

# **ORIGINAL SCIENTIFIC PAPER**

# Prevalence and Correlates of Injury Occurrence in Basketball Referees: Preliminary Retrospective Study

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# Abstract

Studies dealing with injury occurrence in basketball refereeing are scarce. The aim of this preliminary investigation was to retrospectively observe injury occurrence and analyze some specific predictors of injury in high-level basketball referees. The participants were basketball referees from Croatia and Bosnia and Herzegovina (all males, n=39, 25–45 years of age, with more than 5 years of experience in basketball refereeing). Data were collected via structured, previously validated questionnaire, and the variables included specific sociodemographic factors, basketball refereeing factors, and medical (injury-related) factors. Differences between injured and noninjured referees were calculated via t tests and chi-square tests, whereas associations between predictors and injury occurrence (criterion) were evaluated via logistic regression for binarized criterion. Injury occurrence was relatively low, with only 15% of referees reporting an injury during the previous competitive season. A higher level of basketball refereeing (more advanced competitive level) was associated with a greater likelihood of being injured (OR=1.44, 95% CI: 1.02–1.98). Additionally, referees who used dietary supplements were more likely to be injured during the previous competitive season (OR=1.51, 95% CI: 1.01–2.05). Although preliminary, the results emphasize the need for structured prevention strategies and support systems tailored specifically to the challenges of high-level officiating.

Keywords: risk factors, protective factors, logistic regression, anatomical locations

## Introduction

Basketball is a dynamic and fast-paced sport that demands high levels of physical fitness, technical skill, and mental alertness from its participants (Fox, Stanton, & Scanlan, 2018; Iglesias-Torres, Gonzalez-Artetxe, Scanlan, & Arcos, 2024). Played and followed worldwide, it involves quick transitions, constant movement, and close player interactions, making it one of the most intense team sports (Selmanovic, Jeličić, & Dizdar, 2023). Within this high-energy environment, referees play a central role in managing the game flow and upholding the rules (Pojskic, Uzicanin, Suarez-Iglesias, & Vaquera, 2024; Ruiz, Albaladejo-Garcia, Reina, & Moreno, 2024). Their presence ensures fairness, discipline, and consistency, all of which are crucial to the integrity of the sport. Referees must make rapid decisions under pressure, often in challenging or emotionally charged situations, requiring a deep understanding of the game and strong focus (Leicht, 2008). In elite basketball, where the speed and skill level of play are extremely high, the demands placed on referees are particularly intense (Leicht, Connor, Conduit, Vaquera, & Gomez, 2021). They must maintain a clear view of the action, stay physically close to the play, and communicate effectively with players, coaches, and officials. As the game evolves with new tactics and technologies, so too does the role of the referee—who must continually adapt, learn, and perform at a professional level. The contribution of referees is therefore vital not only for rule enforcement but also for shaping the overall experience and fairness of the game.



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The health status of referees is a crucial factor in the quality and consistency of officiating across various team sports (Gabrilo, Ostojic, Idrizovic, Novosel, & Sekulic, 2013; Lima, Devran, Oz, Webb, & Bayraktar, 2023). In football, handball, volleyball, or basketball, referees are required to maintain high levels of physical and mental readiness to meet the demands of competitive play. Their role involves continuous movement, sustained attention, and split-second decision-making, often under pressure from both players and spectators. In basketball, for example, referees must closely follow fast-paced transitions, monitor multiple player interactions simultaneously, and position themselves optimally to observe infractions-all of which require cardiovascular endurance, agility, and concentration (Leicht, 2008; Pojskic et al., 2024). Similar physical demands are evident in sports, such as soccer, where referees may cover up to 10 kilometers in a single match (Gabrilo et al., 2013). Maintaining optimal health enables referees to perform consistently, avoid fatigue-induced errors, and manage the psychological stress of officiating high-stakes games. Moreover, a referee's physical condition can directly influence their authority in the field and credibility among players and coaches (Garcia-Santos, Pino-Ortega, Garcia-Rubio, Vaquera, & Ibanez, 2019). As sports become more professionalized and physically demanding, the expectation for referees to be in peak health has increased accordingly. Ensuring their well-being is not only beneficial for individual officials but also vital for the integrity and fairness of the sports they oversee.

Although referees are often perceived as neutral observers, their role in modern sports demands considerable physical involvement, exposing them to a range of injury risks (Corrigan, O'Keeffe, Whyte, & O'Connor, 2023; Kordi, Chitsaz, Rostami, Mostafavi, & Ghadimi, 2013; O'Connor, Sherlock, Moran, & Whyte, 2022). Like athletes, referees must remain in motion for most games, often sprinting, changing direction rapidly, and maintaining high alertness throughout. In sports such as soccer and basketball, the physical intensity of officiating is particularly high because of the pace of play and the need for continuous positioning. These demands increase the risk of overuse injuries, muscle strains, joint stress, and even acute trauma. Basketball referees, in particular, experience high levels of repetitive lower-limb impact due to frequent running on hardwood surfaces and quick directional changes. Studies across various team sports have reported that referees are prone to musculoskeletal injuries similar to those of players, although their risk profiles may vary on the basis of age, match frequency, and physical preparedness (Gabrilo et al., 2013; Heyn & Fleckenstein, 2021). The cumulative load from frequent officiating without adequate recovery or conditioning can heighten vulnerability to both chronic and acute injuries. Furthermore, unlike professional athletes, referees may not always have access to structured fitness programs, medical support, or rehabilitation, which can delay recovery or increase recurrence (Gabrilo et al., 2013). Recognizing these risks is essential for developing effective prevention and management strategies tailored to the specific demands faced by referees in each sport.

Referees in team sports are susceptible to a variety of musculoskeletal injuries, most commonly affecting the lower extremities. In basketball, ankle sprains, calf strains, and patellar tendinopathy are frequently reported due to constant sprinting, pivoting, and sudden stops on hard indoor surfaces (Paula, Cunha, & Andreoli, 2021). Similarly, soccer referees often experience hamstring pulls, Achilles tendon injuries, and groin strains resulting from long-distance running and abrupt directional changes (Gabrilo et al., 2013). Overuse injuries such as plantar fasciitis and iliotibial band syndrome are also common, especially in referees who officiate multiple games per week without adequate rest. Lumbar spine discomfort and lower back pain are prevalent across sports because of prolonged standing, twisting motions, and a lack of core stability. Upper body injuries, although less frequent, can occur from falls or collisions, particularly in crowded court situations. Chronic joint stress and degenerative conditions such as osteoarthritis may also develop over time, especially in older referees or those with poor biomechanics. These injuries can significantly affect performance, lead to match absences, and, in some cases, cause early retirement from officiating duties (Paula et al., 2021).

Despite the physical and mental demands placed on referees in team sports, the scientific literature on injury occurrence and associated risk factors in this population remains relatively limited-particularly in the context of basketball (Paula et al., 2021). While numerous studies have explored injuries in athletes, referees are often overlooked as active participants who are equally vulnerable to physical strain and musculoskeletal issues. Most available research focuses on soccer referees, with an evident lack of studies addressing injury profiles, mechanisms, or predictive factors in basketball officiating. This gap is particularly concerning given the unique biomechanical and environmental demands of refereeing in basketball, such as officiating hard court surfaces and managing fast-paced transitions. Without targeted data, the development of effective prevention and intervention strategies remains challenging. Therefore, the aim of this study was to analyze the occurrence of injuries among basketball referees and to identify specific factors that may be associated with an increased risk of injury. The findings can contribute to better health management, training protocols, and support systems for referees, similar to those developed for athletes in various sports (Al Attar et al. 2022).

### **Materials and methods**

The participants in this study were basketball referees from Croatia and Bosnia and Herzegovina (all males, n=39, 25-45 years of age). All the participants had been involved in basketball refereeing for more than five years and were engaged in refereeing basketball competitions at the highest national level, while the majority were involved in refereeing international games (including top-level European competitions). They were invited to participate in the study by individual contacts and were informed that their participation was voluntary and anonymous and that no personal information would be asked. The study was initially approved by the Ethical Committee of the corresponding author's institution.

Data were collected via a structured, previously validated questionnaire (Zaletel et al., 2017). For this study, the variables included specific sociodemographic factors, reference factors, and medical factors. The sociodemographic variables observed in the study included participants' age (in years), educational level (elementary school, high school, college/ university level), and marital status (single, partnership/marriage). The specific refereeing factors included experience in basketball refereeing (5–7 years, 8–10 years, 11–15 years, >15 years) and basketball refereeing level (national competitions, international–regional competitions, international–European competitions). consumption of dietary supplements (no, from time to time, irregularly, regularly), usage of pain killers (no, from time to time, regularly), injury occurrence over the last competitive season (No, I did not experience any injury; Yes, once; Yes, I suffered multiple injuries over the last season), and location of the injury (participants were provided with an image of the human body, and they highlighted the body location where they suffered the injury over the last competitive season; please see Results for presentation). For the purpose of the later statistical analyses, injury occurrence was additionally dichotomized and participants were grouped into "Injured" and "Noninjured", accordingly.

Statistical analyses included calculations of the means and standard deviations (for age), whereas frequencies and percentages were reported for the remaining variables due to their nonparametric nature. Differences in study variables on the basis of injury occurrence were evaluated via the chi-square test ( $\chi$ 2) and independent samples t test (for age). The associations between the study variables and injury occurrence were established via logistic regression analysis for dichotomized criteria (injured vs. noninjured), with odds ratios (OR) and 95% confidence intervals (95% CI) reported.

Statistica ver. 14.1 (Cloud Software Group Inc., Palo Alto, USA) was used for all calculations, and a p-level of 95% was applied.

## Results

No significant difference in age was detected between injured and noninjured referees (t test =0.34, p>0.05). The number of reported injuries and the locations of the injuries are presented in Figure 1. The participants reported six injuries during the last competitive season, which resulted in 15% injured referees. Calves were the most commonly injured location (with one reoccurrence of the injury for this body location), followed by groins (one in total, one reoccurrence), hamstrings (one injury in total), and shoulders (one injury in total).



FIGURE 1. Injured body locations and number of reported injuries (the number in parentheses represents multiple injuries to the same body location)

Descriptive statistics and differences in the study variables between injured and noninjured referees are presented in Table 1. In general, no significant differences between groups in terms of injury occurrence were detected for the study variables. However, it must be noted that the analysis of differences was not performed because null frequencies for three of the six observed variables

Table 1. Descriptive statistics (F – frequency, % - percentage) and differences in	i study variables between injured and
noninjured basketball referees calculated by Chi square test ( $\chi^2$ )	

	Non injured		Injured		χ² test	
	F	%	F	%	X²	p-level
Educational level *						
High school	18	54.55	2	33.33		
College/University level	15	45.45	4	66.67	0.91	0.33
Marital status						
Married/Partnership	13	39.39	3	50.00		
Single	20	60.61	3	50.00	0.23	0.62
Experience in refereeing						
5-7 years	3	9.09	0	0.00		
8-10 years	7	21.21	2	33.33		
11-15 years	11	33.33	2	33.33		
>15 years	12	36.36	2	33.33	NA	NA

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**Table 1.** Descriptive statistics (F – frequency, % - percentage) and differences in study variables between injured and noninjured basketball referees calculated by Chi square test ( $\chi^2$ )

	Non injured		Injured		χ² test	
	F	%	F	%	X²	p-level
Refereeing level						
National competitions	10	30.30	0	0.00		
International - regional competitions	14	42.42	1	16.67		
International - European competitions	9	27.27	5	83.33	NA	NA
Usage of the pain killers	10	30.30	1	16.67		
No	18	54.55	5	83.33		
From time to time	5	15.15	1	16.67		
Regularly	10	30.30	1	16.67	0.87	0.66
Dietary supplementation						
No	8	24.24	0	0.00		
From time to time (sporadically)	5	15.15	0	0.00		
Irregularly	11	33.33	1	16.67		
Regularly	9	27.27	5	83.33	NA	NA

Legend: \* - none of the participants reported elementary school level, NA –  $\chi^2$  test was not applicable due to null frequencies

The results of the logistic regressions for the binarized injury-occurrence criterion are presented in Table 2. Two of the six predictors were significantly associated with the criterion. Specifically, a more advanced refereeing level was associated with a greater likelihood of being injured (OR=1.44, 95% CI: 1.02--1.98). Additionally, referees who used dietary supplements were more likely to be injured during the previous competitive season (OR=1.51, 95% CI: 1.01-2.05).

**Table 2.** Analysis of the associations between study variables and injury occurrence in basketball referees calculated by logistic regression

	Odds Ratio	95% Confidence Interval
Educational level	0.98	0.57-1.61
Marital status	0.99	0.46-1.61
Experience in refereeing	1.06	0.38-1.91
Refereeing level	1.44	1.02-1.98
Usage of the pain killers	1.03	0.22-1.95
Dietary supplementation	1.51	1.01-2.05

# Discussion

This study aimed to retrospectively evaluate the prevalence and correlates of injury occurrence in basketball referees, with the following results. Fewer than 15% of the tested participants reported injury occurrence during the last competitive season. A greater risk for injury occurrence was associated with an advanced level of refereeing. Referees who were injured were more likely to consume dietary supplements.

The finding that fewer than 15% of basketball referees reported an injury in the past year suggests a relatively low rate of injury occurrence compared with some other sports professions and previous reports from basketball (Gabrilo et al., 2013; Paula et al., 2021). There are several explanations for such findings. First, this may reflect effective self-management strategies and appropriate physical conditioning of the basketball referees studied herein. Specifically, this study was conducted in two countries with long tradition in basketball and where basketball is one of the most popular sports. As a result, basketball referees' physical demands are well known, referees are specifically trained, and their specific conditioning status is

monitored. Additionally, it is probable that referees, especially those with more experience, have developed efficient movement patterns that reduce unnecessary strain and minimize risk. However, underreporting cannot be ruled out, as some referees may not perceive certain injuries as severe enough to be reported as injuries. This is especially possible considering the retrospective study design (please see later limitations of the study for more details)

The relatively low injury rate observed among basketball referees in this study aligns partially with findings from previous research in other officiating populations, although comparisons remain limited owing to scarce and heterogeneous data. For example, studies on soccer referees often report higher injury rates—ranging from 30% to over 50% annually—most likely because of longer match durations and greater field coverage (Gabrilo et al., 2013; Szymski et al., 2022). In contrast, the shorter bursts of activity and controlled indoor environment in basketball may contribute to fewer overall injuries. However, the prevalence of lower limb injuries, particularly groin and calf strains, appears consistent across sports,

reinforcing the idea that rapid directional changes and sprintrecovery cycles are common mechanisms of injury among referees. This is supported by our second finding, namely, the high prevalence of injuries to the lower extremities.

Indeed, injuries among the studied basketball referees were most commonly reported in the lower extremities. This is not surprising given that these regions are known to be heavily engaged during the high-demand movements typical in basketball and basketball refereeing, such as repeated sprints, lateral shuffling, and abrupt changes in direction (Stojanovic, Terrence Scanlan, Radovanovic, Jakovljevic, & Faude, 2023). The need to maintain optimal positioning throughout the game requires referees to perform sudden accelerations, decelerations, and pivots, often without prior anticipation-placing substantial mechanical stress on the musculotendinous structures of the lower body. Groin strains, in particular, are associated with quick lateral movements and twisting motions, whereas calf injuries are frequently linked to rapid propulsion and deceleration on hard court surfaces. Importantly, unlike athletes, who may have more structured warm-up and recovery routines, referees might engage in these demanding actions without adequate neuromuscular preparation, further increasing injury susceptibility.

Our results revealed a greater risk of injury with increasing competition level, and this is consistent with studies done on athletes, where higher performance level indicated higher risk for being injured (Skomrlj et al. 2024). There is no doubt that referees officiating at advanced competitive levels are exposed to significantly greater physical and psychological demands during matches. These games are typically faster, more intense, and involve highly skilled athletes, requiring referees to adjust their position constantly, maintain high-speed movement, and make quick decisions under pressure (Sansone et al., 2025; Suarez Iglesias, Leicht, Pojskic, & Vaquera, 2021). In this environment, even small delays in reaction or poor positioning can have critical consequences, leading to greater stress and physical workload. The frequency of directional changes, sprinting, and sustained attention required at more elite levels may contribute to cumulative musculoskeletal strain. Moreover, high-level referees are subject to increased scrutiny from coaches, players, fans, and media, which adds a psychological dimension that further elevates the intensity of their role, increasing the risk of being injured.

Beyond the match itself, referees engaged in high-level competitions often face additional off-court stressors that can impact injury risk. Extensive travel, frequent schedule changes, and pressure to maintain peak performance with limited rest intervals can lead to fatigue and inadequate recovery (Huyghe, Scanlan, Dalbo, & Calleja-Gonzalez, 2018; Ochoa-Lacar et al., 2022). Disrupted sleep patterns, long hours spent in transit, and limited access to consistent training or rehabilitation routines may further compromise their physical readiness. Over time, these external demands can reduce the body's capacity to recover and adapt, increasing the vulnerability of referees to both overuse injuries and acute strains. Therefore, the combination of intense in-game demands and lifestyle-related stressors highlights the need for tailored injury prevention strategies for referees operating at the highest levels of competition.

Greater injury occurrence is evident in referees who consume dietary supplements more often. One possible explanation for such findings is that individuals who have previously sustained injuries may be more proactive about their health and recovery, whereas previous injury is known to be the most significant predictor of future injury (Fulton et al., 2014). Experiencing an injury could prompt referees to seek additional support for tissue repair, inflammation reduction, or performance optimization, leading them to incorporate supplements such as protein powders, collagen, omega-3 s, or joint-support formulas. This pattern reflects a common behavior in both athletes and active professionals, where injury history influences future health practices (Bjelanovic et al., 2023; Kozjek, Tonin, & Gleeson, 2025). Moreover, some referees may view supplementation as a way to accelerate recovery or prevent reinjury, particularly in the absence of regular access to physiotherapy or medical care. In this context, supplementation may act more as a compensatory strategy rather than a direct cause of injury. Therefore, the observed association may reflect a reactive approach rather than a predictive approach, indicating that previous injury is a driving factor behind increased supplement use.

Another possible interpretation is that referees who operate at higher competitive levels are more likely to engage in structured nutrition and supplementation practices as part of their overall performance routine. These individuals may be more likely to invest in maintaining optimal physical conditions due to the elevated demands of elite officers-leading to more frequent use of vitamins, minerals, and performance-enhancing supplements. At the same time, higher-level referees typically have better access to sports nutrition information, peer networks, or institutional guidance, which may normalize supplement use. It is also possible that these referees are more aware of or influenced by athletic culture, where dietary supplementation is often seen as a standard component of recovery and performance (Garthe & Maughan, 2018). In this scenario, supplement use might be greater not because of injury itself but because of the environment and performance expectations associated with top-level officiating. This behavior, while health-oriented, may coincide with increased exposure to physical stress and injury risk at higher competitive levels (please see previous discussion), creating an indirect link between supplementation and injury prevalence.

This study has several limitations that should be acknowledged when interpreting its findings. First, the retrospective component of injury history is susceptible to recall bias, as referees may not accurately remember or report past injuries, especially minor injuries. Additionally, the relatively small sample size of 39 participants limits the generalizability of the results to broader reference populations. The study also had a preliminary design with a limited range of variables, restricting deeper exploration of potential injury predictors such as biomechanical, nutritional, or psychosocial factors. Future research with larger samples and more comprehensive data collection is needed to build on these findings.

On the other hand, one of the main strengths of this study is that it is among the first to specifically investigate injury occurrence in basketball referees, filling a notable gap in the literature. The study involved referees who operate at a highly competitive level, which enhances the relevance of the findings to elite officiating environments. Moreover, the study was conducted in countries with a strong basketball culture and high-quality competitions, ensuring that participants were regularly exposed to demanding game conditions.

#### Conclusion

This study revealed relatively low injury rates among basketball referees, with fewer than 15% of participants experiencing injuries over the past competitive season. The most affected regions were the lower extremities, particularly the groin, calves, and ankles—areas subjected to high mechanical loads during refereeing. These findings suggest that basketball referees, particularly those in countries with strong basketball traditions, may benefit from effective physical conditioning and movement efficiency. Nonetheless, the possibility of underreporting and the limitations of retrospective recall must be considered when interpreting injury prevalence.

A clear pattern emerged, indicating that referees operating at more advanced competitive levels face a greater risk of injury. The increased speed, intensity, and scrutiny of elite matches impose greater physical and psychological demands on referees. When coupled with frequent travel, inconsistent

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#### **Conflict of interest**

The authors declare that there is no conflict of interest.

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recovery, and heightened performance pressure, these factors may cumulatively contribute to musculoskeletal overuse and acute injuries. These findings emphasize the need for structured prevention strategies and support systems tailored specifically to the challenges of high-level officiating.

The observed association between injury occurrence and dietary supplement use among referees may have two overlapping explanations. On the one hand, referees with a history of injury may adopt supplements as a compensatory recovery strategy, especially in the absence of formal medical support. On the other hand, advanced-level referees may engage more proactively in supplementation as part of broader performance and health maintenance routines. While the data do not imply causation, the link between supplementation and injury warrants further exploration, ideally through prospective studies that examine behavior, recovery practices, and competitive level in tandem.

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