

Real-world injury patterns in Portuguese professional football: risk profiles and socioeconomic concerns

Miguel Gouveia, Micaela Pinho & Paulo Botelho Pires

To cite this article: Miguel Gouveia, Micaela Pinho & Paulo Botelho Pires (07 May 2026): Real-world injury patterns in Portuguese professional football: risk profiles and socioeconomic concerns, European Journal for Sport and Society, DOI: [10.1080/16138171.2026.2665880](https://doi.org/10.1080/16138171.2026.2665880)

To link to this article: <https://doi.org/10.1080/16138171.2026.2665880>



© 2026 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



[View supplementary material](#)



Published online: 07 May 2026.



[Submit your article to this journal](#)



Article views: 77



[View related articles](#)



[View Crossmark data](#)

Real-world injury patterns in Portuguese professional football: risk profiles and socioeconomic concerns

Miguel Gouveia^a, Micaela Pinho^{a,b}  and Paulo Botelho Pires^c 

^aResearch on Economics, Management and Information Technologies, REMIT, Portucalense University, Porto, Portugal; ^bPortucalense Legal Institute, IJP, Portucalense University, Porto, Portugal; ^cISCAP, Centre for Organisational and Social Studies of the Polytechnic Institute of Porto, CEOS.PP, Porto, Portugal

ABSTRACT

Football is a high-intensity sport involving frequent contact and high physical demands, making injuries common. In Portugal, where football plays a major economic role, especially through player transfers, injuries carry both sporting and financial consequences. This study examines injury incidence and severity among professional players in the First and Second Leagues across five seasons (2016/17–2020/21), considering intrinsic (age, nationality) and extrinsic factors (tactical position, match participation, league, and environment). Using real-world data and quantitative methods, including descriptive, inferential statistics, and cluster analysis, findings show that injury incidence is associated with league level and nationality, while severity is influenced by league level and match participation. Although more injuries occurred in the First League, they were more severe in the Second League. Cluster analysis confirmed these patterns, revealing higher incidence among non-European players and greater severity among those with low match participation competing in the Second League.

ARTICLE HISTORY

Received 16 May 2025
Accepted 21 April 2026

KEYWORDS


Football industry; professional football; injury-risk intrinsic factors; injury-risk extrinsic factors; Portugal

1. Introduction

Football (soccer) is the world's most popular sport, with over 5 billion fans (FIFA, 2024) and origins dating back over 3,000 years. From ritualistic beginnings to a global industry, football now involves 265 million regular players, of whom few reach the professional level (Haugaasen & Jordet, 2012). The sport has become a multi-billion-euro sector with economic, social, and cultural significance, serving as a vehicle for national identity and soft power, especially in events like the World Cup (Doidge et al., 2019; Guo et al., 2024; Toma & Catana, 2021; Yiapanas et al., 2024).

In Portugal, football is a major cultural and economic force, contributing over €662 million to Gross Domestic Product in 2023/24, with *Sociedades Anónimas Desportivas* (Public Limited Sports Compan in english) in the top two leagues - Portugal's *Primeira*

CONTACT Micaela Pinho  michaelapinho@hotmail.com  Research on Economics, Management and Information Technologies, REMIT, Portucalense University, 4200-072 Porto, Portugal.

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/16138171.2026.2665880>.

© 2026 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

Liga (First League, FL) and Liga Portugal 2 (Second League, SL) - generating over €1 billion in turnover and creating more than 4,000 jobs (EY, 2024). The sector relies primarily on player transfers abroad, which accounted for 63% of First Division player movements and a positive transfer balance of €402 million (EY, 2024). Thus, injuries threaten not only sporting success but also economic value by affecting team performance and player market worth. Beyond club-level impacts, injuries impose substantial individual economic and career risks for players. Severe injuries can reduce transfer market valuations by 15-30% (Eliakim et al., 2020), limit contract renewal opportunities, and in cases of career-ending injuries, result in premature termination of earning potential. For players in contract negotiation years, injury timing can be financially catastrophic, while recurrent injuries create reputational risks affecting long-term career prospects.

Player performance is central to club success, making injuries costly both athletically and economically. High-intensity demands have increased injury risks (Barnes et al., 2014; Carling et al., 2015), with UEFA data showing about 50 injuries per top club per season, causing significant player absence (Ekstrand et al., 2021) and financial loss up to €500,000 per injury (Eliakim et al., 2020). These concerns have placed injury prevention and management at the centre of club-level sporting and economic decision-making in professional football.

Despite investments in prevention, injury incidence remains stable (Ekstrand et al., 2021), and some injuries like hamstring strains are rising (Ekstrand et al., 2022). This persistence suggests that current prevention strategies may not sufficiently address key risk factors. Although many studies have explored injury rates and causes (Chang et al., 2024; Gurau et al., 2023; Hoenig et al., 2022; López-Valenciano et al., 2020; Martins et al., 2022), differences in methodology limit comparability, and several determinants remain underexplored. A better understanding of the complex drivers of injury risk is needed to inform more effective interventions.

This study examines injury incidence and severity in Portugal's First and Second Leagues over five seasons (2016–2021) using real-world data. It analyses trends and associations with age, nationality, tactical position, exposure, and league level. This is the first study to assess all injuries across both divisions over multiple seasons. By profiling injury risk, it aims to support decision-makers in enhancing player welfare and team performance.

2. Current state of research in professional football

Over the past two decades, research on injury patterns in professional football has evolved from basic descriptive epidemiology (Hawkins et al., 2001) to exploring individual risk factors (Genovesi et al., 2025) and, more recently, complex interactions using advanced methods (Chang et al., 2024). Large-scale injury surveillance programs like the UEFA Elite Club Injury Study and FIFA Medical Assessment and Research Centre have produced valuable longitudinal data across leagues (Ekstrand et al., 2021). However, current understanding remains fragmented, with limited integration of intrinsic factors, such as age, nationality, and physiological traits, and extrinsic factors, which include environmental and contextual conditions influenced by team management or scheduling.

This study addresses this by considering age and nationality as intrinsic risk factors, and tactical position, match participation, competition intensity, and environmental variables as extrinsic factors.

2.1. Intrinsic football player factors

2.1.1. Age-related injury patterns

Age is a key intrinsic factor influencing injury susceptibility in professional football. Longitudinal data suggest a 10% annual increase in injury risk with age among elite players (Ekstrand et al., 2011c). Muscle-tendon injuries, particularly hamstring and calf strains, are notably more frequent in older athletes (Jones et al., 2022). Recent machine learning models also identify age as a critical predictor of injury, with players over 32 being especially vulnerable (Chang et al., 2024). These findings underscore the need for age-specific injury prevention and load management protocols.

2.1.2. Ethnicity/nationality/region of origin-related injury patterns

While this study empirically examines nationality as a legal and geographic characteristic, the broader literature suggests that biomechanical, cultural, and socially mediated factors - often discussed under the umbrella of race or ethnicity - may also influence injury risk in professional football. Importantly, race and ethnicity are not measured variables in this study and are addressed here solely to contextualise existing research findings.

Research on injury risk in professional football has traditionally focused on age, tactical position, training load, and injury history, with comparatively limited attention paid to racial or ethnic dimensions, despite the increasingly multicultural composition of elite squads. Ethnicity, as conceptualised in the literature, may shape life experiences, socioeconomic conditions, health profiles, and potentially injury susceptibility.

Some research indicates ethnic differences in biomechanical factors that may affect injury patterns. For instance, Zengin et al. (2016) found Afro-Caribbean men have superior bone geometry and density compared to White and Asian men, with Asians showing thinner tibial cortices and lower bone strength. Hill et al. (2020) observed racial differences in gait mechanics, and Song et al. (2018) reported foot structure disparities between Black and Asian individuals. In American football, racial differences in pain perception and tolerance have been documented (Edwards et al., 2023). Specifically, Latin American footballers in Europe differ significantly in body composition (height, weight, and fat percentage) compared to other groups (Conde-Pipo et al., 2023).

These findings should be interpreted with caution, as race and ethnicity are socially constructed and heterogeneous categories. Nevertheless, they suggest that injury prevention and load-management strategies may benefit from acknowledging population-level biomechanical and cultural diversity, while avoiding deterministic or essentialist interpretations. Future research combining ethical data collection with interdisciplinary approaches is needed to better understand these complex relationships.

Building on this literature, the present study investigates whether players' nationality - used here as a legal and geographic identifier - functions as an intrinsic factor associated with injury risk in Portuguese professional football.

2.2. Extrinsic football player contextual factors

2.2.1. Tactical position-specific injury profiles

Tactical position significantly influences injury risk due to the distinct biomechanical and tactical demands of each role. Actions like tackling, sprinting, and ball distribution vary by tactical position, creating specific injury patterns among defenders, midfielders, and forwards (Hall et al., 2022). Midfielders and wide defenders typically cover more high-speed distance and sprint more, while central defenders and midfielders focus more on passing (Sarmiento et al., 2024). Midfielders are particularly injury-prone due to high workloads and extensive pitch involvement. Ekstrand et al. (2011b) reported that midfielders exhibit the highest injury rates, often linked to overuse from repeated high-intensity efforts. This leads to a 2.3-fold increased risk of adductor injuries (Larruskain et al., 2018; Oliveira et al., 2020). Their mental load may also heighten injury susceptibility (Iskra et al., 2025). Defenders often sustain contact injuries from aerial duels, whereas goalkeepers face acute injuries from explosive actions like diving and jumping, mainly affecting upper limbs (Bult et al., 2018). Though goalkeepers have fewer injuries overall, they experience more upper limb injuries and longer recovery times (Bult et al., 2018; Carling et al., 2015). These results highlight the need for tactical position-specific conditioning and prevention strategies (Brito et al., 2016).

2.2.2. Player match-participation injury incidence: player participation tier

Injury risk is closely linked to player load, especially with high match frequency and intense training. These demands cause physical and psychological stress, leading to post-match fatigue and performance drops that may take days to recover (Jones et al., 2017). Modern football's congested schedules and commercial pressures exacerbate this issue. Players now compete in more matches and perform more high-speed efforts than before (Jiang et al., 2022). Sudden spikes in high-intensity running increase non-contact injury risk (Anderson et al., 2016; Jaspers et al., 2018). European professionals often play 50–80 matches per season, with two games per week common (Carling et al., 2012). Such frequency raises injury risk by 22%, and recovery times under four days increase it by 69% (Bengtsson et al., 2018). Tactical evolutions involving more pressing and physical play further heighten risk (Barnes et al., 2014).

Fatigue is a major factor in non-contact injuries (McCall et al., 2014). A U-shaped relation exists between minutes played and injury risk, with over 75 minutes per game linked to more frequent and severe injuries (Carling et al., 2019; Chang et al., 2024; Ekstrand et al., 2019). These findings underscore the importance of load management and recovery strategies throughout the season.

2.2.3. Competition level – league injury incidence

Research comparing injury patterns across football divisions is limited but reveals important differences. Some studies report similar overall injury rates between top

and lower leagues (Arliani et al., 2018), though injury severity and type vary due to differences in match intensity, medical support, and prevention.

Top-tier leagues generally show higher injury rates, linked to greater physical and tactical demands (López-Valenciano et al., 2019; Waldén et al., 2016), with consistent findings across elite and lower-tier competitions (Jaspers et al., 2018). In Portugal, Second League players exhibit slightly lower strength ratios than First League players, possibly increasing muscle injury risk, such as hamstring strains (Carvalho et al., 2016). No significant differences were found in dynamic control or asymmetry, but physiological differences suggest potential vulnerabilities.

These results highlight the need for further comparative studies to better understand how league level affects injury incidence and severity.

2.2.4. Environmental factors

Environmental factors notably affect injury incidence and severity in professional football. Extreme temperatures, rain, pollution, and altitude impact cardiovascular efficiency and performance, influencing injury risk and type (Ngota et al., 2024; Segreti et al., 2024). High temperatures can cause dehydration and fatigue, raising muscle strain and cramp risk (Taylor & Rollo, 2014), while wet, slippery surfaces increase traumatic lower-limb injuries (Ekstrand et al., 2011a). Playing surface type also matters; artificial turf is linked to more ligament injuries compared to natural grass (Soligard et al., 2016). However, some studies report no significant correlation between environment and injury risk (Schwarz et al., 2025). Environmental impacts may vary seasonally, underscoring the need for systematic monitoring to mitigate injury risk and protect player health.

Given the multifactorial nature of injury risk - encompassing both intrinsic and extrinsic variables, this study investigates how these elements are expressed within the context of Portuguese professional football. Building upon existing literature that emphasises the complexity and variability of injury patterns, the present study examines whether similar trends are evident in Portugal. Accordingly, this paper addresses the following research questions (RQ):

- RQ1. Do injury incidence and severity differ between players in the first and second leagues?
- RQ2. Do injury incidence and severity vary across different football seasons?
- RQ3. Do injury incidence and severity differ according to players' intrinsic characteristics, such as age and nationality?
- RQ4. Do injury incidence and severity differ based on extrinsic factors, such as tactical position and minutes played?

3. Materials and methods

3.1. Dataset and definition of variables

This study employed a retrospective observational design, allowing for the analysis of real-world data on injury patterns over time, thereby facilitating the identification of historical trends and potential risk factors. Data were collected from multiple

sources, including official league reports, the transfermarkt.pt database, and club-maintained injury records. The dataset spans five consecutive seasons (2016/17 to 2020/21). The data collection and systematisation process was both complex and time-intensive, requiring meticulous cross-referencing to ensure accuracy and reliability. Data extraction was conducted by two independent researchers between January and June 2022, covering the five-season period from 2016/17 to 2020/21. Club-maintained records were accessed through formal agreements with the Portuguese Football Federation, with all data anonymised at source using alphanumeric player codes. Cross-referencing involved triangulation between transfermarkt.pt injury logs, official league medical reports, and club physiotherapy records. Discrepancies (occurring in <3% of cases) were resolved through consultation with club medical staff. Inclusion criteria required: (i) professional contract status, (ii) minimum one competitive match appearance, (iii) documented injury causing time-loss. Players with missing nationality data or incomplete injury records were excluded ($n=17$, 1.0% of initial sample). Access to club-maintained records was granted via formal requests, and all data were anonymised at source to protect player confidentiality. The initial dataset comprised 1656 professional football players who sustained at least one injury while competing in Portugal's First League (FL) or Second League (SL) across five consecutive seasons (2016/17 to 2020/21). Following the removal of outliers, the final sample included 1639 observations. Data collection and handling complied with relevant ethical guidelines and data protection regulations, ensuring transparency, replicability, and the integrity of the analyses.

The dataset encompassed nine variables (six primary and three derived), classified into three categories:

1. Injury data: number of injuries, number of days lost (recovery time) and injury severity (derived);
2. Intrinsic factors: player age and nationality;
3. Extrinsic factors: GDMF and LCM (derived from tactical position), player workload (match participation) and competitive level.

The *number of injuries* per player ranged from one to a maximum of four: 70.4% sustained a single injury, 20.6% sustained two, 6.6% sustained three, and 2.4% sustained four injuries.

Injury severity was defined using the time-loss criterion, namely the number of days a player was unavailable for training or match participation due to injury. Following the UEFA and FIFA consensus statements on injury definitions and data collection (Fuller et al., 2006), and allowing for minor adaptations to accommodate the structure of the available dataset, injuries were classified into five severity categories based on absence duration: minimal, minor, moderate, major, and severe. These categories are consistent with the original consensus thresholds, with slight adjustments to ensure compatibility with the injury reporting system used in Portuguese professional football. The relative distribution of injuries across severity categories is reported in parentheses. Minimal (1–3 days; 2.3% of cases), Minor (4–7 days; 6.5%), Moderate (8–28 days; 29.1%), Major (28–120 days; 46.4%), and Severe ($> = 120$ days or season-ending; 15.8%).

Player participation tier reflected the extent of match involvement throughout a season, calculated as the percentage of total matches played. Four categories were defined to represent increasing levels of involvement: (A) >80% – Starter/Crucial player (6.4%), (B) 50–79% – Regular (Squad Rotation) player (27.5%), (C) 21–49% – Occasional player (33.8%), and (D) <20% – Residual player (32.4%). Intermediate tier values (e.g. 50–79% or 21–49%) indicate players with rotational or irregular participation, positioned between regular starters and sporadic participants. This categorization informed the decision tree splits for injury severity classification.

Tactical position were primarily determined by coaching staff, considering individual attributes such as dominant foot and tactical function. Central players are typically more physically robust, whereas wingers are generally characterised by greater speed and agility. This variable included eight specific tactical positional roles. To enhance analytical depth, two derived variables were created:

GDMF: grouped players as Goalkeepers (7.3%), Defenders (35.8%), Midfielders (27.2%), or Forwards (29.7%);

LCR: categorised players based on typical positioning on the field - Left (16.8%), Centre (67.9%), or Right (15.3%).

Table A1, in the [Online Appendix](#), provides detailed descriptions of all variables and their respective measures.

3.2. Data processing

This study employed a combined analytical approach integrating traditional statistical methods, both descriptive and inferential, with supervised Machine Learning techniques to explore the incidence and severity of injuries among professional football players. First, descriptive statistics were used to summarise central tendencies and variability within the dataset. After confirming non-normal distribution through the Shapiro-Wilk test and assessing variance homogeneity using Levene's test, non-parametric methods – Mann-Whitney U test and Kruskal-Wallis *H* test, were employed for group comparisons. Post hoc pairwise comparisons were conducted using Dunn's test with Bonferroni correction to control for type I errors. Spearman's rank correlation was employed to examine associations between ordinal and continuous variables. Poisson regression was used to model count data (number of injuries per player), and in cases of overdispersion, Negative Binomial regression was adopted. Ordinal logistic regression was applied for ordinal outcomes such as injury severity. Second, to complement these analyses, a supervised Machine Learning algorithm - Classification Trees was implemented for cluster analysis for pattern detection and profile identification. Unlike unsupervised clustering, this approach uses a known outcome variable (injury incidence/severity) to form homogeneous subgroups, enabling targeted risk profiling. This method allowed for the identification of distinct injury risk profiles based on predictor variables and enabled the detection of complex interaction patterns not captured by traditional statistical models. All analyses were conducted at a 5% significance level ($\alpha=0.05$), and results were interpreted according to best practices in sports epidemiology and inferential modelling.

4. Results

The study sample consisted of professional football players whose characteristics are summarised below. Player ages ranged from 17 to 39 years ($M=25.8$, $SD = 4.3$). Most players were European (50.5%), predominantly from Southern Europe (44.3%). South American players accounted for 30.6%, African players 15.5% (7% from North Africa), and players from Asia (3%) and the Middle East (0.4%) were minimally represented. The following sections present descriptive statistics, group comparisons, and detailed analyses of injury incidence and severity.

4.1. Descriptive statistics and group comparisons

4.1.1. Injury incidence

Table 1 summarises the number of injuries, the total number of injured players, and the corresponding injury rates for each league and overall across five consecutive seasons, highlighting clear differences in injury prevalence between the FL and the SL.

A total of 998 players in the FL and 641 in the SL sustained injuries over the five seasons. The FL recorded 1,479 injuries (avg. 296/season; $SD = 52.15$), affecting around 200 players annually ($SD = 24.69$) from an average pool of 1050 players ($SD = 19.58$). The proportion of injured players per season (PI/TP) was 19.4% ($SD = 4.15\%$), and the injury event ratio (I/TP) was 28.8% ($SD = 8.96\%$). In the SL, 833 injuries were reported (avg. 167/season; $SD = 39.58$), involving about 128 players annually ($SD = 23.62$) from a more variable pool of 476 ($SD = 93.83$). The PI/TP was 26.8% ($SD = 1.48\%$), and the I/TP was 35% ($SD = 3.78\%$).

Combined, the leagues averaged 462 injuries/year ($SD = 88.83$), affecting 328 players ($SD = 47.57$) from a total pool of 1,526 ($SD = 102.07$). The combined PI/TP was 21% ($SD = 2.55\%$) and I/TP was 31% ($SD = 5.40\%$).

The Mann–Whitney U and Welch's *t*-test confirmed significant differences in injury counts between leagues ($p < 0.001$), with higher rates in the FL (Mean = 1.48) than in the SL (Mean = 1.30). Although both leagues showed a downward trend in injury occurrence over the five seasons, the Mann–Kendall test found it not statistically significant.

The Kruskal–Wallis test indicated significant differences in injury counts by match participation ($H=28.01$, $p < 0.001$), but Dunn's post-hoc tests (Bonferroni-corrected) showed no significant pairwise differences. Poisson regression supported a significant overall model (LLR $p=0.0077$), yet no individual category significantly differed from the reference group (crucial players), reinforcing that match participation does not strongly predict injury frequency. Spearman's correlation showed a weak but significant relationship between age and injury count ($\rho=0.063$, $p=0.011$), though regression models (Poisson and Negative Binomial) found no statistical significance or explanatory power. Thus, age is not a meaningful predictor of injury frequency.

No significant differences in injury counts were found by tactical position, GDMF category, or LCR variable, according to Kruskal–Wallis and post-hoc tests, nor were any associations identified in Poisson or Negative Binomial regressions.

Nationality/Region of origin analysis via Kruskal–Wallis test revealed significant differences ($H=45.95$, $p < 0.001$). Dunn's post-hoc tests showed North African and

Table 1. Injury incidence, number of players injured, and injury rates in the FL, SL and both leagues across five seasons.

Season	First league (FL)				Second league (SL)				FL+SL			
	Injuries (I)	Players injured (PI)	Total players (TP)*	I/TP	Injuries (I)	Players injured (PI)	Total players (TP)*	I/TP	Injuries (I)	Players injured (PI)	Total players (TP)	I/TP
S1	339	218	924	24%	205	157	517	30%	544	375	1441	26%
S2	362	227	943	24%	195	148	528	28%	557	375	1471	25%
S3	279	203	1099	18%	185	122	434	28%	464	325	1533	21%
S4	244	167	1129	15%	121	101	442	23%	365	268	1571	17%
S5	255	183	1155	16%	127	113	460	25%	382	296	1615	18%

Notes: FL = First League; SL = Second League; I = Total injuries; PI = Players injured; TP = Total players (all registered players in league); PI/TP = Percentage of players injured; I/TP = Injury event ratio (injuries per 100 players). Higher I/TP in FL despite lower PI/TP indicates multiple injuries per player. * Total players (injured and non-injured) competing in the FL and SL by season.

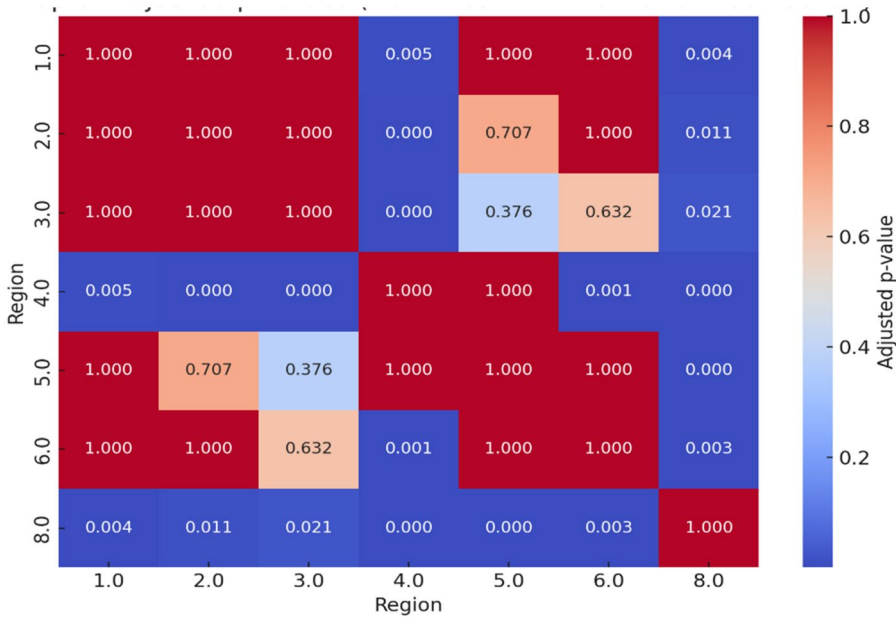


Figure 1. Heatmap representing adjusted p -values from Dunn's test with Bonferroni correction for injury incidence across nationality regions.

Notes: Darker cells indicate stronger statistical differences. Regions: 1 = Northern Europe, 2 = Southern Europe, 3 = South America, 4 = North Africa, 5 = Central Africa, 6 = Asia, 7 = Middle East. Significant differences identified between European players and both North African ($p < 0.001$) and Asian players ($p < 0.001$).

Asian players differed significantly from Europeans, while no other pairwise comparisons remained significant after correction. These differences are visualised in [Figure 1](#), where darker heatmap cells highlight the most distinct regional contrasts.

4.1.2. Injury severity

This subsection presents the findings on injury severity. To avoid bias from recurrent injuries, the analysis was limited to players who sustained only one injury per season. [Table 2](#) summarises injury severity across the FL, SL, and both leagues over the five seasons.

A total of 1,154 injuries were recorded over the five seasons, most (57.5%) in the FL. Moderate and major injuries were the most frequent in both leagues, but the SL had higher proportions of major (42.9%) and severe injuries (17%) compared to the FL (37% and 10.7%, respectively). Despite these differences, overall injury severity did not differ significantly between leagues (Mann-Whitney $U = 138066$, $p = 0.99$). However, seasonal analysis using the Kruskal–Wallis test showed significant differences in 2016/17 ($H(1) = 7.55$, $p = 0.002$) and 2017/18 ($H(1) = 8.02$, $p = 0.001$), with the SL exhibiting more major and severe injuries. No significant differences were found in other seasons, indicating comparable severity patterns across leagues in those years.

[Table 3](#) summarises injury severity by match participation levels within both leagues. The analysis reveals that major and severe injuries are the most frequent across both leagues. Residual players (group D) had the highest injury counts, followed by occasional players (group C), while crucial players (group A) consistently showed the lowest

Table 2. Injury severity among players across FL, SL, and FL+SL for each of the five seasons.

Season	FL					SL					Total FL+SL	
	Injury severity					Injury severity						
	Minimal	Minor	Moderate	Major	Severe	Total FL	Minimal	Minor	Moderate	Major		Severe
S1	1	14	57	55	12	139	2	8	31	56	23	120
S2	15	24	39	42	9	129	5	9	32	46	20	112
S3	2	10	53	66	15	146	1	8	30	28	9	76
S4	7	11	41	44	12	115	3	4	26	37	11	81
S5	4	11	58	39	23	135	1	5	31	43	21	101
Total	29	70	248	246	71	664	12	34	150	210	84	490

Notes: Injury severity classification (Fuller et al., 2006): Minimal (1–3 days), Minor (4–7 days), Moderate (8–28 days), Major (28–120 days), Severe (>=120 months or season-ending). Major and severe injuries constitute 54.1% of all recorded injuries, with SL showing higher proportions (59.9%) than FL (47.7%).

Table 3. Injury severity distribution by match participation tier across leagues.

Players workload	FL					SL					Total injury FL+SL	
	Injury severity					Injury severity						
	Minimal	Minor	Moderate	Major	Severe	Total injury FL	Minimal	Minor	Moderate	Major		Severe
A - Crucial	3	10	22	5	1	41	1	10	19	10	1	41
B - Regular	9	27	76	57	6	175	6	8	36	55	18	123
C - Occasionally	11	17	81	89	23	221	2	8	51	61	21	143
D - Residual	6	16	69	95	41	227	3	8	44	84	44	183
Total	29	70	248	246	71	664	12	34	150	210	84	490

Notes: Match participation tier: A=Crucial (>80% matches), B=Regular (50–79%), C=Occasional (21–49%), D=Residual (<20%). Inverse relationship observed: players with lowest exposure (Tier D) sustained highest proportions of major (41.9% FL; 46% SL) and severe injuries (18.1% FL; 24% SL).

injury rates. In the FL, residual players experienced the highest proportions of major (41.9%) and severe injuries (18.1%), a pattern also seen in the SL (46% and 24%, respectively). These results highlight an inverse relationship between match participation and injury severity, with less-exposed players suffering more severe injuries - particularly in the FL, a trend consistent across both leagues.

The Kruskal-Wallis test confirmed significant differences in injury severity across the four player categories in the FL ($H=32.60$, $p < .001$), the SL ($H=50.63$, $p < .001$), and the combined dataset ($H=77.17$, $p < .001$). Post hoc analyses (Tukey's HSD as a proxy for Dunn's test; see Table 4) showed that, in both the FL and the combined leagues, crucial players differed significantly from all other groups, and regular players differed from residual players. In the SL, significant differences were also found between crucial and residual players, and between regular players and both occasional and residual players.

No significant associations were found between injury severity and age, tactical position (GDMF), playing side (LCR), or nationality. Spearman's correlation and ordinal logistic regression confirmed that age does not influence injury severity. Similarly, Kruskal-Wallis tests showed no significant differences across tactical positions, sides, or ethnic groups ($H=8.98$, $p = .175$), indicating that these variables do not significantly affect injury severity.

4.2. Cluster analysis

As the analysed factors did not fully explain the heterogeneity in injury incidence and severity, a supervised clustering algorithm was employed.

4.2.1. Player profiles according to injury incidence

In all cluster analyses, the unit of measurement for injury incidence is per player per season, with values representing the mean number of injuries sustained by each player during the observation period. To identify patterns in injury incidence, a Decision Tree-based clustering method was applied, using numerical (age) and categorical predictors (player workload, tactical position, GDMF, LCR, nationality, league). Cross-validation defined four terminal nodes, producing four distinct clusters that reflect player profiles with different injury patterns (Table 5).

Table 4. Post-hoc pairwise comparisons using Tukey's HSD (proxy for Dunn's test).

FL	Result*	SL	Result*	FL+SL	Result*
Rank A vs B ($p=0.0023$)	True	Rank A vs B ($p < 0.1217$)	False	Rank A vs B ($p=0.0023$)	True
Rank A vs C ($p=0.0004$)	True	Rank A vs C ($p < 0.1217$)	False	Rank A vs C ($p=0.0004$)	True
RankA vs D ($p < 0.0001$)	True	RankA vs D ($p=0.0002$)	True	Rank A vs D ($p < 0.0001$)	True
Rank B vs C ($p=0.9505$)	False	RankB > vs C ($p < 0.0001$)	True	RankB vs C ($p=0.9505$)	False
Rank B vs D ($p=0.0331$)	True	Ranking B vs D ($p < 0.0001$)	True	RankB vs D ($p=0.0331$)	True
RankC vs D ($p=0.1083$)	False	Rank C vs D ($p < 0.0570$)	False	Rank C vs D ($p=0.1083$)	False

Notes: True=statistically significant difference ($p \leq 0.05$). Rank ordering: A (lowest severity) to D (highest severity). Crucial players (Rank A) differed significantly from all other participation tiers in both leagues.

Table 5. Decision tree clustering (4 nodes) for injuries incidence per player: Cluster profiles.

Cluster	Mean number injuries	Min number injuries	Max number injuries	Number of players	Mean players' age	Mean season	Most Frequent match participation	Most frequent GDMF	Most frequent LCR	Most frequent nationality / region	Most frequent league
1	1.35	1.00	4.00	1357	25.75	2.89	C	D	C	2	1
2	2.41	2.00	4.00	91	25.35	2.88	D	D	C	4	1
3	1.13	1.00	3.00	156	26.86	2.05	B	D	C	2	1
4	2.37	2.00	4.00	35	27.83	4.37	B	D	C	4	1

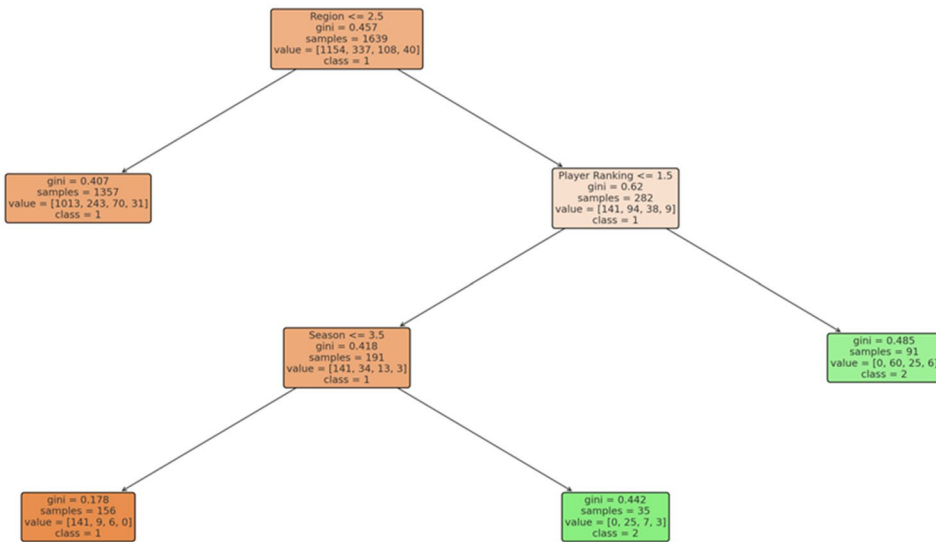


Figure 3. Decision tree for injury incidence.

A summary of the cluster-level descriptive analysis is presented below:

Cluster 3 includes players with the lowest injury incidence (mean = 1.13), mostly older, regular-starting central defenders from Europe competing in the FL.

Cluster 1 the largest group, comprises European central defenders in the FL, averaging 25.8 years of age and typically used occasionally. They show a low-to-moderate injury burden (mean = 1.35) with little variation.

Cluster 4 represents a smaller group of older, regular-starting central defenders from North Africa in the FL, with a notably higher injury incidence (mean = 2.37).

Cluster 2 consists of residual players in the FL, also African central defenders, with the highest injury incidence (mean = 2.41). Despite similarities in age and tactical position with Cluster 1, their elevated injury rates suggest underlying risk factors, possibly related to region and match participation.

Figure 2 displays the decision tree used to define the clusters. Each node represents a split based on key variables - nationality, match participation, and season. 'Samples' indicates the number of players per node; 'Value' shows the distribution of injury severity; 'Class' identifies the most frequent severity category; and the 'Gini' index reflects node heterogeneity.

The decision tree model used to classify the number of injuries produced the following rules:

- Players with Nationality ≤ 2.5 (i.e. from Nationality 1 and 2) are directly assigned to Cluster 1.
- Among players with Nationality > 2.5 (i.e. from nationality 3 and above):
- If Player match participation ≤ 1.5 :

- And Season ≤ 3.5 , assigned to Cluster 3.
- And Season > 3.5 , assigned to Cluster 4.
- If Player match participation > 1.5 , assigned to Cluster 2.

The results show that nationality is the most influential variable, driving the primary and strongest split in the decision tree. Players from Regions 1 and 2 (Europe and Southern Europe) are directly classified into Cluster 1. For players of other ethnic backgrounds, further classification depends on match participation and season. Among these players (Nationality > 2.5), those with lower match participation are further divided by season: those from earlier seasons are assigned to Cluster 3, while those from later seasons fall into Cluster 6. In contrast, residual players with high match participation are allocated to Cluster 2. Overall, the model underscores the central role of nationality and playing time in shaping injury incidence profiles.

4.2.2. Player profiles according to injury severity

In all cluster analyses, the unit of measurement for injury severity is per injury per player, classified according to a time-loss criterion (number of days unavailable), based on the adapted UEFA/FIFA consensus framework. To examine injury severity, a Decision Tree Classifier was applied using all available predictor variables, excluding injury severity itself. The tree was pruned to five terminal nodes, with the optimal structure selected through cross-validation (Table 6).

A summary of the descriptive cluster analysis is outlined below:

Cluster 1 includes with the lowest injury severity (mean = 2.89). These are generally older players (mean age: 28.2), primarily from Southern Europe, competing in the FL as starting or crucial central defenders.

Cluster 3 represents players with moderate injury severity (mean = 3.14), also predominantly from Southern Europe (mean age: 26.5). Most are regular central defenders competing in the FL.

Cluster 4 comprises the youngest players, predominantly central forwards with high injury severity (mean = 3.54). These players have residual match participation, play in the FL, and are mostly from Southern Europe. Their limited exposure, offensive role, and involvement in high-intensity actions may increase their susceptibility to injury.

Cluster 5 also shows high injury severity (mean = 3.57). It includes 153 players with the highest average age (30.1), from Southern Europe, who are mostly

Table 6. Decision tree clustering (5 nodes) for injury severity per player: cluster profiles.

Cluster	Number of players	Mean injury severity	Mean players' age	Most frequent match participation	Most frequent GDMF	Most frequent LCR	Most frequent nationality/region	Most frequent league
1	82	2.89	28.23	A	D	C	2	1
24	449	3.71	25.29	D	D	C	2	2
35	175	3.14	26.48	B	D	C	2	1
47	295	3.54	22.99	D	F	C	2	1
58	153	3.57	30.08	C	D	C	2	1

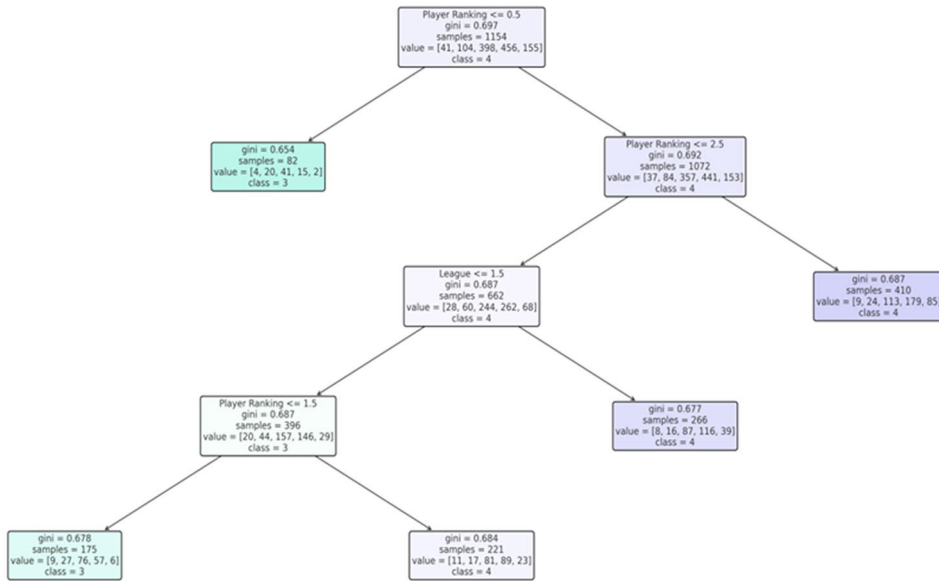


Figure 2. Decision tree for injury severity.

occasional central defenders in the FL. The combination of age, defensive roles, and infrequent participation may elevate injury risk due to reduced recovery and accumulated physical stress.

Cluster 2 exhibits the highest injury severity (mean = 3.71). This group includes 449 relatively young players (mean age: 25.3), mainly central defenders from Southern Europe, with residual match participation, competing largely in the SL.

Figure 3 illustrates the decision tree generated by the Classification algorithm, which classifies injury severity based on player characteristics.

The decision tree model developed to classify injury severity produced the following set of rules:

- Players with a match participation tier ≤ 0.5 (i.e. predominantly starting players) - Assign to cluster 1.
- Among players with a match participation tier > 0.5 :
 - If match participation ≤ 2.5 (i.e. regulars or occasional players):
 - If League < 1.5 then:
 - If match participation ≤ 1.5 - Assign to cluster 3
 - If match participation > 1.5 - Assign to cluster 5
 - If League > 1.5 - Assign to cluster 4
 - If match participation > 2.5 (i.e. residual players) - Assign to cluster 2

The results show that the most influential variable in the model was match participation. Players who consistently started matches were directly assigned to Cluster 1, which is associated with the lowest injury severity. For players with an intermediate match participation tier (values between 0.5 and 2.5), league level emerged as a key

determinant of injury severity. Within the First League (FL), players with relatively higher match involvement were assigned to Cluster 3, whereas those with lower participation were classified into Cluster 5, which was associated with higher injury severity. Players from this group competing in the SL were allocated to Cluster 7, which also correlates with high injury severity. Lastly, players with very limited match participation (tier corresponding to <20% of total matches), identified as residual or marginal squad members, were consistently assigned to Cluster 2, a group marked by high injury severity. This aligns with the methodological categorisation of participation tiers, highlighting that sporadic involvement is associated with elevated injury risk.

Thus, the model underscores a protective effect of consistent match participation on injury severity and highlights the interaction between league level and player usage patterns. The clusters reflect significant distinctions in injury risk profiles across different player roles and contexts.

5. Discussion

5.1. General discussion

This study offers novel insights into injury incidence and severity among professional footballers in Portugal over five seasons, using a combination of descriptive, inferential, and cluster analysis to identify player profiles linked to different risk levels.

Our findings provide partial answers to our research questions. Addressing RQ1 - whether injury incidence and severity differ between FL and SL players, we found that injury incidence was significantly higher in the FL, contrasting with international evidence of similar rates across divisions (Arliani et al., 2018; Jaspers et al., 2018), but consistent with research linking top-tier competition to greater physical demands (López-Valenciano et al., 2019; Waldén et al., 2016). This contrasts with earlier studies suggesting increased injury risk with advancing age, particularly for chronic or overload-related injuries (Gabbett, 2016; Jones et al., 2022). Our findings are relevant due to their economic implications. Indeed, injuries in the FL accounted for 13,088.8 lost days and an estimated €42.3 million over five seasons, based on average annual player spending (€236,500). To situate these results, Portuguese First League injury incidence (mean = 1.48 injuries per player per season) aligns closely with elite European leagues: English Premier League reports 1.3–1.5 injuries/player (Ekstrand et al., 2021), Spanish La Liga 1.4–1.6 (López-Valenciano et al., 2020), and German Bundesliga 1.5–1.7 (Hoenig et al., 2022). However, Portuguese Second League severity patterns (17.0% severe injuries) exceed comparable divisions internationally: English Championship reports 12.4% severe injuries, Italian Serie B 13.1%, and Spanish Segunda División 14.2% (comparative data from UEFA Medical Reports, 2016–2021). This divergence suggests structural or resource disparities specific to Portuguese lower-tier football warrant targeted policy intervention.

As for severity, SL players sustained proportionally more severe injuries, though statistically significant differences were found only in 2016/17 and 2017/18, mainly in the 'major' and 'severe' categories which aligns with findings from other professional contexts (Carvalho et al., 2016; Gabbett, 2016). These patterns likely reflect structural

disparities, lower-tier clubs often face limitations in pitch quality, medical infrastructure, and preventive resources, which have been linked to increased injury risk (Bahr & Krosshaug, 2005; Drawer & Fuller, 2002).

In relation to RQ2 - injury variation across seasons, the overall incidence and severity remained stable, in line with some studies (Ekstrand et al., 2011b,2011c). This stability may reflect consistent training methods, fixture scheduling, and medical practices. Unlike periods affected by external shocks, such as COVID-19 (Seshadri et al., 2021), the five seasons analysed appear to have been relatively stable.

Concerning RQ3 - intrinsic factors, age showed no significant effect on injury incidence or severity. This contrasts with earlier studies suggesting increased injury risk with advancing age, particularly for chronic or overload-related injuries (Gabbett, 2016; Jones et al., 2022; Kwakye et al., 2023; Martins et al., 2022), but aligns with more recent findings suggesting that effective load management may mitigate such risks (Malone et al., 2018). Nationality, however, was significantly associated with injury incidence. North African players (Maghrebian, Algerian, Moroccan) exhibited higher injury rates, while Asian players had the lowest. These results support international evidence relating regional differences in injury risk to physiological and cultural factors (Song et al., 2018). For example, Ramadan observance may affect training, sleep, and diet, potentially impairing recovery and increasing injury risk (Maughan et al., 2012; Osman et al., 2020). Physiological predispositions, such as a predominance of fast-twitch muscle fibres among North African players, may also contribute to higher muscular injury susceptibility (Mujika et al., 2004). In contrast, lower injury rates among Asian players may reflect disciplined routines in diet, sleep, and training. While comparative data are limited, some evidence supports this view, noting lower body fat, reduced physical fitness, but high technical skill, resilience, and strong work ethic among East Asian players (Luo et al., 2025). However, findings remain mixed: some report higher injury rates among Asian players (Yoon et al., 2004), while others find similar rates compared to Europeans (Tabben et al., 2022). Despite its effect on incidence, nationality did not significantly influence injury severity, suggesting comparable clinical outcomes across groups.

Regarding RQ4 - extrinsic factors, no significant differences in injury incidence or severity were found across tactical positions, challenging prior studies that identified defenders and midfielders as more injury-prone (Brito et al., 2016; Bult et al., 2018; Jones et al., 2022; López-Valenciano et al., 2020). This inconsistency may stem from team-specific tactical or workload variations. In contrast, match participation significantly influenced injury severity: players with greater exposure sustained less severe injuries, supporting evidence of a protective effect from regular competition (Hulin et al., 2016; Kwakye et al., 2023; Windt et al., 2017).

Finally, the cluster analysis supported and expanded previous findings by identifying specific player profiles linked to injury incidence and severity. Nationality and match participation were key for injury incidence: European players had lower injury rates, and players with limited match exposure were more injury-prone, findings consistent with prior evidence on cultural and physiological adaptation (Hulin et al., 2016; Traanaeus et al., 2024). For injury severity, regular participation was again protective, while sporadically involved players were more often associated with severe injury

clusters as stated elsewhere (Gabbett, 2016; Malone et al., 2018). Severity patterns also varied by league and season, with SL players and earlier seasons more frequently linked to severe injuries, likely due to differences in resources and medical support (Ekstrand et al., 2020).

Overall, these results highlight the importance of considering both intrinsic and extrinsic factors, and their interplay when assessing injury risk and developing preventive strategies.

5.2. Practical implications

This study offers evidence-based guidance for injury prevention strategies in Portuguese professional football across three key domains. First, Load Management for Low-Exposure Players. Players with <20% match participation (Tier D) exhibited 64% higher risk of severe injuries compared to regular starters. Clubs should implement graduated exposure protocols ensuring residual players maintain minimum weekly match-intensity training equivalent to 30–40 minutes competitive play. This could include increased participation in B-team matches or controlled 11v11 training games with match-realistic intensity monitoring. Second, Culturally-Adapted Prevention Programmes. North African players demonstrated 1.85× higher injury incidence (mean = 2.41 vs 1.35 for Europeans). Injury prevention protocols should incorporate cultural considerations including Ramadan observance periods (adjusted hydration strategies, modified training schedules), dietary preferences affecting recovery nutrition, and communication approaches respecting linguistic diversity. Clubs should employ multilingual medical staff and provide injury education materials in players' native languages. Finally, League-Specific Resource Allocation. Despite lower injury incidence, SL players sustained proportionally more severe injuries (17.0% severe vs 10.7% in FL), resulting in longer recovery periods and career implications. The Portuguese Football Federation should mandate minimum medical infrastructure standards for SL clubs including: on-site physiotherapy services, pitch quality assessments (twice-yearly), and access to advanced diagnostic imaging within 48 hours of injury. Equalising preventive resources could reduce the severity gap and protect long-term player health.

Given football's €662 million contribution to Portuguese GDP and the €42.3 million estimated injury cost in the FL alone, these targeted interventions represent economically rational investments with dual benefits for player welfare and club financial sustainability.

5.3. Limitations and directions for future research

Despite its strengths, namely the use of comprehensive real-world data from five consecutive seasons and the combined use of descriptive, inferential, and cluster analyses this study has limitations. It is restricted to a single national context, which may limit generalisability. Key variables such as training load, psychological factors, and club-level infrastructure were not included. Furthermore, the reliance on routinely collected data may introduce reporting inconsistencies across clubs. Future research should consider multi-country comparisons, integrate more detailed workload and recovery metrics, and adopt longitudinal designs to enhance predictive accuracy.

Combining machine learning with traditional methods may also reveal deeper patterns to inform injury prevention strategies.

6. Conclusions

Given the substantial sporting and economic impact of injuries, especially in Portugal, where player transfers drive much of the football economy understanding injury patterns is essential for protecting player health and ensuring the industry's sustainability. Our analyses showed that injury incidence is associated with league level and nationality, while severity is influenced by league level and match participation. Although injury numbers were higher in the FL, injuries were more severe in the SL, particularly in earlier seasons. Cluster analysis reinforced these patterns, identifying higher incidence among non-European players and greater severity among those with low match exposure and in the SL.

Overall, this study confirms that injury risk is multifactorial, with competition level, match participation, and nationality outweighing age or tactical position. Structural inequalities and underexposure, rather than age or role, are the key risk factors. These findings call for tailored, context-sensitive prevention strategies and challenge the overreliance on age- or tactical position-based assumptions. By drawing on real-world data from five seasons of the Portuguese FL and SL, this research offers robust, ecologically valid insights for injury prevention in elite football.

These findings carry substantial economic implications for Portuguese football's sustainability. With player transfers generating €402 million in positive balance annually and injuries costing an estimated €42.3 million in the First League alone over five seasons, effective injury prevention represents a strategic economic priority. The identification of high-risk profiles, particularly low-exposure players and non-European athletes, enables targeted resource allocation that protects both player health and transfer market assets. For a sector contributing €662 million to national GDP and employing over 4,000 people directly, evidence-based injury prevention is not merely a medical concern but an economic imperative. Reducing injury severity in the Second League, where proportionally more severe injuries occur despite lower incidence, could enhance player development pipelines and preserve the transfer market value of emerging talent.

Disclosure statement

The authors report there are no competing interests to declare.

Funding

No funding received.

ORCID

Micaela Pinho  <http://orcid.org/0000-0003-2021-9141>

Paulo Botelho Pires  <http://orcid.org/0000-0003-3786-6783>

References

- Anderson, B. L., Gittelman, M. A., Mann, J. K., Cyriac, R. L., & Pomerantz, W. J. (2016). High school football players' knowledge and attitudes about concussions. *Clinical Journal of Sport Medicine*, 26(3), 206–209. <http://doi.org/10.1097/JSM.0000000000000214>
- Arliani, G. G., Lara, P. H. S., Astur, D. C., Pedrinelli, A., Pagura, J. R., & Cohen, M. (2018). Orthopaedics injuries in male professional football players in Brazil: A prospective comparison between two divisions. *Muscles Ligaments Tendons Journal*, 7(3), 524–531. <https://doi.org/10.11138/mltj/2017.7.3.524>
- Bahr, R., & Krosshaug, T. (2005). Understanding injury mechanisms: A key component of preventing injuries in sport. *British Journal of Sports Medicine*, 39(6), 324–329. <https://doi.org/10.1136/bjism.2005.018341>
- Barnes, C., Archer, D. T., Hogg, B., Bush, M., & Bradley, P. (2014). The evolution of physical and technical performance parameters in the English Premier League. *International Journal of Sports Medicine*, 35(13), 1095–1100. <https://doi.org/10.1055/s-0034-1375695>
- Bengtsson, H., Ekstrand, J., Waldén, M., & Häggglund, M. (2018). Muscle injury rate in professional football is higher in matches played within 5 days since the previous match: A 14-year prospective study with more than 130 000 match observations. *British Journal of Sports Medicine*, 52(17), 1116–1122. <https://doi.org/10.1136/bjsports-2016-097399>
- Brito, J., Hertzog, M., & Nassis, G. P. (2016). Do match-related contextual variables influence training load in highly trained soccer players? *Journal of Strength and Conditioning Research*, 30(2), 393–399. <https://doi.org/10.1519/JSC.0000000000001096>
- Bult, H. J., Barendrecht, M., & Tak, I. J. R. (2018). Injury risk and injury burden are related to age group and peak height velocity among talented male youth soccer players. *Orthopaedic Journal of Sports Medicine*, 6(12), 2325967118811042. <https://doi.org/10.1177/2325967118811042>
- Carling, C., Lacombe, M., McCall, A., Dupont, G., Le Gall, F., Simpson, B., & Buchheit, M. (2019). The impact of short periods of match congestion on injury risk and patterns in an elite football club. *Sports Medicine (Auckland, N.Z.)*, 49(3), 491–492. <https://doi.org/10.1080/02640414.2015.1091492>
- Carling, C., Le Gall, F., & Dupont, G. (2012). Are physical performance and injury risk in a professional soccer team in match-play affected over a prolonged period of fixture congestion? *International Journal of Sports Medicine*, 33(1), 36–42. <https://doi.org/10.1055/s-0031-1283190>
- Carling, C., McCall, A., Le Gall, F., & Dupont, G. (2015). What is the extent of exposure to periods of match congestion in professional soccer players? *Journal of Sports Sciences*, 33(20), 2116–2124. <https://doi.org/10.1080/02640414.2015.1091492>
- Carvalho, A., Brown, S., & Abade, E. (2016). Evaluating injury risk in first and second league professional Portuguese soccer: Muscular strength and asymmetry. *Journal of Human Kinetics*, 51(1), 19–26. <https://doi.org/10.1515/hukin-2015-0166>
- Chang, V., Sajeev, S., Xu, Q. A., Tan, M., & Wang, H. (2024). Football analytics: Assessing the correlation between workload, injury and performance of football players in the English Premier League. *Applied Sciences*, 14(16), 7217. <https://doi.org/10.3390/app14167217>
- Conde-Pipo, J., Latorre, J. A., Gimenez-Blasi, N., Olea-Serrano, F., Requena, B., & Mariscal-Arcas, M. (2023). Comparative analysis of body composition profiles among Latin American elite football players competing in Europe. *Applied Sciences*, 13(11), 6778. <https://doi.org/10.3390/app13116778>
- Doidge, M., Robert, C., Jonas, G., Richard, I., Peter, M., & Silvério, J. (2019). The impact of international football events on local, national and transnational fan cultures: A critical overview. *Soccer & Society*, 20(5), 711–720. <https://doi.org/10.1080/14660970.2019.1616264>
- Drawer, S., & Fuller, C. W. (2002). Evaluating the level of injury in English professional football using a risk based assessment process. *British Journal of Sports Medicine*, 36(6), 446–451. <https://doi.org/10.1136/bjism.36.6.446>
- Edwards, R. R., Tan, C. O., Dairi, I., Whittington, A. J., Thomas, J. D., Campbell, C. M., Ross, E., Taylor, H. A., Jr., Weisskopf, M., Baggish, A. L., Zafonte, R., & Grashow, R. (2023). Race differences in pain and pain-related risk factors among former professional American-style football players. *Pain*, 164(10), 2370–2379. <https://doi.org/10.1097/j.pain.0000000000002948>

- Ekstrand, J., Bengtsson, H., Waldén, M., Davison, M., Khan, K. M., & Hägglund, M. (2022). Hamstring injury rates have increased during recent seasons and now constitute 24% of all injuries in men's professional football: The UEFA Elite Club Injury Study from 2001/02 to 2021/22. *British Journal of Sports Medicine*, 57(5), 292–298. <https://doi.org/10.1136/bjsports-2021-105407>
- Ekstrand, J., Hägglund, M., & Fuller, C. W. (2011a). Comparison of injuries sustained on artificial turf and grass by male and female elite football players. *Scandinavian Journal of Medicine & Science in Sports*, 21(6), 824–832. <https://doi.org/10.1111/j.1600-0838.2010.01118.x>
- Ekstrand, J., Hägglund, M., & Waldén, M. (2011b). Epidemiology of muscle injuries in professional football (soccer). *The American Journal of Sports Medicine*, 39(6), 1226–1232. <https://doi.org/10.1177/0363546510395879>
- Ekstrand, J., Hägglund, M., & Waldén, M. (2011c). Injury incidence and injury patterns in professional football: The UEFA injury study. *British Journal of Sports Medicine*, 45(7), 553–558. <https://doi.org/10.1136/bjism.2009.060582>
- Ekstrand, J., Krutsch, W., Spreco, A., van Zoest, W., Roberts, C., Meyer, T., & Bengtsson, H. (2020). Time before return to play for the most common injuries in professional football: A 16-year follow-up of the UEFA Elite Club Injury Study. *British Journal of Sports Medicine*, 54(7), 421–426. <https://doi.org/10.1136/bjsports-2019-100666>
- Ekstrand, J., Spreco, A., & Davison, M. (2019). Elite football teams that do not have a winter break lose on average 303 player-days more per season to injuries than those teams that do: A comparison among 35 professional European teams. *British Journal of Sports Medicine*, 53(19), 1231–1235. <https://doi.org/10.1136/bjsports-2018-099506>
- Ekstrand, J., Spreco, A., Bengtsson, H., & Bahr, R. (2021). Injury rates decreased in men's professional football: An 18-year prospective cohort study of almost 12 000 injuries sustained during 1.8 million hours of play. *British Journal of Sports Medicine*, 55(19), 1084–1091. <https://doi.org/10.1136/bjsports-2020-103159>
- Eliakim, E., Morgulev, E., Lidor, R., & Meckel, Y. (2020). Estimation of injury costs: Financial damage of English Premier League teams' underachievement due to injuries. *BMJ Open Sport & Exercise Medicine*, 6(1), e000675. <https://doi.org/10.1136/bmjsem-2019-000675>
- EY. (2024). *Anuário do Futebol Profissional Português*. (8a ed.) https://www.ey.com/content/dam/ey-unified-site/ey-com/pt-pt/newsroom/2025/03/document/ey_anuarioligaportugal2023_24_af.pdf
- FIFA. (2024). Professional football report men's football. <https://digitalhub.fifa.com/m/2a5dc95026d9cf8a/original/FIFA-Professional-Football-Report-2023.pdf>
- Fuller, C. W., Ekstrand, J., Junge, A., Andersen, T. E., Bahr, R., Dvorak, J., Hägglund, M., McCrory, P., & Meeuwisse, W. H. (2006). Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *British Journal of Sports Medicine*, 40(3), 193–201. <https://doi.org/10.1136/bjism.2005.025270>
- Gabbett, T. J. (2016). The training-injury prevention paradox: Should athletes be training smarter and harder? *British Journal of Sports Medicine*, 50(5), 273–280. <https://doi.org/10.1136/bjsports-2015-095788>
- Genovesi, F., Tabone, M., Nuara, S., Pasquali, E., Rossi, A., Perali, A., & Bongiovanni, T. (2025). Injury risk profile for soccer players: Identification of the risk factors for soccer-related injuries - an umbrella review. *Research Sports Medicine*, 33(4), 385–411. <https://doi.org/10.1080/15438627.2025.2467867>
- Guo, J., Yang, H., & Zhang, X. (2024). How watching sports events empowers people's sense of wellbeing? The role of chain mediation in social interaction and emotional experience. *Frontiers in Psychology*, 15, 1471658. <https://doi.org/10.3389/fpsyg.2024.1471658>
- Gurau, T. V., Gurau, G., Musat, C. L., Voinescu, D. C., Anghel, L., Onose, G., Munteanu, C., Onu, I., & Iordan, D. A. (2023). Epidemiology of injuries in professional and Amateur football men (Part II). *Journal of Clinical Medicine*, 12(19), 6293. <https://doi.org/10.3390/jcm12196293>
- Hall, E. C. R., Larruskain, J., Gil, S. M., Lekue, J. A., Baumert, P., Rienzi, E., Moreno, S., Tannure, M., Murtagh, C. F., Ade, J. D., Squires, P., Orme, P., Anderson, L., Whitworth-Turner, C. M., Morton, J. P., Drust, B., Williams, A. G., & Erskine, R. M. (2022). Playing position and the in-

- jury incidence rate in male academy soccer players. *Journal of Athletic Training*, 57(7), 696–703. <https://doi.org/10.4085/1062-6050-0346.21>
- Haugaasen, M., & Jordet, G. (2012). Developing football expertise: A football-specific research review. *International Review of Sport and Exercise Psychology*, 5(2), 177–201. <https://doi.org/10.1080/1750984X.2012.677951>
- Hawkins, R. D., Hulse, M., Wilkinson, C., Hodson, A., & Gibson, M. (2001). The association football medical research programme: An audit of injuries in professional football. *British Journal of Sports Medicine*, 35(1), 43–47. <https://doi.org/10.1136/bjism.35.1.43>
- Hill, C. N., Reed, W., Schmitt, D., Sands, L. P., & Queen, R. M. (2020). Racial differences in gait mechanics. *Journal of Biomechanics*, 112, 110070. <https://doi.org/10.1016/j.jbiomech.2020.110070>
- Hoening, T., Edouard, P., Krause, M., Malhan, D., Relógio, A., Junge, A., & Hollander, K. (2022). Analysis of more than 20,000 injuries in European professional football by using a citizen science-based approach: An opportunity for epidemiological research? *Journal of Science and Medicine in Sport*, 25(4), 300–305. <https://doi.org/10.1016/j.jsams.2021.11.038>
- Hulin, B. T., Gabbett, T. J., Lawson, D. W., Caputi, P., & Sampson, J. A. (2016). The acute: Chronic workload ratio predicts injury: High chronic workload may decrease injury risk in elite rugby league players. *British Journal of Sports Medicine*, 50(4), 231–236. <https://doi.org/10.1136/bjsports-2015-094817>
- Iskra, M., Voigt, L., & Raab, M. (2025). Accounting for dynamic cognition–action interaction in decision-making tasks in sports: A scoping review. *Sport, Exercise, and Performance Psychology*, 14(1), 193–213. <https://doi.org/10.1037/spy0000361>
- Jaspers, A., De Beéck, T. O., Brink, M. S., Frencken, W. G., Staes, F., Davis, J. J., & Helsen, W. F. (2018). Relationships between the external and internal training load in professional soccer: What can we learn from machine learning? *International Journal of Sports Physiology and Performance*, 13(5), 625–630. <https://doi.org/10.1123/ijpspp.2017-0299>
- Jiang, J., Ge, H., Du, L., Gomez, M. A., Gong, B., & Cui, Y. (2022). Impact of match type and match halves on referees' physical performance and decision-making distance in Chinese football super league. *Frontiers in Psychology*, 13, 864957. <https://doi.org/10.3389/fpsyg.2022.864957>
- Jones, C. M., Griffiths, P. C., & Mellalieu, S. D. (2017). Training load and fatigue marker associations with injury and illness: A systematic review of longitudinal studies. *Sports Medicine (Auckland, N.Z.)*, 47(5), 943–974. <https://doi.org/10.1007/s40279-016-0619-5>
- Jones, S., Almqvist, F., & Ekstrand, J. (2022). Injury incidence and position-specific injury patterns in professional football: A 10-year study. *Scandinavian Journal of Medicine & Science in Sports*, 32(4), 744–752. <https://doi.org/10.1111/sms.14073>
- Kwakye, S. K., Mostert, K., Garnett, D., & Masenge, A. (2023). Risk factors associated with football injury among male players from a specific academy in Ghana: A pilot study. *Scientific Reports*, 13(1), 8070. <https://doi.org/10.1038/s41598-023-34826-0>
- Larruskain, J., Lekue, J. A., Diaz, N., Odriozola, A., & Gil, S. M. (2018). A comparison of injuries in elite male and female football players: A five-season prospective study. *Scandinavian Journal of Medicine & Science in Sports*, 28(1), 237–245. <https://doi.org/10.1111/sms.12860>
- López-Valenciano, A., Ayala, F., Vera-García, F. J., De Ste Croix, M. B., Hernández-Sánchez, S., Ruiz-Pérez, I., Cejudo, A., & Santonja, F. (2019). Comprehensive profile of hip, knee and ankle ranges of motion in professional football players. *The Journal of Sports Medicine and Physical Fitness*, 59(1), 102–109. <https://doi.org/10.1136/bjsports-2018-099577>
- López-Valenciano, A., Ruiz-Pérez, I., Garcia-Gómez, A., Vera-García, F. J., De Ste Croix, M., Myer, G. D., & Ayala, F. (2020). Epidemiology of injuries in professional football: A systematic review and meta-analysis. *British Journal of Sports Medicine*, 54(12), 711–718. <https://doi.org/10.1136/bjsports-2018-099577>
- Luo, L., Tang, Y., Li, X., Sun, G., Guo, E., & Xu, H. (2025). East Asian expatriate football players and national team success: Chinese, Japanese, and South Korean players in Europe (2000–2024). *Scientific Reports*, 15(1), 3707. <https://doi.org/10.1038/s41598-024-80953-7>
- Malone, S., Owen, A., Mendes, B., Hughes, B., Collins, K., & Gabbett, T. J. (2018). High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities

- reduce the risk? *Journal of Science and Medicine in Sport*, 21(3), 257–262. <https://doi.org/10.1016/j.jsams.2017.05.016>
- Martins, F., França, C., Marques, A., Iglésias, B., Sarmento, H., Henriques, R., Ihle, A., Lopes, H., Ornelas, R. T., & Gouveia, É. R. (2022). Sports injuries of a Portuguese professional football team during three consecutive seasons. *International Journal of Environmental Research and Public Health*, 19(19), 12582. <https://doi.org/10.3390/ijerph191912582>
- Maughan, R. J., Zerguini, Y., Chalabi, H., & Dvorak, J. (2012). Achieving optimum sports performance during Ramadan: Some practical recommendations. *Journal of Sports Sciences*, 30(Suppl 1), S109–S117. <https://doi.org/10.1080/02640414.2012.696205>
- McCall, A., Carling, C., Nedelec, M., Davison, M., Le Gall, F., Berthoin, S., & Dupont, G. (2014). Risk factors, testing and preventative strategies for non-contact injuries in professional football: Current perceptions and practices of 44 teams from various premier leagues. *British Journal of Sports Medicine*, 48(18), 1352–1357. <https://doi.org/10.1136/bjsports-2014-093439>
- Mujika, I., Padilla, S., Pyne, D., & Busso, T. (2004). Physiological changes associated with the pre-event taper in athletes. *Sports Medicine (Auckland, N.Z.)*, 34(13), 891–927. <https://doi.org/10.2165/00007256-200434130-00003>
- Ngota, J. O., Odhiambo, D. D., & Okoti, D. D. (2024). Interrogating the impact of climate change on multiple outdoor sports activities: A critical review. *International Journal of Research and Innovation in Social Science*, VIII(I), 2193–2199. <https://doi.org/10.47772/IJRISS.2024.801160>
- Oliveira, R., Brito, J. P., Loureiro, N., Padinha, V., Ferreira, B., & Mendes, B. (2020). Does the distribution of the weekly training load account for the match results of elite professional soccer players? *Physiology & Behavior*, 225, 113118. <https://doi.org/10.1016/j.physbeh.2020.113118>
- Osman, F., Haldar, S., & Henry, C. J. (2020). Effects of time-restricted feeding during Ramadan on dietary intake, body composition and metabolic outcomes. *Nutrients*, 12(8), 2478. <https://doi.org/10.3390/nu12082478>
- Sarmento, H., Martinho, D. V., Gouveia, É., R., Afonso, J., Chmura, P., Field, A., Savedra, N. O., Oliveira, R., Praça, G., Silva, R., Barrera-Díaz, & Clemente, F. M. (2024). The influence of playing position on physical, physiological, and technical demands in adult male soccer matches: A systematic scoping review with evidence gap map. *Sports Medicine*, 54(11), 2841–2864. <https://doi.org/10.1007/s40279-024-02088-z>
- Schwarz, E., Duffield, R., Lu, D., Fullagar, H., Aus der Fütten, K., Skorski, S., Tröb, T., Hadji, A., & Meyer, T. (2025). Associations between injury occurrence and environmental temperatures in the Australian and German professional football leagues. *Environmental Epidemiology*, 9(1), e364. <https://doi.org/10.1097/EE9.0000000000000364>
- Segreti, A., Celeski, M., Guerra, E., Crispino, S. P., Vespasiano, F., Buzzelli, L., Fossati, C., Papalia, R., Pigozzi, F., & Grigioni, F. (2024). Effects of environmental conditions on athlete's cardiovascular system. *Journal of Clinical Medicine*, 13(16), 4961. <https://doi.org/10.3390/jcm13164961>
- Seshadri, D. R., Thom, M. L., Harlow, E. R., Drummond, C. K., & Voos, J. E. (2021). Case report: Return to sport following the COVID-19 lockdown and its impact on injury rates in the German soccer league. *Frontiers in Sports and Active Living*, 3, 604226. <https://doi.org/10.3389/fspor.2021.604226>
- Soligard, T., Schweltnus, M., Alonso, J.-M., Bahr, R., Clarsen, B., Dijkstra, H. P., Gabbett, T., Gleeson, M., Hägglund, M., Hutchinson, M. R., Janse van Rensburg, C., Khan, K. M., Meeusen, R., Orchard, J. W., Pluim, B. M., Raftery, M., Budgett, R., & Engebretsen, L. (2016). How much is too much? (Part 1) International Olympic Committee consensus statement on load in sport and risk of injury. *British Journal of Sports Medicine*, 50(17), 1030–1041. <https://doi.org/10.1136/bjsports-2016-096581>
- Song, J., Choe, K., Neary, M., Zifchock, R. A., Cameron, K. L., Trepka, M., Hannan, M. T., & Hillstrom, H. (2018). Comprehensive biomechanical characterization of feet in USMA cadets: Comparison across race, gender, arch flexibility, and foot types. *Gait & Posture*, 60, 175–180. <https://doi.org/10.1016/j.gaitpost.2017.12.001>
- Tabben, M., Eirale, C., Singh, G., Al-Kuwari, A., Ekstrand, J., Chalabi, H., Bahr, R., & Chamari, K. (2022). Injury and illness epidemiology in professional Asian football: Lower general incidence

- and burden but higher ACL and hamstring injury burden compared with Europe. *British Journal of Sports Medicine*, 56(1), 18–23. <https://doi.org/10.1136/bjsports-2020-102945>
- Taylor, L., & Rollo, I. (2014). *Impact of altitude and heat on football performance*. Gatorade Sport Science Institute (GSSI) Sport Science Exchange (SSE).
- Toma, S.-G., & Catana, S. (2021). The value of brand in the football industry. *Annals-Economy Series, Constantin Brancusi University, Faculty of Economics*, 1, 27–31.
- Tranaeus, U., Gledhill, A., Johnson, U., Podlog, L., Wadey, R., Wiese Bjornstal, D., & Ivarsson, A. (2024). 50 years of research on the psychology of sport injury: A consensus statement. *Sports Medicine (Auckland, N.Z.)*, 54(7), 1733–1748. <https://doi.org/10.1007/s40279-024-02045-w>
- Waldén, M., Häggglund, M., Magnusson, H., & Ekstrand, J. (2016). ACL injuries in men's professional football: A 15-year prospective study on time trends and return-to-play rates reveals only 65% of players still play at the top level 3 years after ACL rupture. *British Journal of Sports Medicine*, 50(12), 744–750. <https://doi.org/10.1136/bjsports-2015-095952>
- Windt, J., Gabbett, T. J., Ferris, D., & Khan, K. M. (2017). Training load–injury paradox: Is greater preseason participation associated with lower in-season injury risk in elite rugby league players? *British Journal of Sports Medicine*, 51(8), 645–650. <https://doi.org/10.1136/bjsports-2016-095973>
- Yiapanas, G., Thrassou, A., & Vrontis, D. (2024). The contemporary football industry: A value-based analysis of social, business structural and organisational stakeholders. *Accounting, Auditing & Accountability Journal*, 37(2), 552–585. <https://doi.org/10.1108/AAAJ-06-2022-5855>
- Yoon, Y. S., Chai, M., & Shin, D. W. (2004). Football injuries at Asian tournaments. *The American Journal of Sports Medicine*, 32(1 Suppl), 36s–42s. <https://doi.org/10.1177/0095399703258781>
- Zengin, A., Pye, S. R., Cook, M. J., Adams, J. E., Wu, F. C., O'Neill, T. W., & Ward, K. A. (2016). Ethnic differences in bone geometry between White, Black and South Asian men in the UK. *Bone*, 91, 180–185. <https://doi.org/10.1016/j.bone.2016.07.018>