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## Application of the Hooper Index in monitoring training load and player well-being: a theoretical review on performance optimization in soccer

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### Abstract

*Introduction and aim.* The aim of this study was to explore the significance of monitoring training processes using the Hooper Index (HI) and its impact on performance optimization and injury prevention among soccer players.

*Materials and Methods.* A systematic approach was used to identify and review studies focusing on the application of HI in soccer. Databases such as PubMed, ScienceDirect, and Google Scholar were searched using keywords like “soccer,” “training,” “Hooper Index,” and “sports performance.” Studies were selected based on their focus on competitive soccer players and their analysis of HI values in relation to sleep quality, stress, fatigue, and delayed onset muscle soreness. This review provided a foundation for interpreting the role of HI in optimizing training processes.

*Results.* Monitoring the training process is key to optimizing performance and preventing injuries in soccer. The HI is a reliable tool for assessing players’ fatigue, stress, and recovery. Regular monitoring enables dynamic training adjustments, reducing the risk of overload and improving readiness. High HI values negatively affect speed, strength, and endurance, emphasizing the importance of balancing training and recovery. Factors such as fatigue, poor sleep, and muscle soreness are closely linked to injury risk, especially during intense match schedules or intense training periods. Lower training loads before matches enhance performance, while sudden increases in intensity elevate injury risks. HI trends indicate that players well-being is lowest during preparatory phases, with increased stress and slower recovery observed after away games. Adjusting training based on HI ensures readiness and supports sustained performance throughout the season.

*Conclusion.* In conclusion, HI is a practical and accessible tool for effectively managing the training process. It supports players’ physical readiness and well-being while reducing injury risks and enhancing long-term performance outcomes on the field.

**Key words:** *fatigue, Hooper questionnaire, performance optimization, recovery*

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## Introduction

Monitoring the training process and its impact on athletes has become a fundamental responsibility for coaches and sports professionals in recent years (Halson, 2014; Williams et al., 2017). The significance of monitoring psychological and physiological factors, such as stress, fatigue, and recovery, has grown particularly in professional soccer, where the aim is to maximize player performance (Selmi et al., 2020; Selmi et al., 2021). Daily monitoring enables coaches to effectively adjust training loads based on the current state of athletes, thereby enhancing decision-making effectiveness (Haddad et al., 2013). This approach has extended to junior teams, where regular assessments of training intensity and player well-being are becoming increasingly common (Akenhead & Nassis, 2016; Salter et al., 2021). Jones et al. (2016) highlight that athletes face increased risks of injury and illness during critical training periods, especially when training loads intensify or accumulate. Monitoring training load and fatigue markers is therefore essential in team sports to help balance adaptation with minimizing risks.

Positive training adaptations require adherence to core principles such as individualization, progressive load increases, and adequate recovery (Kasper, 2019). Although not all teams have access to advanced technology for monitoring training demands, there are simple and affordable methods, such as the Hooper Index (HI) (Hooper, 1995), which provide valuable information on the psychophysiological state of players (Impellizzeri et al., 2019). Regular monitoring of the HI and gradual increases in training loads enable coaches to improve players' physical capacities, thereby reducing the risk of injuries. Gabbett (2016) emphasizes that appropriate adaptation to higher training loads provides a protective effect against injuries, while sudden increases in load may increase the risk of non-contact injuries.

This article provides a theoretical overview of the influence of the HI on soccer players' physical abilities and performance. It also explores the connection between player well-being monitoring and training process optimization, which can significantly contribute to injury prevention and performance enhancement across various performance levels.

## Materials and Methods

For this theoretical overview, we employed a systematic approach to identify and select relevant studies examining the impact of the HI on athletic performance in soccer. Our goal was to gather literature that offers key insights into how HI, as a tool for assessing players' wellness, influences training processes and sports performance.

**Database Selection:** We utilized PubMed, ScienceDirect, and Google Scholar as primary sources, as these databases contain a rich collection of scientific studies in sports science.

**Selection Criteria:** Included studies specifically investigated soccer players at competitive or professional levels and used HI to monitor aspects such as sleep quality, stress, fatigue, and delayed onset muscle soreness (DOMS). Our focus was on studies detailing the relationship between HI values and player performance or fitness.

**Purpose:** This approach ensured that selected studies were relevant and provided reliable data on the impact of training load on the wellness and performance of soccer players. The goal was to assemble a literature review that supports the theoretical framework of this study, forming a foundation for further insights into optimizing soccer training processes.

The importance of the HI in monitoring training processes and soccer player performance has been confirmed by numerous studies, validating its effectiveness as a tool for tracking players' psychophysiological conditions. This simple yet effective tool enables coaches and sports professionals to adjust training loads based on players' current conditions, which is crucial for achieving optimal performance.

The reliability of the HI was confirmed in a study by Rabbani et al. (2019), which compared the usefulness of HI with heart rate variability (HRV) for tracking recovery in professional soccer players. The study found that HI is more useful than HRV for monitoring post-match fatigue due to its lower error rate and higher sensitivity to changes in players' fatigue levels. This highlights HI as a simple, cost-free, and efficient tool for monitoring fatigue throughout the season.

Additionally, Lourenço et al. (2023) emphasized that objective and subjective fatigue metrics, such as HI and physiological tests, measure different yet complementary aspects of fatigue. To gain a comprehensive view of

players' fatigue status, both approaches are necessary, indicating that while HI is highly effective, it may not capture all aspects of player fatigue and recovery.

The HI is evaluated through rating scales that measure four key factors: sleep quality, stress, fatigue, and delayed onset muscle soreness (DOMS). Each factor is assessed on a scale from 1 to 7, with sleep quality rated from 1 (very good) to 7 (very poor), and the other factors—fatigue, stress, and muscle soreness—rated from 1 (very low) to 7 (very high). HI is calculated by summing these four scores, giving a comprehensive index of the player's overall psychophysiological state (Hooper, 1995).

## **Results**

### ***HI and Performance***

Effective monitoring of training load and adapting it to players' current condition is essential for optimal performance. Oliveira et al. (2024) found that smaller changes in internal and external load throughout the season can be tracked using HI. The reduction in external load the day before a match, while maintaining stable internal load values, highlights the importance of timing adjustments in training routines. Furthermore, the choice of training methods significantly impacts player well-being. Ouertatani et al. (2022) found that small-sided games (SSG) provide similar physiological benefits to high-intensity interval training (HIIT) but with greater enjoyment, supporting both better performance and player well-being.

Studies have shown varying correlations between training load and aspects of well-being such as sleep quality, fatigue, and stress (Duignan et al., 2020; Nobari et al., 2020). Monitoring HI, along with other parameters, can enhance player recovery. High HI values, particularly those related to fatigue and stress, were found by Clemente et al. (2021a) to negatively impact speed, strength, and endurance. Additionally, Selmi et al. (2018) indicate that poor sleep quality and increased muscle soreness can directly affect technical performance during training and matches.

The role of HI in preseason and intensive training periods is especially important. Riansoi et al. (2024) demonstrated that structured training involving small-sided games and stress monitoring during the pre-season optimizes physical and psychological adaptation in young soccer players. Clemente et al. (2017) also reported that internal training load closely correlates with player well-being, with high-intensity weeks showing a marked decline in well-being indicators. Fessi et al. (2016) add that high training loads and monotony in the preseason may lead to decreased focus and slower reaction times, emphasizing the importance of adjusting training according to HI not only for performance optimization but also for injury prevention. Collectively, these findings highlight the critical role of HI in managing both performance and well-being within the training process.

### ***HI and Injury Prevention***

Psychological factors such as fatigue, stress, sleep quality, and muscle soreness significantly affect the risk of injuries in soccer players, underscoring the importance of their careful monitoring. Moalla et al. (2016) confirmed significant correlations between HI (including indicators like fatigue, muscle soreness, sleep quality, and stress) and daily training load (TL), supporting HI as a valuable indicator of players' training readiness. Nobari et al. (2020) also state that high HI values associated with intensive training may increase the risk of injuries, particularly in young soccer players. These findings suggest that HI effectively reflects players' subjective experiences and their ability to handle training loads, allowing coaches to adjust training plans dynamically and prevent overload. Regular HI monitoring therefore plays a key role in injury prevention. Sleep is another critical factor in maintaining performance and reducing injury risk. Clemente et al. (2021b) found that inadequate sleep can significantly impair athletic performance and increase injury risk, highlighting the need for further research in this area. Poor sleep habits can significantly elevate injury risk, making these insights crucial for coaches and medical professionals when planning players' training regimes and recovery processes.

Overall, HI represents a crucial tool not only for injury prevention but also for managing players' return from injury. Regular HI monitoring contributes to players' physical and psychological readiness, potentially enhancing their safety and performance as they return to competitive play.

### ***HI and Seasonal Training Load Monitoring***

Throughout the soccer season, players experience various phases of training load, adjusted according to their current condition and upcoming matches. This dynamic process requires continuous monitoring of both physical and psychological factors to optimize performance and minimize injury risk. The HI has become a crucial tool in this process, as it enables coaches to adapt training plans based on the individual needs and current status of players. The importance of HI is particularly evident in managing training load during the season when players face varying levels of stress, fatigue, and physical load.

Silva et al. (2022) analyzed weekly variations in player well-being and the intensity of training and matches among young soccer players, finding that well-being, as measured by a modified version of HI, fluctuated significantly in response to training loads across the season. The correlation between fatigue and session-rated perceived exertion suggests that training intensity can impact players' subjective sense of well-being. Several studies emphasize the importance of adjusting training load according to the time frame before a match. For example, Douchet et al. (2022) found that shorter training sessions the day before a match resulted in better performance, reflected in lower HI scores and suggesting improved player readiness. Similarly, Oliveira et al. (2020) confirmed that shorter, more intense training sessions before matches yield better outcomes. Another study by Oliveira et al. (2021) demonstrated that training load and HI can vary based on whether the match is home or away, with higher HI values and slower recovery observed after away games.

Sioud et al. (2023) examined the impact of playing one or two games per week on players' subjective perceived exertion (RPE), training load, and well-being. Although players found two games per week more challenging, there were no significant changes in injury rates or well-being, indicating that an increased game frequency does not necessarily impact well-being if managed effectively. Nobari et al. (2021a) observed that fatigue, stress, and HI variability increase towards the end of the season, emphasizing the need to adjust training loads according to seasonal fluctuations. Nobari et al. (2021b) also warned of the increased injury risk associated with higher loads at the season's end if not properly managed. Nobari et al. (2021c) highlighted that players' well-being, particularly regarding stress and sleep quality, can fluctuate significantly throughout the season, with the greatest variations often occurring towards the end, underlining the need for consistent monitoring of players' psychophysiological status. Castilla-López and Romero-Franco (2024) reported that players' well-being is at its lowest during the preseason, with factors such as fatigue, muscle soreness, and stress having the most impact, and that low well-being correlates with an increased injury risk not only in the preseason but throughout the season. The importance of monitoring recovery is also underscored by Pillitteri et al. (2023), who demonstrated that higher training loads can reduce players' recovery, negatively affecting performance and increasing injury risk not only on the day of assessment but also on the following day. Delaval et al. (2022) further noted that post-game fatigue and muscle soreness correlate with a higher injury risk, emphasizing the need for regular monitoring of these factors, particularly during a dense match schedule. Nobari et al. (2023) examined differences in training monotony and load between the first and second halves of the season among young players, finding that monotony was higher in the second half, while chronic load and delayed onset muscle soreness (DOMS) were higher in the first half. Nobari et al. (2022) added that training intensity tends to be higher at the end of the season, which can negatively impact team performance if players' well-being is not considered. These studies highlight the critical need for regular monitoring and adjustment of training load and player well-being throughout the season to optimize performance and reduce injury risk.

Furthermore, Oliveira et al. (2022) emphasize that starting players are exposed to higher training loads, resulting in higher training monotony, stress and a greater acute-to-chronic workload ratio. This finding underscores the importance of adjusting training loads not only based on players' current condition but also according to their positions on the field, reducing the risk of overload and injuries.

## Discussion

Monitoring the training process has become essential for coaches and sports professionals today (Halson, 2014; Williams et al., 2017), especially in professional soccer, where factors like stress, fatigue, and recovery play a crucial role in optimizing player performance (Selmi et al., 2020; Selmi et al., 2021). Daily monitoring enables coaches to adjust training loads effectively based on players' current conditions, which enhances decision-making

and reduces the risk of overload (Haddad et al., 2013). This approach is used not only in professional settings but is increasingly part of training routines in junior teams as well (Akenhead & Nassis, 2016; Salter et al., 2021).

The HI offers a straightforward, cost-effective tool for monitoring players' psychophysiological states (Hooper, 1995; Impellizzeri et al., 2019). HI provides valuable insights for gradual and safe increases in training load, potentially reducing injury risk. Rabbani et al. (2019) confirmed HI's reliability, finding it more sensitive than heart rate variability (HRV) in detecting post-match fatigue, making it particularly effective for monitoring recovery. Lourenço et al. (2023) emphasized that HI and physiological tests measure complementary aspects of fatigue. A comprehensive view requires both approaches, as HI, while effective, cannot capture all facets of fatigue and recovery. Gabbett (2016) adds that gradual adaptation to increased training loads can help protect against injuries, while sudden load increases could elevate the risk of non-contact injuries. Studies further suggest that effectively monitoring HI alongside other indicators can positively influence players' physical performance. Oliveira et al. (2024) found that managing load, including reducing external load the day before a match, contributes to optimal performance. Ouertatani et al. (2022) found that training methods like small-sided games (SSG) provide similar physiological benefits to high-intensity interval training (HIIT) but enhance player well-being through greater enjoyment in training. Clemente et al. (2021a) also observed that high HI values, particularly those related to fatigue and stress, can negatively affect players' speed, strength, and endurance. Moalla et al. (2016) confirmed correlations between HI and training load, highlighting HI as a valuable indicator of players' readiness.

Regular HI monitoring is essential not only for performance optimization but also for injury prevention. These injuries are often more prevalent among younger players after intense training sessions (Nobari et al., 2020) or due to lack of sleep (Clemente et al., 2021b). HI provides a practical overview of players' readiness for training loads, allowing coaches to adapt plans flexibly and avoid overload. For instance, Silva et al. (2022) found that HI values fluctuate considerably over the season according to training and match intensity, highlighting the importance of adjusting load relative to the season. Douchet et al. (2022) observed that shorter training sessions the day before a match lead to improved performance and lower HI values, indicating greater player readiness. Oliveira et al. (2021) reported that HI values are often higher after away games and that recovery is slower, which can increase injury risk. Nobari et al. (2021a) also noted increased variability in fatigue and stress toward the season's end, underscoring the need for dynamic load adjustments to reduce injury risk. Additionally, the study by Castilla-López and Romero-Franco (2024) demonstrated that player well-being is lowest during the preparatory period when factors such as fatigue, muscle soreness, and stress are most pronounced. This low well-being correlates with higher injury risk not only during preparation but also throughout the season. Similarly, Delaval et al. (2022) found that post-match fatigue and muscle soreness are associated with a higher risk of injuries, underscoring the need for regular monitoring of these factors during periods of intense match schedules.

## Conclusions

Monitoring the training process using the HI has proven to be an effective tool not only for optimizing performance but also for preventing injuries in soccer. Studies emphasize that factors such as fatigue, stress, sleep quality, and muscle soreness significantly impact players' readiness to handle training loads and their ability to avoid injuries. The value of HI lies particularly in its simplicity, accessibility, and practicality, allowing it to be widely used across various sports teams, including professional or junior categories.

Research findings confirm that regular HI monitoring, supplemented with additional physiological measurements, provides coaches with a more comprehensive understanding of player status and aids in dynamically adapting the training process throughout the season. Thanks to this flexibility, coaches can more effectively manage training loads, optimize player performance, and reduce injury risk, especially during intense match periods. These findings underscore the importance of systematic monitoring and adaptation of training practices, which could significantly enhance athletic performance and player safety across all competitive levels.

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