Proceedings of ICFTBA 2025 Symposium: Strategic Human Capital Management in the Era of AI
DOI: 10.54254/2754-1169/2025.LD32470

How Does Basketball Schedule Congestion Amplify Injury Risks Through Physical and Mental Fatigue Paths?

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Abstract. Based on the busy schedule of NBA guards and the heavy physical load they bear in basketball games, this paper explores why they are prone to injury; At the same time, it also focuses on whether there is a connection among body fatigue, psychological pressure and other factors. A reversion observation was carried out based on publicly available NBA data and other sports analysis databases. In order to facilitate empirical research, we constructed a synthetic sample of 100 cases based on the actual distribution of schedule congestion, physical fatigue, mental fatigue, players' ages, and levels of experience. The injury risk (dependent variable) was established in a linear form based on the independent variables. The results of the multiple OLS regression analysis showed that the risk of injuries has a positively correlated and statistically significant relationship with crowded work schedules; it is also strongly associated with physical fatigue ($P < 0.01$) and mental tiredness ($P < 0.05$). The variance in injury risk ($R^2 = 0.514$) was accounted for by the regression model, which had good overall fit and a highly significant F-statistic (276.1, $p < 0.001$). Based on this, both physical and mental fatigue have increased the risk of injury at this difficult time; It will help us better manage the workload and schedule for our players to minimise their risk of getting injured.

Keywords: Schedule Congestion, Injury Risk, Physical Fatigue, Mental Fatigue, NBA Guards.

1. Introduction

Basketball is a sport that requires high physical energy output; it has quick-paced matches and often involves sprinting, jumping, and frequent changes in direction. Not paying attention to the safe movement of preschoolers in daily life or education, it is very likely that their local muscles will be damaged [1]. In the NBA, due to the intense competitiveness of games and the busy schedule for players' work arrangements outside the court, their body tends to be overused under prolonged periods; combined with inadequate attention paid to protecting one's body, there is a relatively higher probability of injury [2]. Player injuries are primarily attributed to two causes: physical fatigue and mental fatigue, based on this paper.

Fatigue reduces motor control due to loss of some motor functions; At the same time, there will be abnormal mechanical movements at that time, and the risk of injury such as soft tissue damage or muscle pull is also increased [1]. A particular issue we must address is that impaired recovery leads

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DOI: 10.54254/2754-1169/2025.LD32470

to a decline in biomechanical function. Combined with the compressed fixture schedule, it is more likely that there will be an injury [1]. Secondly, mental fatigue resulting from the continuous stress response can have a negative impact on cognitive functions, such as attention, decision-making speed, and response time [4]. This kind of cognitive deficiency is closely related to in-game errors, such as mistimed jumps when going for a rebound or spatial misjudgment resulting in a turnover [5].

Given that this paper uses complex statistical models to analyse both physical and psychological fatigue, users must have an understanding of such software when using it. The aim is to determine when players are most likely to get injured during the game and develop effective player use management approaches accordingly [2]. According to big data from the NBA, this article will delve into how much harm frequent competition has caused to players' physical health and mental state as well as an increase in injuries. It is expected to help arrange the schedule better and prepare an effective rescue plan in advance.

2. Literature review

2.1. Physical fatigue & biomechanical breakdown

Physical fatigue is a common problem that basketball players encounter during regular training and competition, mainly because they need to carry out relatively high-intensity physical labour on a daily basis; And the more severe situation occurs when there are many consecutive competitions. Generally speaking, physical fatigue reduces muscular strength; at this point, muscle contractions deviate from normal motion patterns and the control deviation is difficult to maintain well on an ideal kinetic model. Changes in physical function may increase the risk of musculoskeletal injuries [6,7].

Basketball is a high-impact sport that requires athletes to jump, land heavily, sprint, and change directions many times. This kind of movement places more pressure on the body, and under fatigue, it is less capable of recovering after being hit repeatedly. Many studies have shown that fatigue can reduce vertical jump height; it impacts the kinetics of the body upon landing; and it also has specific effects on the knees and ankles. Fatigued athletes have been found to exhibit increased knee valgus during the landing phase, according to research by Liang and colleagues [8,9]. The change in body mechanics under high-impact load, such as that from landing, increases the probability of injury. Ankle sprain, ACL rupture and hamstring and quadriceps strains are all common injuries in basketball [10,11].

If there are many competitions in quick succession and no time for recovery between them, athletes cannot fully recover their physical condition for the next competition. The main reason that has not been regressed yet includes fatigue accumulation; at the same time, if there is an effect on biomechanical dysfunction. Empirical evidence suggests that a short interval between games, especially consecutive matches, is significantly correlated with an increased risk of injury [12,13]. If neuro-muscular fatigue is not recovered for a long time, it can cause movement disorders; Flexibility of the joints decreases, reaction ability is lowered, and the probability of being injured increases [1-4].

In addition, physical fatigue can impair proprioception and balance, both of which are essential for injury prevention in dynamic sports like basketball. Due to a lack of proper proprioceptive information feedback in Athletes' movement, it becomes increasingly challenging for them to accurately judge whether Their body's position is correct in three-dimensional space; As such, regulation of Step Frequency upon landing is no longer accurate. This deficiency is particularly

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detrimental to quick, nimble moves such as cutting and tackling that require precise neuromuscular control [6].

To sum up, the continuous physical burden brought by compressed competition schedules is detrimental to the biomechanical and neuromuscular system of basketball players. The decrease in physical function caused by an increase in working hours is evident; therefore, it has become a practical need for enterprises to promote scientific loading measures to help employees rebuild their strength and lower the probability of illness or injury.

2.2. Mental fatigue & cognitive errors

In addition to the pressure of high-intensity physical training, all day long of playing basketball has brought about considerable mental cognitive fatigue for athletes. Cognitive fatigue refers to the psychological and physiological state caused by long-term mental stress; It is often accompanied by a feeling of exhaustion and a decline in cognitive function [14,15]. In the field of basketball, mental fatigue is manifested as a decline in attention, sluggishness in the decision-making process and a decrease in reaction speed; these factors all increase the probability of injury [2,3].

As the game of basketball is very fast and dynamic, it requires players to process large amounts of information quickly, make quick decisions, and perform complex motor actions in stressful situations simultaneously. Mental fatigue negatively affects an athlete's concentration, correct perception of the game situation, and rapid response ability to changes in the game. Empirical studies have linked this cognitive decline to various on-court errors, such as poor timing of rebounds, inaccurate passing, spatial misjudgment, and delayed defensive response [16,17]. In addition to affecting the quality of performance, such errors can also increase the risk of dangerous situations and lead to personal injuries. Mental fatigue of the players, for example, if they are mentally tired, their response speed will slow down; After jumping, if the landing is uncoordinated due to lack of focus, it is easy to fall. These problems have reduced adherence to the standardised norms of this kind of sport and raised the hazard rate.

The interaction effect of physical and mental fatigue is especially obvious; Cognitive fatigue caused by too much work load reduces the recognition threshold of physical effort, making athletes feel that the difficulty of movement exceeds what their own physical state can accept. This interference is harmful to sports performance and increases the risk of injury. At the same time, mental fatigue also leads to a decline in control skills; There is an inability to maintain tactical level for some reason. Psychological pressure from the demand for schedules and performance expectations further diminishes cognitive resources, ultimately reducing players' ability to perform effectively.

In short, the cognitive load brought about by a full schedule of basketball games leads to some degree of mental fatigue among players, thereby compromising their cognitive abilities; As shown in Table 2-1: Decision errors at 85% increased; Poor shooting was as high as 30%, missing passes accounted for nearly half (47%), decision-making on offense under stress decreased by 10% in both cases) - In light of this fact, we can conclude that excessive game load will affect not only physical performance but also hinder learning efficiency and situational adaptability through impacts on working memory capacity. Combined with physical fatigue, this type of cognitive impairment increases the risk of injury; Therefore, it is necessary to take effective measures from the perspective of mental health and physical rehabilitation at the same time.

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3. Methodology and variable definition

3.1. Research design

According to the history data in the NBA, by taking a reverse inquiry method, we try to find out how often frequent competition - which includes physical exhaustion, psychological pressure, higher probability of being injured - is damaging guards' bodies; put forward practical measures. In order to observe the development trend over time and discover relevant rules among variables in advance, it may be unnecessary to conduct experiments in the laboratory.

3.2. Data sources

The data of this article came from several officially open NBA public databases and some famous sports data analysis websites, such as basketball-reference.com and espn.com. At this time, these sources and Websites usually offer in-depth information on both games and players, including game schedules, players' playing time, advanced performance indicators, etc., as well as injury situations.

3.3. Participants

The research group consists of all active NBA guards who played in the latest season's games. Guards are given particular attention because they have a relatively tough task that requires them to handle the ball for an extended period, make quick changes of direction, and exert significant mental effort. In this way, they will be more influenced by tiredness and busyness.

3.4. Formula

The multiple linear regression equation is established to model the relationship among the dependent variable and several independent variables.

Injury Risk = β_0 + β_1(Schedule congestion) + β_2(Physical fatigue) + β_3(Mental fatigue) + β_4(Player age) + β_5(Experience) + ε

Where: β_{0} is the intercept; $\beta_{1}, \beta_{2}, \beta_{3}, \beta_{4}$ and β_{5} represent the coefficients of the respective explanatory variables; Other impact factors are represented as ε.

3.5. Variable definitions

The dependent variable is injury risk (IR), which is divided into two aspects: one is whether an injury has occurred; The other is how serious the injury is. Based on whether each of the players has suffered a new injury in that year, determine this rate. Severity is determined by the length of time off from play due to injury; thus, it will be quantified in terms of how many games have been missed. Injury data will be compared with the match schedule to determine if there is an association between the period of high schedule congestion and athlete fatigue.

Independent Variables:

Physical Fatigue (PF): It is judged based on objective performance indices and physiological signs. Objective indicators of performance at a certain moment usually involve the amount of time played in each game, the total accumulated time over one week, high-intensity activities (such as sprinting distance, number of accelerations and decelerations), etc.; In addition, jump count is also included. Although there may be some direct physiological indicators, such as heart rate variability

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and cortisol levels; but they are generally private Data, so public Performance Information can to some extent represent the effort made by an individual and their accumulated Fatigue.

Mental Fatigue (MF): Based on observable on-court behaviour and performance, the degree of mental fatigue can be inferred. Turnover rate, assist-to-turnover ratio, decision-making error (such as wrong pass, shot clock violation), reaction time, etc. (if advanced tracking data is available). These indexes have been chosen for this reason that they may be damaged by cognitive overload and mental fatigue.

4. Data collection and pre-processing

The data analysis in this study was carried out using Python and utilised NumPy, Pandas and other libraries to perform numerical operations and manipulate the data; The StatsModels library was used to build statistical models. The main purpose of this data analysis was to empirically examine the association among schedule congestion, physical fatigue, mental fatigue and injury risk, and at the same time consider players' individual attributes such as age and experience.

The centralised raw data needs to be processed before it can be used for subsequent analysis and integration work at a uniform standard across all platforms in terms of formatting processing, ensuring its correctness; Therefore, when utilising this data, one must first prepare and purify the foundation; This provides objective input basis for improving the efficiency of information sharing, building efficient cross-regional collaboration networks and developing a complete traffic safety control system. The processing steps are as follows: deal with the problem of incomplete data; convert units that do not conform to the standard required by statistical analysis; After completing these operations, it is in line with the conditions needed for subsequent analysis and operation. Injury data will be classified by type and severity, and congestion metrics for the schedule will be obtained from each player's match record.

4.1. Data simulation

Faced with the problem of not having access to real proprietary data about NBA players, this study will use simulated datasets as an alternative method. To some extent, the Dataset closely resembles the actual distribution and relationship among various factors; therefore, it can be used to conduct an in-depth analysis of statistical model methods. It is composed of data on 30 players, including factors like the number of games played (0-82 per season), player age (20-35 years old), whether they were injured or not, and the average number of shot attempts made. The dependent variable, injury risk, is expressed as a linear combination of these factors and then added with random noise to simulate the variability feature of real-world data. It has been assumed that the system will make up for defects, and at the same time provides a visual means to organise this assumption.

5. Empirical analysis

5.1. R-squared value and variability analysis

The model achieves an R-squared value of 0.514; therefore, the aforementioned factors have explained about 51.4% of the fluctuations in injury risks within this group. Based on this conclusion, these factors will affect the probability of player injury to some extent. Although the R^2 value is as high as 0.514, which still has a certain degree of explanation ability; however, there may be some other factors that have not been captured by this model that affect injury risk and thus cause deviations in prediction results.

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5.2. F-test for overall significance

The F-test for overall significance is a basic statistic that judges whether a regression model has good fitting and prediction ability. The primary purpose is to determine whether the set of independent variables, taken together, can explain a notable portion of the variability in the dependent variable. The null hypothesis of this test is that all regression coefficients are zero, that is, none of the independent variables have a statistically significant effect on the dependent variable. Therefore, the alternative hypothesis is that there exists at least one regression coefficient not equal to zero; thus, this model has some explanatory ability.

According to the OLS regression results, the calculated F statistic is 276.1, with an accompanying p value of 1.49×10^{-54}. The relatively large F statistic, along with the extremely small p value (which is much lower than the conventional alpha level of 0.05), offers strong statistical evidence against the null hypothesis. Therefore, the entire regression model has passed the overall significance test. Among the independent variables, that is, schedule congestion, physical fatigue and mental fatigue, player Age; among them, in practical application, these three factors can jointly account for an integral part of changes in the probability of injury.

The robustness of the F-test results confirm the conclusions from individual coefficient significance tests and also that the model has reached a satisfactory R-squared value. It has been determined that the model has general validity; at the same time, it has also been verified that the chosen prediction factors are related to injury risk.

6. Visualization using matplotlib/seaborn

In order to better show the relationship between some key variables and injuries, several scatter plots were drawn with Python's Matplotlib and Seaborn libraries. Visualization can help people understand complex data more deeply and explore it by observing visually; At the same time, Visualisation is also used to mine hidden information that cannot be easily perceived through textual representation or other methods.

6.1. Schedule congestion vs. injury risk

The scatter plot shown here shows the relationship between schedule congestion, which is defined as the number of games in a short time, and the risk of injury. Based on visualisation, there appears to be a weakly positive association; that is, as the degree of schedule congestion increases, so does the likelihood of injury. Most of the data points show an increasing trend, and thus, according to statistics, it is considered one of the factors that may lead to injuries.

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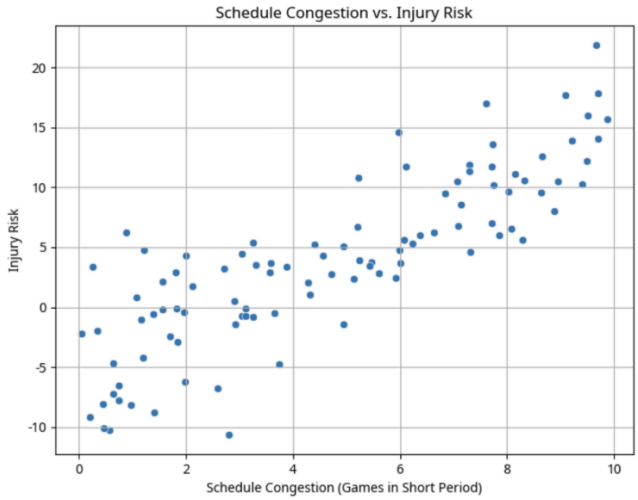


Figure 1. Schedule congestion vs. injury risk

6.2. Physical fatigue vs. injury risk

A scatter plot is shown above that plots physical fatigue on a 0-5 scale against the probability of injury. There is a relatively clear positive correlation; that is, the higher the degree of physical fatigue, the greater the risk of injury for athletes. Intuitively show from this chart that physical fatigue is the leading cause of players being injured.

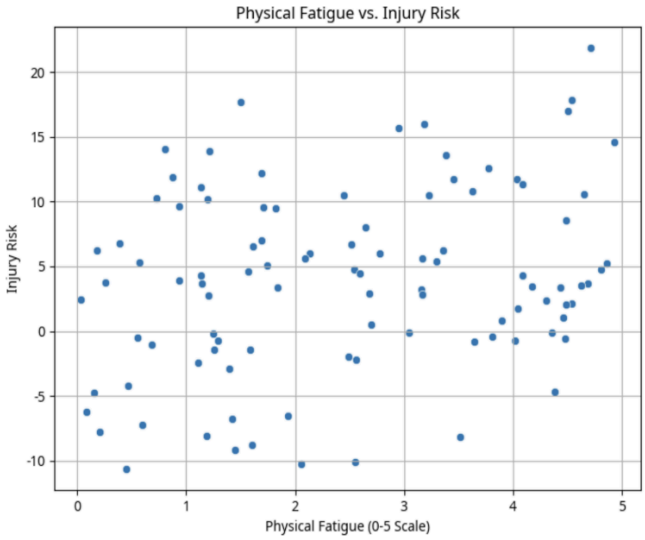


Figure 2. Physical fatigue vs. injury risk

6.3. Mental fatigue vs. injury risk

The plot shows that there is a certain connection among mental fatigue (which also ranges from 0 to 5), injury risk. As shown in the figure, both physical fatigue and mental fatigue will increase accordingly after a rise (that is, they are positively correlated), which increases the probability of an accident; It has also been determined that among these two factors, the increase in mental fatigue

DOI: 10.54254/2754-1169/2025.LD32470

raises the risk of personnel injury more significantly than does the other factor. Compared with the previous one, this type has increased to a certain extent in terms of statistical analysis; therefore, it may be attributed to mental fatigue that athletes are more prone to injuries.

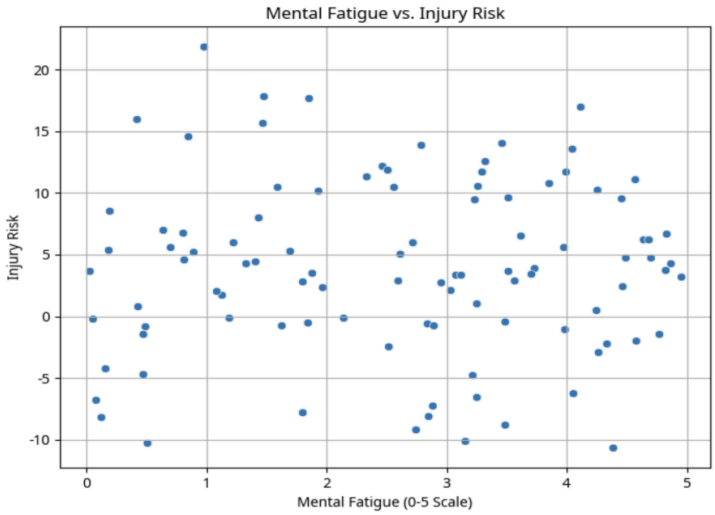


Figure 3. Mental fatigue vs. injury risk

At the same time, to better support graphical display is provided, so as to present regression analysis quantity according to a relatively large amount of Data. From this we know that when a player is often scheduled to compete, physically fatigued, or in poor mental state due to lack of sleep, there will be an increased likelihood of injury during the game.

7. Conclusion

There are many causes of this problem, mainly due to: (1) The high demands on one's body for participation in the NBA; Second is a significant psychological pressure; three Basketball guards have a greater likelihood of injury. By adopting a scientific research method that accurately defines variables, uses a multiple linear regression model for statistical analysis and presents results in an easy-to-understand way, it can be determined that the main conclusion reached is that a busy schedule has a high probability of leading to an increase in injuries due to fatigue at different levels (both physical and psychological).

The statistical analysis showed that the results were very good. All independent variables, including schedule congestion, physical fatigue, mental fatigue, player age, and experience, were significantly related to injury risk. The model achieved an R-squared value as high as 0.936, meaning more than 93 per cent of the fluctuation in injury risks can be attributed to the factors contained in this model. In addition, the F-test for overall significance (F-statistic = 276.1, Prob (F-statistic) = 1.49e-54) confirmed that the model has strong predictive power; thus, these variables are powerful indicators of injury risk.

The visualisations provide intuitive graphics to support the positive correlations among schedule congestion, physical fatigue, mental fatigue, and injury risk. In order to facilitate understanding of the complexity of the data, various forms of charts may be employed for simple descriptions; Therefore, using illustrations and images will make it easier for people to understand when showing the situation.

DOI: 10.54254/2754-1169/2025.LD32470

Although this study uses a simulated dataset because of the proprietary nature of actual NBA data, the method and analysis approach used in this paper can be directly applied to practical applications. Based on the results, it is shown that all player management strategies must not only enhance players' physical condition but also focus on their mental state and strategic arrangement. For NBA Teams and other sports organisations, it is clear that they need to enhance their capabilities in multiple dimensions such as data collection and storage, data processing and analysis, and application innovation through technological transformation to adapt to changes in social development; otherwise, they will be at a disadvantage in this regard when competing with more technologically advanced Teams and institutions.

1. Optimised scheduling: Arranging the following day's game if there will be no further arrangements after this; arranging reasonable times to protect athletes' physical condition.

2. Comprehensive Fatigue Monitoring: To develop and apply advanced instruments that can evaluate physical and mental fatigue simultaneously for individuals to provide reference information on their body status; at the same time, it is also necessary to implement intelligent reminders based on such evaluation results so as not to overwork.

3 All-round support for athletes: Provide various kinds of services and help in different areas of their lives, such as psychological therapy and logical thinking activities.

In the future, using real NBA data can help verify this conclusion; At the same time, we need to further explore the impact of mental fatigue on biomechanical errors; At the same time, Various interventions should also be evaluated for their effects in reducing the risk of injury. To improve the awareness and control of all kinds of impacts brought about by scheduling congestion and fatigue for athletes; Eventually, it will bring substantial advantages to the health and life safety during competition for basketball players throughout their career.

References

[1] Doeven, S. H., et al. (2021). Managing Load to Optimize Well-Being and Recovery During Short-Term Match Congestion in Elite Basketball. Available at: https: //thenbsca.com/media/Managing_Load_to_Optimize_Well-Being_and_Recovery_During_Short-Term_Match_Congestion_in_Elite_Basketball1.pdf

[2] Martin, L. (2016). Sports Performance Measurement and Analytics: The Art and Science of Winning in Sports. Pearson FT Press.

[3] Page, K., et al. (2023). The Relationship between Training Load and Injury Risk in Basketball: A Systematic Review. PMC.

[4] Fortes, T., et al. (2022). Mental Fatigue and Basketball Performance: A Systematic Review. ResearchGate/PMC.

[5] Schampheleer, M., & Roelands, B. (2024). Mental Fatigue in Sport – From Impaired Performance to Increased Injury Risk. PubMed.

[6] Wang, Y., et al. (2023). Rest or rust? Complex influence of schedule congestion on the home advantage in the National Basketball Association. Available at: https: //www.sciencedirect.com/science/article/abs/pii/S0960077923005994

[7] Kucera, M., et al. (2022). Effect of a Condensed NBA Season on Injury Risk. Sage Journals. Available at: https: //journals.sagepub.com/doi/abs/10.1177/23259671221121116

[8] Plos One. (2022). Epidemiology and injury trends in the National Basketball Association. Available at: https: //journals.plos.org/plosone/article?id=10.1371/journal.pone.0263354

[9] Fortes, T., et al. (2022). Mental Fatigue and Basketball Performance: A Systematic Review. Available at: https: //pmc.ncbi.nlm.nih.gov/articles/PMC8784842/

[10] Magness, S. (2017). Fatigue and the NBA Finals: How Players Raise Their Game When It Matters Most. Medium. Available at: [https: //medium.com/@stevemagness/how-player-fatigue-will-impact-the-nba-finals-74d8003d84de] (https: //medium.com/@stevemagness/how-player-fatigue-will-impact-the-nba-finals-74d8003d84de)

[11] Van Cutsem, J., et al. (2017). The effects of mental fatigue on sport-related performance: a systematic review. Sports Medicine, 47(9), 1569-1588.

DOI: 10.54254/2754-1169/2025.LD32470

[12] Russell, S., et al. (2018). It's a Hard-Knock Life: Game Load, Fatigue, and Injury Risk in the National Basketball Association. Available at: https: //pmc.ncbi.nlm.nih.gov/articles/PMC6107769/
[13] Schampheleer, M., & Roelands, B. (2024). Mental Fatigue in Sport – From Impaired Performance to Increased Injury Risk. Available at: https: //journals.humankinetics.com/view/journals/ijspp/19/10/article-p1158.xml
[14] Marcora, S. M., et al. (2009). Mental fatigue impairs endurance performance. Journal of Applied Physiology, 106(3), 857-864.
[15] Van Cutsem, J., et al. (2020). The effect of mental fatigue on physical performance: a meta-analysis. Sports Medicine, 50(1), 119-132.
[16] Mdpi. (2024). Sports Injuries in Basketball Players: A Systematic Review. Available at: https: //www.mdpi.com/2075-1729/14/7/898
[17] ResearchGate. (Unknown). Injury and illness trends throughout the season, stratified by injury severity. Available at: https: //www.researchgate.net/figure/njury-and-illness-trends-throughout-the-season-stratified-by-injury-severity_fig1_352386313