

Injury prevention and performance in basketball officiating: perceptions, practices, and challenges in physical preparation

Prevenção de lesões e desempenho na arbitragem do basquete: percepções, práticas e desafios na preparação física

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Abstract – Basketball referees face challenges in physical preparation, particularly in injury prevention and performance optimization. This study mapped the perceptions, practices, and difficulties faced by these professionals, considering age differences, experience, and adopted strategies. The results indicate that younger referees engage in higher-intensity training, while more experienced ones prioritize maintaining conditioning. Game overload, insufficient recovery, and the lack of specialized support increase vulnerability to musculoskeletal injuries, compromising career longevity in refereeing. Adherence to preventive programs varies, with a lack of standardization in the strategies used. Therefore, implementing a systematic support system, including continuing education, physiotherapy monitoring, and periodization strategies, is essential to mitigate risks and ensure greater sustainability in refereeing careers.

Key words: Athletic injuries; Basketball; Post exercise recovery; Strength training.

Resumo – Os árbitros de basquete enfrentam desafios na preparação física, especialmente na prevenção de lesões e na otimização do desempenho. Este estudo mapeou as percepções, práticas e dificuldades enfrentadas por esses profissionais, considerando diferenças etárias, experiência e estratégias adotadas. Os resultados indicam que árbitros mais jovens realizam treinamentos de maior intensidade, enquanto os mais experientes priorizam a manutenção do condicionamento. A sobrecarga de jogos, a recuperação insuficiente e a ausência de suporte especializado aumentam a vulnerabilidade a lesões musculoesqueléticas, comprometendo a longevidade na arbitragem. A adesão a programas preventivos varia, com falta de padronização nas estratégias utilizadas. Diante disso, a implementação de um suporte sistemático, incluindo educação continuada, acompanhamento fisioterápico e estratégias de periodização, é fundamental para mitigar riscos e garantir maior sustentabilidade à carreira dos árbitros.

Palavras-chave: Lesões esportivas; Basquetebol; Recuperação pós-exercício; Treinamento de força.

INTRODUCTION

Basketball is one of the most widely played sports in the world, with over 450 million people engaged globally¹. Beyond its sporting significance, basketball

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Received: March 21, 2025

Accepted: September 09, 2025

How to cite this article

Inchauspe RM, Vaqueira A, Almeida FR, Andreoli CV, Teixeira C. Injury prevention and performance in basketball officiating: perceptions, practices, and challenges in physical preparation. Rev Bras Cineantropom Desempenho Hum 2025, 27:e105844. DOI: <https://doi.org/10.1590/1980-0037.2025v27e105844>

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Scientific Editor:

Diego Augusto Santos Silva

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drives a billion-dollar industry focused on sports technology, performance science, and sports medicine. Maintaining a high level of competitiveness requires a network of highly qualified professionals, including coaches, physiotherapists, physicians, and strength and conditioning coaches. However, referees, despite being essential for the conduct of matches, are not frequently the subject of studies on physical preparation and injury prevention, especially when compared to athletes.

Elite basketball refereeing requires high physical intensity, with referees achieving up to 90.5% of maximum heart rate, especially in the first quarter of games². The biomechanical and psychological demands of basketball officiating, which include high physical intensity and complex decision-making, lead to fatigue. This fatigue, in turn, increases the risk of injuries and compromises the referees' performance, especially when it interferes with decision-making³. Furthermore, unlike athletes, who undergo structured training and recovery cycles, referees often balance their officiating duties with other professional activities, making it challenging to maintain adequate physical conditioning.

This study aims to map the perceptions, practices, and challenges in the physical preparation of basketball referees, with a focus on injury prevention strategies and performance optimization. It also seeks to investigate the perceptions of this group based on their diversity, as the participants in this research include individuals with over 25 years of officiating experience, alongside those who are just beginning their careers. In this context, the study aims to assess potential differences in the perception of physical preparation and injury prevention, influenced by age and officiating experience, in order to understand how these variables affect the strategies adopted to maintain physical performance. By analyzing these practices and challenges, the goal is to understand the strategies for developing specific training and recovery programs for referees, recognizing their unique characteristics while promoting longevity in their role and ensuring higher quality in officiating.

METHOD

This study is characterized as a descriptive and cross-sectional research, with both quantitative and qualitative approaches. The research was conducted through the application of a structured questionnaire, collecting data on sociodemographic profile (age, years of officiating experience, number of games officiated per season, and competition level), injury history (injuries sustained in recent years), training routines, perceptions, and recovery strategies used by referees (frequency and type of exercises practiced, perceptions of risk factors). The questionnaires were made available online, through a digital platform, ensuring greater accessibility for participants and facilitating data tabulation. This research was approved by the Research Ethics Committee of the *Universidade Federal de Ciências da Saúde de Porto Alegre* (UFCSPA) under protocol number (CAAE: 82991324.9.0000.5345), following the ethical guidelines established by Resolution No. 466/2012 of the National Health Council, which regulates research involving human beings in Brazil. All referees were informed about the research objectives and signed an Informed Consent Form (ICF). The study sample consisted of 36 basketball referees, active at different competitive levels, including national and state leagues.

The inclusion criteria were: (i) being a federated referee, (ii) having a minimum of three years of experience in the role, and (iii) regularly officiating in official competitions over the last two years. Data analysis was performed using SPSS software (version 26.0). The referees were divided into two groups: Group A (referees up to 39 years old) and Group B (referees aged 40 years or older). Initially, training practices and frequencies were investigated for each group, observing differences in physical preparation approaches. Subsequently, to understand the risk factors and injuries, perceptions regarding referees' injury experiences, prevention strategies, and what they considered risk factors for injury were collected. The quantitative analysis used descriptive statistics to characterize the sample, while perceptions were analyzed qualitatively. A one-way ANOVA test was applied to compare training practices between the groups, and the Chi-square test was used to explore associations between categorical variables, such as experience and injury history. The significance level adopted was $p < 0.05$.

RESULTS

The profile of the referees surveyed revealed diversity in terms of age and experience, leading to segmentation into two groups to assess differences in training practices and perceptions regarding injury prevention. Group A consisted of 17 referees aged up to 39 years, while Group B included 19 referees aged 40 years or older.

In Group A, the average years of experience in officiating was 7.88 years, with an average of 3.24 seasons in the NBB. The standard deviation of 2.91 and the range of 8 indicated high variability among the referees. In Group B, the average years of experience was 20.79 years, with 9.16 seasons in the NBB, with the median being 10 seasons and the most frequent value 12 seasons. This group showed a higher concentration of referees with extensive experience in the competition (Figure 1).

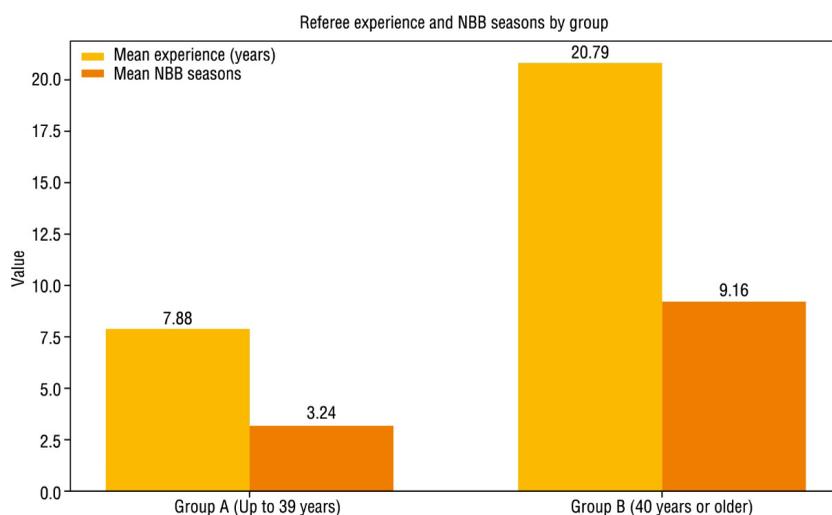


Figure 1. Profile and Experience of Referees Surveyed in the NBB, Segmented by Age Groups.

Regarding training strategies, differences in the frequency and type of training sessions were identified. In Group A, running varied between two and four weekly sessions, while in Group B, the frequency was three or more weekly sessions. Sprint training was more common in Group A (Figure 2).

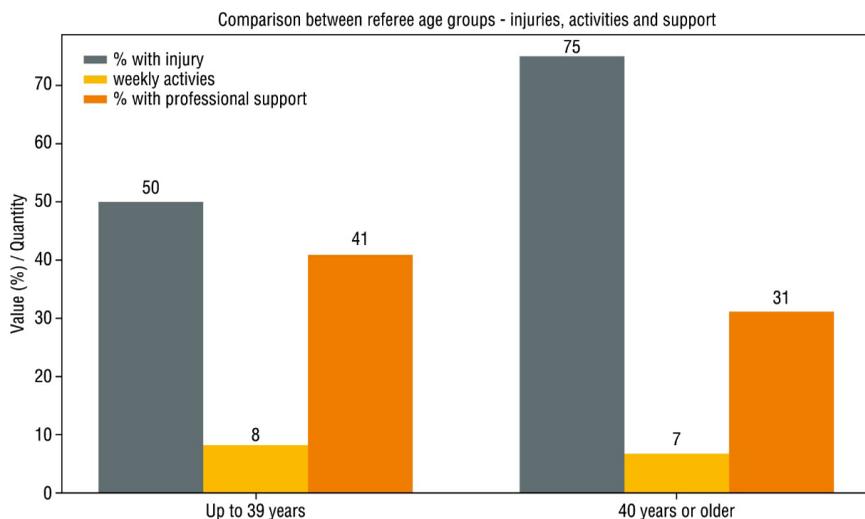


Figure 2. Differences in Training Strategies Between Referee Age Groups.

Functional training was more widely adopted in Group A, while weight training was commonly practiced in both groups, but with higher frequency in Group B. CrossFit and circuit training were less frequent in the overall sample but more common in Group A. Pilates had the lowest adherence among all referees (Table 1). The referees’ perceptions about injuries were also investigated, identifying risk factors, challenges faced in prevention and recovery, and their experiences with injuries during the current and previous seasons. Aspects related to physical preparation and the impacts of the high workload of games were analyzed.

Table 1. Adherence to Training Modalities by Referee Age Group

Training Modality	Group A	Group B	General Observation
	(Up to 39 years)	(40 years or older)	
Functional Training	Higher adherence	Lower adherence (implied)	–
Weight Training	Common practice	Common practice, higher frequency	Practiced by both groups
CrossFit / Circuit Training	More common	Less common (implied)	Less frequent in the overall sample
Pilates	Low adherence	Low adherence	Lowest adherence among all referees

The responses indicated that the main risk factors, according to the referees’ perceptions, include workload overload, lack of proper injury prevention guidance, and difficulties in muscle recovery due to the intensity of the competitions. Many referees, who also engage in other professional activities such as long hours of driving, mentioned that these extrinsic tasks either aggravate or cause injuries, regardless of their training. Additionally, inadequate volume and intensity of training, especially during periods of intense competition, were also cited as risk factors. The high volume of games and the difficulty in balancing rest and training were other recurring points. Referees reported officiating multiple games in the same day, which hinders physical recovery. Perceptions of the importance of continuous physical preparation varied: some referees highlighted the need to maintain physical conditioning to prevent injuries, while others reported neglecting preventive measures when injuries were infrequent. Moreover, poor nutrition and lack of time for rest during travel were identified as critical issues

for recovery and physical performance. A mindset was also observed among some referees of training only to pass the required physical tests, without considering long-term health maintenance throughout the season (Figure 3).

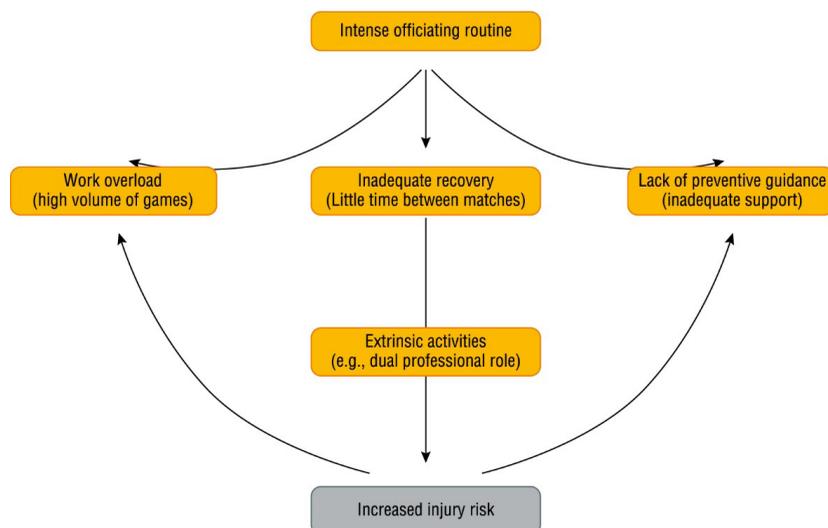


Figure 3. Contributing Factors to injury risk in referees' perceptions.

DISCUSSION

The analysis indicates that Group B consists of referees with more years of experience in the league, suggesting greater career stability and consolidation. This experience may contribute to more effective strategies in managing the game and interacting with players and coaches. In contrast, Group A shows a predominance of referees with less time in the NBB. The difference in professional stability reinforces the hypothesis that longevity in officiating depends not only on technical skill but also on physical and psychological adaptation. This distinction may indicate a generational variation in perception, preparation, and performance.

Referees in Group A, being younger, tend to have better aerobic capacity, which favors their adaptation to the volume and intensity of training⁴. In contrast, in Group B, the increased frequency of training may serve as a strategy to mitigate the progressive loss of aerobic capacity associated with aging⁵.

The findings from this analysis indicate that, although all referees share the common goal of maintaining an adequate level of physical conditioning to perform their duties, the training strategies adopted vary significantly between the groups, reflecting differences in career stages and specific physiological needs of each age group.

Group A, composed of younger referees, seems to prioritize a diversification of stimuli and emphasis on high-intensity training, such as sprints. These workouts, focused on muscle explosiveness and speed, indicate an effort to optimize immediate athletic performance, aligning with the physiological capacities typical of this age range.

In contrast, Group B, formed by older referees, appears to adopt a more focused approach on preserving and maintaining physical conditioning over time. The higher frequency of continuous running sessions and strength training in this

group can be seen as a strategy to combat the progressive loss of aerobic and muscular capacity associated with aging. In this sense, the training choices of Group B seem to reflect an adaptation to the physiological demands imposed by age, where consistency and the preservation of long-term physical capacities are valued more than striving for high peaks of performance.

These distinctions in training approaches between the groups illustrate the adaptive strategies that referees of different ages adopt to optimize their performance and minimize the risk of injury. Group A's preference for more dynamic, speed-focused training contrasts with Group B's emphasis on endurance and functional maintenance, suggesting a search for solutions that not only adjust to the physical challenges posed by refereeing but also to the limitations and potentialities associated with age groups.

Thus, the data reinforce the idea that referee training practices are strongly modulated by age, with each group adopting specific approaches to maximize performance within their physiological conditions and recovery capabilities.

The qualitative responses from referees reveal challenges in injury prevention, physical preparation, and recovery. Workload overload, both on and off the court, was one of the main points raised, especially among those balancing other professional activities, such as long-distance driving as app drivers. This highlights the need to consider not only training and games but the total load of daily activities, including inadequate sleep patterns. The biomechanics of movement and the improper dosage of training volume and intensity were also identified as risk factors for injuries, emphasizing the importance of periodization.

Another challenge reported was the difficulty in balancing training and recovery during intense competition periods, with referees officiating multiple games in the same day, compromising muscle recovery. The literature suggests that overload and fatigue may increase the predisposition to musculoskeletal injuries, making it essential to monitor and balance the workload⁶.

The maintenance of physical conditioning was widely recognized as essential to prevent injuries, but some referees reported that the absence of frequent injuries creates a false sense of security, leading to neglect of preventive care⁷. The lack of ongoing education programs and specific training makes it difficult to adopt effective measures. Additionally, inadequate nutrition and reduced rest time, especially during travel and game weekends, were mentioned as critical factors for muscle recovery and performance⁸.

Finally, some referees criticized colleagues who train only to pass the mandatory fitness test, without concern for maintaining health throughout the season. While some view training as essential for professional longevity, others see it as a circumstantial requirement. These multifactorial challenges — high game load, lack of guidance, and ineffective recovery strategies — emphasize the need for specific prevention and recovery programs to ensure performance and longevity in refereeing.

CONCLUSION

The results of this study show that basketball referees face considerable challenges in injury prevention, which are closely linked to the high volume of games, insufficient recovery, and the lack of individualized and specialized monitoring. For younger referees, the main challenge lies in balancing the volume of games with adequate recovery, as they have greater physical endurance but face pressure to maintain a high level of performance in all competitions.

On the other hand, more experienced referees, although they have a considerable body of knowledge and practice, report a higher incidence of previous injuries and physical overload resulting from the lack of renewal in the refereeing pool, which increases the difficulty of sustaining performance throughout the seasons.

Adherence to training and injury prevention programs varies significantly between the two groups, with differences in the frequency and type of training performed. Additionally, there is a discrepancy in the perceptions of injury risks and in the recovery strategies adopted. The absence of systematic and continuous support from the institutions responsible for refereeing limits the implementation of effective strategies to mitigate accumulated fatigue and reduce the susceptibility to musculoskeletal injuries, which are key factors for the health and longevity of referees' careers. Without proper support, the ideal conditions for recovery and injury prevention are not met, compromising referees' continuity and performance.

In light of this scenario, the adoption of a structured and personalized prevention and recovery program becomes essential to optimize the longevity of referees' careers. Implementing ongoing training focused not only on technical aspects but also on health education, recovery, and rehabilitation can help minimize the impacts of physical overload. Additionally, periodization strategies and systematic medical and physiotherapy monitoring are crucial to ensure that referees maintain high performance without compromising their health.

Thus, it is recommended that the Brazilian Basketball Confederation (CBB)⁹ and the organizations responsible for the training and management of referees expand the support offered to referees, promoting initiatives that not only meet the physical and technical demands of the profession but also ensure the sustainability of referees' performance throughout the seasons. These strategies should include individualized training programs, support for physical and mental recovery, and a holistic approach to referees' well-being, ensuring that they can perform their duties efficiently and healthily throughout their careers.

COMPLIANCE WITH ETHICAL STANDARDS

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This study was funded by the authors

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Universidade Federal de Ciências da Saúde de Porto Alegre

(UFCSPA) and the protocol (no. 82991324.9.0000.5345) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: RMI; AV; CT; CVA; FRA. Performed the experiments: RMI; CT; CVA; FRA. Analyzed the data: RMI; CT. Contributed reagents/materials/analysis tools: RMI; CT; CVA; FRA. Wrote the paper: RMI; AV. Final Approval of the Version for Publication: AV.

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