete offers a contemporary theoretical framework that emphasises artificial intelligence not as a substitute for human decision-making processes in sport, but as an element that supports, transforms, and enhances human cognition (Ding et al., 2020).

Applications of Decision Making in Sport

Athlete Performance

It has been reported that the primary objective of individuals engaged in training is not limited to physical development alone, but also involves achieving optimal performance by enhancing both physical and mental well-being; within this process, psychological capacity is considered to be at least as determinative as physical

capacity (Adıgüzel et al., 2022; Ceviz & Adıgüzel, 2024; Göncü & Balcı, 2023 Şarvan Cengiz & Delen, 2019).

In athletes, decision-making behaviour is shaped by psychosocial processes such as attitudes toward sport and motivation, while physical components, including balance, posture, and motor proficiency, determine how these decisions are translated into performance outcomes. This interaction highlights that decision-making in sport is a multidimensional structure that emerges from the interplay between psychological and physical dimensions (Şahin et al., 2022).

The ability to voluntarily direct mental processes supports attentional control and cognitive regulation, which are fundamental components of decision making in sport, thereby enhancing the quality of decisions made under performance conditions (Şakar & Kızılkaya Namlı, 2023). Athletes' decision-making skills directly influence numerous performance components, such as pass selection, shot timing, defensive positioning, and regulating game tempo. Particularly in team sports, effective decision making is regarded as one of the primary determinants of team success (Mann et al., 2007; Vickers, 2007).

The effectiveness of the decision-making process in athletes is considered a core cognitive skill that is closely associated with performance outcomes (Raab et al., 2019). In this context, recent studies suggest that decision-making effectiveness encompasses both internal cognitive evaluation processes and external factors influenced by environmental feedback (Araújo et al., 2016). Research conducted with licensed athletes further demonstrates that decision-making processes exhibit a multidimensional structure and that internal and external decision-making tendencies should be examined conjointly (Çetin & Kara, 2024). These findings suggest that the effectiveness of decision-making in sport is shaped not only by individual characteristics but also by contextual and environmental variables.

Coaching and Tactical Management

Coaches are responsible for critical decisions, including pre-match strategy development, in-game adjustments, and player selection. The effectiveness of these decisions depends not only on technical expertise but also on understanding athlete psychology, accurately interpreting the competitive context, and considering long-term performance objectives (Côté & Gilbert, 2009; Jones et al., 2004).

Research conducted with intercollegiate hockey athletes indicates that athletes generally display high levels of decision-making self-esteem and vigilant decision-making styles, while avoidant and procrastinating styles remain relatively low; some decision-making styles also vary according to demographic characteristics (Akpınar

et al., 2015). These findings suggest that decision-making styles should be evaluated in relation to sport-specific demands and individual differences.

Similarly, coaches' decision-making processes are shaped by decision-making self-esteem, emotional regulation, and responses under pressure, in addition to technical knowledge (Laborde et al., 2015). Tükel (2021) reported that coaches typically exhibit high levels of vigilant decision-making and low levels of avoidant, procrastinating, and panic decision-making styles, with professional experience and higher educational attainment associated with more balanced and functional decision-making tendencies. Overall, these findings indicate that coaches' decision-making styles represent a developable psychological structure influenced by education and professional experience.

Sports Officiating

Referees are among the actors in sports who operate under the highest levels of time pressure and the lowest tolerance for error in decision-making. Decisions made during competition are often irreversible and directly influence the fairness and safety of the game (Mascarenhas et al., 2005). Consequently, decision-making in officiating is closely associated with perceptual speed, attentional control, and emotional regulation skills (Plessner & Haar, 2006). The increasing use of video analysis and simulation-based training in referee education is regarded as an effective intervention for enhancing the quality of decision-making (Hancock & Ste-Marie, 2013).

Sport Psychology and Education

Research conducted in the fields of sport psychology and education demonstrates that decision-making skills constitute a developable structure that can be enhanced through cognitive training programs and psychological interventions (Vickers, 2007; Raab et al., 2019). Video analyses, simulations, and game-based applications are widely employed as effective methods for improving decision-making quality by enhancing athletes' perceptual-cognitive awareness (Williams & Ward, 2007; McPherson & Kernodle, 2007).

Practical decision-making skills in sport are not limited to the cognitive dimensions of performance, but are also closely related to learning processes and affective experiences associated with sport participation. In this context, a study conducted with university students who actively participate in sport identified positive and significant relationships between metacognitive processes during

competition and perceived learning levels (Karademir, Gezer, & Gezer, 2025). The findings indicated that athletes with higher levels of metacognitive awareness perceived their learning processes more effectively and demonstrated higher levels across cognitive, affective, and psychomotor learning domains.

These results suggest that decisions made by athletes during competition are associated not only with immediate performance outcomes, but also with broader learning processes. The strengthening of metacognitive processes enables athletes to monitor, evaluate, and regulate their own thinking and decision-making processes when necessary, thereby enhancing both decision-making effectiveness and the quality of the learning experience (Karademir et al., 2025). Accordingly, the adoption of holistic approaches that simultaneously target metacognitive awareness and decision-making skills has become increasingly important in sport psychology–based educational programs.

Moreover, it has been reported that athletes' perceptions of competence and effectiveness in their decision-making processes enhance feelings of enjoyment, pleasure, and satisfaction experienced during physical activity, thereby strengthening subjective sport-related well-being (Kartal & Yarım, 2025). From this perspective, decision-making effectiveness can be regarded as a key determinant not only of behavioural performance outcomes but also of the psychological and educational quality of the sport experience.

Conclusion

Decision-making in sport constitutes a multidimensional and dynamic process that lies at the core of athletic performance. The effective utilisation of physical, technical, and tactical competencies largely depends on athletes' ability to make appropriate decisions at the right time and under the right conditions. In this regard, decision-making skills should not be conceptualised merely as a cognitive selection process, but rather as a holistic structure shaped by the interaction of attitudes, intentions, self-efficacy, emotional states, and environmental factors.

In this study, the concept of decision-making in sport has been examined through its theoretical foundations, including individual and environmental determinants, decision-making styles, differences between team and individual sports, and social–cognitive models, which have been systematically addressed. In particular, the Theory of Planned Behaviour (TPB) and the COM-B model provide complementary theoretical frameworks for explaining not only *the* decisions made in sport, but also *the psychological and contextual conditions* under which these decisions emerge.

Furthermore, it has been emphasised that artificial intelligence–supported decision support systems should be positioned not as substitutes for decision-making processes in sport, but as tools that enhance athletes' cognitive awareness, render

decision options more explicit, and support decision quality. In this regard, the proposed hybrid decision-making athlete approach presents a contemporary decision-making model that integrates human intuition with data-driven analytical systems.

In conclusion, decision-making in sport represents a dynamic process shaped by the reciprocal interaction of individual cognitive characteristics, psychological states, physical competencies, and environmental conditions. The development of this process contributes not only to enhanced athletic performance but also to improvements in learning processes, psychological well-being, and the overall quality of the sport experience. Therefore, addressing decision-making skills in sport through an integrated framework encompassing training programs, sport psychology interventions, and technological support systems is of critical importance for both researchers and practitioners.

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CHAPTER 5

Movement, Sleep, and Well-Being: Exercise, Physical Activity, and Life Satisfaction

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1. Introduction

The Concepts of Physical Activity, Sleep, and Life Satisfaction

Sleep is one of the most fundamental biological necessities for individuals and constitutes an indispensable life process for maintaining physiological integrity, sustaining cognitive functions, and ensuring psychological well-being (Mougin et al., 2001). During sleep, the body partially disengages from the metabolically active processes of the day, allowing for physiological recovery and reorganisation; this process plays a decisive role in physical development, conscious emotional regulation, cognitive performance, and overall quality of life (Brand et al., 2021). In this respect, sleep is not merely a passive state of rest but is also regarded as a core biological function, often described metaphorically as the "nutrient of the brain" (Walker, 2017).

The literature widely acknowledges that sleep plays a critical role in both cognitive and physiological functioning (Fullagar et al., 2015; Leeder et al., 2012). From a physiological perspective, sleep deprivation has been associated with impaired immune function, decreased natural killer cell activity, and reduced maximal exercise capacity. In contrast, its adverse effects on maximal muscle strength appear to be more limited (Leeder et al., 2012). From a cognitive standpoint, sleep deprivation can lead to deficits in attention and concentration, decreased motivation and arousal levels, and increased perceived exertion and pain, ultimately resulting in diminished performance. In this regard, sleep emerges as a fundamental factor for athletes, as it supports post-training recovery and facilitates preparedness for subsequent training sessions or competitive events (Marshall & Turner, 2016; Lang, 2016).

To maintain a healthy life, individuals must achieve a balanced fulfilment of their physical, psychological, social, intellectual, and spiritual needs. Within this holistic framework, sleep is regarded as a fundamental biological variable that directly influences quality of life and overall well-being (Önler & Yılmaz, 2008; Potter & Perry, 2009; Engin & Özgür, 2004; Ertekin & Doğan, 1999). For this reason, sleep health has become a concept of considerable importance in both contemporary clinical practice and scientific research, and has been conceptualised as a multidimensional construct encompassing duration, quality, timing, and regularity (Buysse, 2014). The high prevalence of sleep-related complaints, the potential of poor sleep quality to serve as an early indicator of various medical conditions, and the strong associations between sleep health and both physical and psychological well-being constitute the primary drivers of this growing interest (Keshavarz Akhlaghi & Ghalebandi, 2009).

Studies focusing on sleep disorders have been increasing worldwide (Altıntaş et al., 2006). Although prevalence rates vary across societies and age groups, sleep disorders are reported to affect between 5% and 71% of the population. Research conducted in Türkiye indicates that approximately 21.8% of the population experiences impaired sleep quality, while 34% report difficulties in initiating sleep and problems with early morning awakening (Demir, 2010). The widespread nature of sleep problems becomes particularly pronounced among young adult populations, such as university students. There is a prevailing view that university students tend to experience insufficient and irregular sleep patterns (Orzech, Salafsky, & Hamilton, 2011). Longitudinal data further demonstrate that the average reported sleep duration declined from approximately 7.75 hours in 1969 to 6.65 hours in 2001, while sleep-related complaints increased markedly from 24% to 71% over the same period (Vail-Smith, Felts, & Craig, 2009).

Numerous studies have demonstrated significant associations between sleep quality and psychological health among university students. Evidence indicates that psychological health problems are more prevalent among students with poor sleep quality (Liu et al., 2008) and that sleep quality is significantly related to overall health status (Keshavarz Akhlaghi & Ghalebandi, 2009). A study conducted by Erbaş and Çakır (2021) found that engaging in regular training and maintaining efficient training practices had a positive influence on sleep quality. In contrast, cigarette smoking and alcohol consumption had adverse effects. Additionally, sleep quality was shown to deteriorate as the number of individuals sharing the same living environment increased. In one of the limited studies carried out in Türkiye, it was reported that 54.4% of medical students perceived themselves as experiencing sleep-related problems (Altıntaş et al., 2006). Collectively, these findings suggest that sleep quality is not confined solely to physiological functioning; rather, it represents a multidimensional construct closely associated with psychological well-being, cognitive performance, and overall quality of life.

The amount of sleep required by individuals varies depending on age, level of physical activity, and individual characteristics. Nevertheless, the recommended sleep duration for adults is generally considered to be 7–9 hours per night (Hirshkowitz et al., 2015; American College of Sports Medicine et al., 2022).Among individuals who report sleep deprivation, mental and neurological functions are identified as the domains most adversely affected (Kurt et al., 2010). From an athletic perspective, the increased recovery demands associated with high-intensity training loads necessitate a greater volume of sleep compared with non-athletic populations (Marshall & Turner, 2016; American College of Sports Medicine et al., 2022). In

particular, for young athletes engaged in intensive training, a minimum of 10 hours of sleep per night is recommended (Calder, 2003). Indeed, it has been reported that maintaining optimal sleep patterns among athletes has a direct and decisive impact on performance outcomes (Mah et al., 2011).

Nevertheless, it has been reported that elite athletes tend to exhibit poorer sleep quality compared with non-elite individuals, with expert consensus highlighting sleep as a critical performance and recovery determinant in athletic populations (Walsh et al., 2021). That sleep problems are more prevalent among athletes participating in individual sports than those engaged in team sports; and that sleep disturbances frequently occur in the days preceding competition (Leeder et al., 2012; Watson, 2017; Simpson et al., 2017; Walsh et al., 2021). Although sleep requirements vary across individuals, they may also fluctuate within the same individual depending on factors such as illness, accumulated sleep debt, and physiological or psychological stress. Accordingly, sleep duration alone does not constitute a sufficient indicator, and sleep quality has increasingly been recognized as a fundamental component of overall health and well-being (Watson, 2017; Direkçi & Tekeş, 2025).

In contemporary society, the rise of sedentary lifestyles, irregular working hours, and excessive exposure to digital screens are among the principal environmental factors threatening sleep health (Şarvan Cengiz & Delen, 2019). Çulha et al. (2020) reported that the use of communication technologies adversely affected sleep and physical activity levels among nursing students. The rapid pace of technological advancement and the widespread integration of digital systems into daily life—particularly through smartphones, tablets, and computers—have led to a marked increase in screen time (Güler & Yıkılmaz, 2025; Reyhan, 2020; Reyhan, & Duyan 2020; Konur Tekeş, 2023). Increased screen exposure enhances blue light exposure, suppresses melatonin secretion, and disrupts circadian rhythms; consequently, it prolongs sleep onset latency and negatively affects sleep quality (Chang et al., 2015; Hale & Guan, 2015; Samar, 2022). Intensive use of digital technologies, especially during nighttime hours, has been associated with irregular sleep–wake cycles, shorter sleep duration, and excessive daytime sleepiness. As a result, sleep disorders are more commonly observed among populations with higher exposure to digital technologies, such as young adults and university students.

Sleep health constitutes a shared domain of multiple medical disciplines, including otorhinolaryngology, pulmonology, neurology, and psychiatry. However, when athletes and individuals who regularly engage in physical activity are considered, the perspective of sports medicine must also be incorporated. This

necessity stems from the fact that sleep problems observed in these populations may be associated not only with environmental and behavioral factors but also with training load–related pathological processes such as overreaching and overtraining. In particular, the detrimental effects of digital screen use on recovery processes may lead to both reduced sleep quality and compromised sustainability of athletic performance.

In recent years, regular exercise has emerged as an effective non-pharmacological regulator of sleep. The beneficial effects of exercise on sleep extend beyond increases in sleep duration and encompass multidimensional parameters such as sleep onset latency, the proportion of deep sleep, and subjective sleep quality (Kredlow et al., 2015). These effects are attributed to the regulatory role of exercise on physiological systems and psychological processes. Consequently, adopting a holistic approach to examining the relationship between sleep, exercise, and life satisfaction is considered a crucial requirement for both general health and athletic performance.

2. Physiological Mechanisms of Regular Exercise

During exercise, core body temperature increases, followed by a subsequent decline in the post-exercise period. However, vigorous late-night exercise may differentially affect sleep parameters depending on intensity and timing, with evidence suggesting that high-intensity exercise performed close to bedtime can alter sleep onset latency and sleep architecture (Myllymäki et al., 2012). This decrease is considered a critical physiological signal that facilitates the initiation of sleep. Horne and Staff (1983) reported that the post-exercise reduction in body temperature is associated with an increase in the duration of deep sleep, and recent systematic evidence indicates that evening exercise does not impair sleep quality in healthy individuals (Stutz et al., 2019).

Exercise has a significant regulatory effect on hormones related to sleep. Regular physical activity enhances melatonin secretion, thereby contributing to the strengthening of circadian rhythms (Buxton et al., 2012; Özaltaş & Özbek, 2021). In parallel, cortisol levels associated with chronic stress are reduced through regular exercise, which in turn facilitates the transition to sleep (Çabuk et al., 2020; Aydemir et al., 2024; Yaşartürk et al., 2013). Moreover, growth hormone secretion is closely linked to the deep sleep stage, and resistance training has been shown to support this process (Van Cauter et al., 2000).

Regular exercise also contributes to increased parasympathetic activity within the autonomic nervous system. Parasympathetic predominance leads to reductions in

heart rate and promotes physiological relaxation, thereby supporting the process of sleep initiation (Trinder et al., 2001).

3. Physical Activity and Psychological Well-Being

Exercise exerts both direct and indirect effects on psychological well-being. Through reductions in stress hormone levels and increases in endorphin release, perceived stress levels are significantly decreased (Öktem et al., 2025; Özavcı et al., 2023; Geri et al., 2015). Biddle and Asare (2011) reported that regular physical activity significantly reduces symptoms of anxiety and shortens sleep onset latency (Çakır et al., 2025a; 2025b; Özaltaş, 2019). Furthermore, the reduction of exercise-induced oxidative stress and the acceleration of recovery processes constitute physiological factors that indirectly influence sleep quality (Çetin Sarışık & Şahin, 2021).

A bidirectional relationship exists between depression and sleep disorders. Regular exercise contributes to a reduction in depressive symptoms, thereby indirectly improving sleep quality (Blumenthal et al., 2007; Tunçkol & Şahin, 2022; Bar vd., 2016). Additionally, exercise helps alleviate the accumulation of cognitive load throughout the day and supports pre-sleep mental relaxation by reducing mental rumination (Kline, 2014). These psychological benefits represent key components that enhance individuals' overall life satisfaction (Yıldız et al., 2024a; 2024b).

4. Sleep Quality, Recovery, and Emotional Regulation

Sleep plays a fundamental role in physiological recovery, immune functioning, and emotional regulation. In particular, non-REM sleep—especially the N3 stage—is crucial for growth hormone secretion and physical restoration (Carskadon & Dement, 2017). REM sleep, in contrast, is closely associated with learning processes, memory consolidation, and emotional balance.

The sleep–wake cycle is regulated by circadian rhythms, which are controlled by the suprachiasmatic nucleus (SCN) located in the hypothalamus. Disruptions in this rhythm may lead to difficulties in sleep initiation and increased sleep fragmentation (Czeisler et al., 1999).

5. The Interaction Between Exercise, Sleep, and Life Satisfaction

Exercise supports individuals' daily functioning and emotional stability by enhancing sleep quality, which in turn has a positive impact on life satisfaction, particularly among older adults engaging in regular aerobic exercise (Reid et al.,

2010). High-quality sleep accelerates post-exercise recovery and ensures the sustainability of physical performance (Hepsert et al., 2024; Osmanoğlu, 2021). This reciprocal relationship gives rise to a cyclical structure within the exercise–sleep–life satisfaction triad (Konur Tekeş, 2022).

6. Sedentary Lifestyle, Digitalisation, and Behavioural Mechanisms

Sedentary behaviours associated with modern lifestyles, together with increased use of digital screens, constitute major factors that adversely affect sleep quality. A lack of physical activity contributes to the weakening of circadian rhythms and to an increased prevalence of sleep disorders. In this context, regular exercise is a protective behavioural mechanism against the adverse effects of digitalisation on sleep health.

7. The Holistic Relationship Between Nutrition, Exercise, Sleep, and Performance

Nutrition is a fundamental lifestyle component that serves as a bridge between exercise performance, recovery processes, and sleep quality. Adequate and balanced nutrition has a direct influence on both physical performance and sleep regulation, affecting energy metabolism, hormonal balance, and neurological functions (Sarıtaş & Koç, 2018; Thomas et al., 2016). Particularly among individuals who engage in regular exercise, inadequate nutritional intake may prolong recovery periods and lead to impairments in sleep quality.

The literature demonstrates significant associations between energy intake and both sleep duration and sleep quality. Insufficient energy intake may disrupt the balance of hormones such as leptin and ghrelin, resulting in shorter sleep duration and increased nocturnal awakenings (St-Onge et al., 2016). In addition, dietary composition plays a regulatory role in neurotransmitter synthesis and circadian rhythms; foods rich in tryptophan have been reported to facilitate sleep onset by supporting the synthesis of serotonin and melatonin (Peuhkuri et al., 2012).

In the post-exercise recovery process, nutrition and sleep are considered complementary and interdependent elements of the recovery process. High-quality sleep supported by adequate nutrient intake enhances muscle protein synthesis and reduces central nervous system fatigue, thereby positively influencing subsequent performance (Kerksick et al., 2017). Conversely, the consumption of stimulants such as caffeine during late hours is known to prolong sleep latency and disrupt sleep continuity (Drake et al., 2013).

In conclusion, nutrition, exercise, and sleep represent interrelated and mutually reinforcing components that are essential for the sustainability of performance and favourable long-term health outcomes (Saldıray & Ziyagil, 2022; İnençli & Ziyagil, 2017). Accordingly, optimising performance requires a holistic approach in which nutritional strategies are integrated with exercise timing and sleep regulation.

8. Conclusion and Future Perspectives

The evidence presented in the literature suggests that sleep, for athletes and physically active individuals, is not merely a period of rest but a fundamental biological process closely linked to training performance, recovery, cognitive functioning, and psychological well-being. Ulusoy's (2020) review emphasises that, alongside sleep duration, sleep quality is a decisive factor for the sustainability of athletic performance and highlights that sleep quality can be supported through appropriate nutritional habits. In this context, the sleep-enhancing effects of tryptophan-rich foods and the detrimental impact of stimulants such as caffeine and alcohol on sleep regulation underscore the importance of the integrated relationship between sleep, nutrition, and recovery.

Studies conducted among young adults and university students clearly demonstrate the effects of sleep quality on psychological well-being and quality of life. The findings of İyigün et al. (2017) reveal that declines in sleep quality are associated with increased levels of anxiety, depression, and stress, while self-esteem, body image, physical activity level, and various dimensions of quality of life are adversely affected. These results suggest that sleep health is a critical determinant of both physiological and psychosocial functioning among university students.

Research focusing on athletes suggests that the relationship between sleep quality and dietary habits may vary depending on the type of sport. In the study by Altunhan and Bayer (2021), positive nutritional habits were found to be associated with better subjective sleep quality, and differences were reported between individual and team sport athletes in the sleep disturbance subdimension. These findings demonstrate that sleep and nutrition are interrelated core lifestyle components in athletes and that performance processes should be evaluated within the framework of this interaction.

Circadian rhythm–based studies provide an important biological framework for explaining the sleep–performance relationship (Gürbüz, 2023a; 2023b). Uluç's (2023) review indicates that circadian rhythms influence athletic performance, training timing, and physiological adaptation processes. Planning sports activities in accordance with individuals' biological clocks is therefore considered an essential requirement for optimising performance and supporting recovery processes.

Research involving adult and older populations indicates that the relationship between physical activity and sleep may vary across different age groups. In the study by Aktaş et al. (2016), no direct significant association was found between physical activity level and sleep quality; however, increases in body mass index and the presence of chronic diseases were associated with poorer sleep quality. Similarly, a study conducted by Çalık (2013) among older adults found that, although no significant relationship was observed between physical activity level and sleep quality, low physical activity levels were associated with increased daytime sleepiness. These findings suggest that the sleep–different determinants across various stages of life shape the activity relationship.

Studies focusing on adolescents highlight the adverse effects of sedentary lifestyle habits on sleep and quality of life. The review by Özsaydı and Güngör (2023) demonstrates that low physical activity levels and impaired sleep quality in adolescents negatively affect not only physical health but also psychosocial functioning and subjective well-being. In this regard, the acquisition of regular physical activity and high-quality sleep habits at an early age is emphasised as being of critical importance for long-term health outcomes.

Overall, the literature suggests that the relationship between sleep, physical activity, and nutrition is not unidirectional or simplistic; rather, it represents a complex and multifaceted process shaped by interactions among age, health status, lifestyle, and environmental factors. Enhancing sleep quality emerges as a key element that supports not only athletic performance and recovery but also psychological well-being and quality of life. Accordingly, approaches that prioritise sleep health, in conjunction with physical activity and nutritional strategies, are considered essential for maintaining sustainable health and quality of life among athletes and individuals across various age groups.

Future research is recommended to investigate the effects of exercise modalities, individual differences, chronotype characteristics, digital lifestyle habits, and environmental factors on the relationship between sleep, exercise, and life satisfaction using experimental and longitudinal study designs. Such holistic approaches are expected to contribute to both the advancement of scientific knowledge and the development of effective, evidence-based intervention strategies.

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