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AN ANALYSIS OF KNEE LIGAMENT MATCH INJURY INCIDENCE, BURDEN AND SEVERITY PATTERNS ACROSS THE TOP FIVE EUROPEAN FOOTBALL LEAGUES THROUGHOUT THE 2022/2023 SEASON

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ABSTRACT

This study aims to evaluate and comparatively assess the incidence and burden of knee ligament match injuries in the top five European football leagues (Italy, France, Germany, Spain, and England) throughout the 2022–2023 season. Beyond that, knee ligament match injury classification is based on layoff days and injury severity patterns for each registered injury. A total of 3015 players from “the big” five (UEFA, 2023) European football leagues (with a total of 98 football clubs), namely, Bundesliga, La Liga, Ligue 1, Premier League and Serie A, with an average of 30.8 players, a mean age of 25.1 (SD ± 4.6) years, were included in the study, also with an average of 14451.4 minutes exposure hours per league. The total exposure hours amounted to 71,382.7. The medical team recorded individual player time-loss knee ligament match injuries. In this investigation, descriptive and inferential statistical analysis methods were deployed. The football players' injury characteristics, along with other variables, were statistically evaluated using descriptive statistics of means, standard deviations (SDs), and frequencies.

Based on descriptive statistics concerning the knee ligament match injury severity patterns, the data reflect that the Premier League (43.86%) and Ligue 1 (43.1%) have the highest percentage of severe injuries, suggesting that both leagues have a larger burden of severe injuries. Although they are still over 40%, the severe injury rates in the Bundesliga and Serie A are marginally lower. While the Premier League has the lowest percentage of mild injuries (15.79%), La Liga separates with a comparatively higher percentage of moderate injuries (30%) than the other leagues, indicating that injuries in the Premier League tend to be more severe in nature. In general, Minimal injuries are rare; the lowest percentage is found in Ligue 1 (3.45%).

The collected data wasn't in line with a normal distribution therefore the non-parametric Kruskal-Wallis test was used to assess the incidence and burden of knee injuries within the five leagues. Subsequently, Dunn's test was performed to determine exactly which leagues are different, the pairwise comparisons assessed differences in detail between every pair of leagues. The null hypothesis, as defined by which there is no difference in the knee ligament match incidence or knee ligament match burden of injuries between the leagues, was examined for every comparison. We reject the null hypothesis for the two analyses since the p-values for the incidence and burden of knee ligament match injuries are both 0.000, indicating substantial differences between the leagues for the knee ligament match injury incidence and burden

Keywords: football, match, injury, incidence, burden, ligament, ACL, MCL

INTRODUCTION

Undoubtedly the elevated incidence of injuries in professional football and the rising demand for matches are some of the factors contributing to FIFA, UEFA, and national football bodies' high concerns regarding the

safety of football players and injury risks. (Bizzini et al., 2019, McCall et al., 2015, Junge & Dvorak, 2015). Knee ligament injuries are prevalent in professional football and result in significant time loss

from football matches and training (Barth et al., 2019, Ekstrand et al., 2021, Holtus et al., 2023, Jones et al., 2019, Klein et al., 2020, Lundblad et al., 2019, Lundblad et al., 2020). Comparative studies of knee ligament match injury incidence, burden and severity in Europe's top leagues are scarce. Chamari and others (2024) found the overall injury pattern and risk were similar to those seen in European versus Asian football and match injuries indicated a much higher injury burden compared to training injuries, indicating that total tears of the ACL were the most consequential affecting recovery period, which should be very worrying for all stakeholders (Niederer et al., 2018). Professional football is a sport highly susceptible for ACL injuries, as confirmed by the high incidence of ACL injuries among elite European football players (Mazza et al., 2022). Reportedly knee MCL, LCL and PCL ligament injuries are nearly three out of four injuries were contact injuries, with tackling and being tackled being the most frequent causes of injury (Barth et al., 2019, Klein et al., 2021, Lundblad et al., 2019). A majority of ACL tears are caused by noncontact trauma, typically from cutting, leaping or rotating (Barth et al., 2019, Buckthorpe et al., 2024, Della Villa et al., 2021). During the study over 16 years, Ekstrand et al. (2020) found that knee ligament injuries in elite football represent over 6% of the injury incidence for the 31 most common index injuries. Players' performance and health may be impacted shortly afterwards and over time by severe knee ligament injuries (Krutsch et al., 2020). Male professional football players face significant risks of becoming injured particularly during games (Klein et al., 2018, Klein et al., 2021, López-Valenciano et al., 2020). For instance, Koch and others (2021) emphasized that prospective preventive measures should concentrate on knee injuries and put policies in place for preventing osteoarthritis after retirement. They also found that the knee very often injured the body region accounting for around 20% of the total injuries. The most common type of injury, according to the study's distribution of knee injury types, was a collateral ligament injury of the knee of the MCL/LCL (Krutsch et al., 2020). A contact injury mechanism is linked to these specific knee ligament injuries (MCL/LCL/PCL), which usually occur in matches.

Injury is defined as an event where a player's physical complaints prevent him or her from completely participating in future football training or matches (Hägglund et al., 2005, Fuller et al., 2006, Bahr et al., 2020). Injury incidence, usually expressed as the number of injuries per 1,000 hours of player exposure or participation in a football training or match. In proportion to the overall amount of time spent playing or training, it gives an indication of how frequently injuries occur over time (Fuller et al., 2006, Ekstrand,

et al., 2011). Injury severity is defined as the number of days of absence from participation (Hawkins, & Fuller, 2019, Hawkins et al., 2001, Ekstrand, & Gillquist, 1983). When using a time loss injury definition, it is crucial to assess the severity of the injury (Hägglund et al., 2005). Injury burden is an indicator which includes the injury incidence and injury severity, resulting in the player's burden and the team's implications. The ratio of days of absence to 1,000 hours of exposure is used for estimating injury burden (Bahr et al., 2018). The definitions of injuries and the methodology for data collection adhere to the 2006 consensus statement on football injuries. (Fuller et al., 2006).

This article is motivated by the UEFA project launched as a study program in 2001 to improve player safety in its competitions and positively contribute to the understanding of injuries in football and sports. This ongoing study program is the UEFA Elite Club Injury Study-ECIS (Hägglund et al., 2005) making it one of the largest injury databases of its type in professional football. This research applies the same standardised injury surveillance methodology and utilizes this approach among teams in the top five European football leagues to analyze and compare differences, characteristics and similarities. This ECIS study's main goal was to investigate the incidence and burden of football injuries in professional men's football during a 23-season period starting from 2001 (Ekstrand et al., 2023).

A top-level football club (with average of 25-28 players) will sustain just over 50 injuries on average per season, with 17% of these being re-injuries and to reduce the total injury impact, professional teams should focus on injury prevention strategies (Hägglund et al., 2018). One of the several projects (ECIS) objectives was to observe the rising load placed on professional football players and to examine the relationships between this increase in load and injuries (McCall et al., 2018). Pragmatic recommendations for epidemiological research of football injuries is presented in the UEFA ECIS approach. This study would contribute to the updated literature review, facts and a better understanding of the injury risks (internal and external) in professional football. Likewise, this research will contribute to the assessment and evaluation of match-related knee ligament injury severity patterns among all 98 clubs (Table 1.) participating during the 22/23 season, a total of 3015 players, including:

1. Premier League, England, 20 clubs.
2. Serie A, Italy 20 clubs.
3. La Liga, Spain, 20 clubs.
4. Ligue 1, France, 20 clubs.
5. Bundesliga, Germany, 18 clubs.

This proposed research explores specific knee ligament match injury incidence, injury burden and severity patterns among teams in the top five European football leagues (English Premier League, German Bundesliga, Italian Serie A, Spanish La Liga and French Ligue One). Following the UEFA consensus guidelines (Fuller et al., 2006), injuries were categorized into four severity levels: minimal (causing 1–3 days of missed training and playing), mild (causing 4–7 days of missed training and playing), moderate (8–28 days of missed training and playing), and severe (over 28 days of missed training and playing).

The Noisefeed injury repository (<https://noisefeed.com>) for professional football was employed to gather data on the incidence and severity patterns of knee ligament injuries during matches. With over 150,000 entries, it represents the ultimate database when looking for injury information. The dataset was processed for the five European football leagues (Premier League, Ligue 1, Serie A, La Liga and Bundesliga). The SPSS database of injury files is processed and classified according to the number of days of absence from training and matches and the type of knee ligament injury. The mean of player age, exposure hours and players that played during the season 2022/2023 in each league, but also friendlies, cups, and international club competitions are presented in Table 1.

Table 1. Players' age, exposure hours per league and number of players that played matches in each league (average values)

League	Age	Exposure hours	Players
	25.1	11919.2	29.3
La Liga	25.8	14801.0	31.0
Ligue	24.5	14287.1	30.6
Premier League	24.9	15449.8	31.7
Serie A	25.2	14925.6	30.9
Mean	25.1	14451.4	30.8
(SD)	(0.94)	(1113.1)	(0.69)

METHODS

Procedure

The match knee ligament injury incidence rate was calculated using the following equation:

$$\text{Knee ligament match Injury Incidence} = \left(\frac{\text{Number of match knee ligament Injuries}}{\text{Total Hours of Exposure}} \right) \times 1000$$

According to Häggglund et al. (2005), injury burden is a measure that includes the incidence (injury rate) and severity (lay-off days/absence) of such injuries to estimate a player's injury burden as well as the team's

implications. The number of days missed per 1,000 hours of exposure is used to express the injury burden. The match knee ligament injury burden rate was calculated using the following equation:

$$\text{Knee ligament match Injury Burden} = \left(\frac{\text{Number of lay-off days}}{\text{Total Hours of Exposure}} \right) \times 1000$$

The femur (thighbone) and tibia (shin bone) are connected by the four primary ligaments of the knee (Tria & Scuderi, 2024), their classifications are as follows:

- Anterior Cruciate ligament (ACL) This ligament is in the center of the knee. (Image 1. yellow ligament)
- Posterior cruciate ligament (PCL). This ligament is in the back of the knee. (Image 1. red ligament)
- Medial collateral ligament (MCL). This ligament gives stability to the inner knee. (Image 1. blue ligament)
- Lateral collateral ligament (LCL). This ligament gives stability to the outer knee. (Image 1. green ligament)

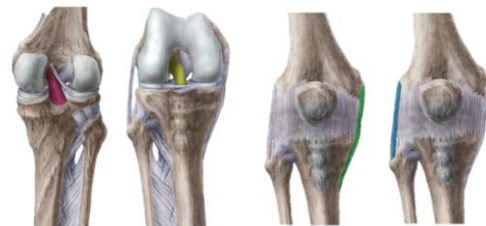


Image 1. Main knee ligaments

Retrieved October 2024, from

<https://www.kenhub.com/en/library/anatomy/lower-leg-and-knee-anatomy>
the image is modified by the authors

The severity of an injury was evaluated by the length of absence from football participation (football training and playing). An injury's severity can be classified into four categories: minimum, mild, moderate, and severe, according to prior epidemiological literature on injury studies, (Häggglund et al., 2005) this classification is presented in Table 2.

Table 2. Injury severity classification

Minimal injury resulting in 1–3 days absence from training and playing.
Mild injury resulting 4–7 in days absence from training and playing.
Moderate injury resulting in 8–28 days absence from training playing.
Severe injury resulting in >28 days absence from training and playing.

Confidentiality

All individual data was kept confidential. Each player and club participating in the study has their names evaluated anonymously. Following ethical approval,

the anonymous data forms are obtained from the professional football injury database (Noisefeed, <https://noisefeed.com>).

Statistical analysis

SPSS Statistics 22 software (SPSS Inc., Chicago, IL) was used for every statistical analysis. Descriptive and inferential statistical methods were applied in this analysis. Descriptive statistics of means, standard deviations (SDs), and frequencies were used to statistically characterise the injury characteristics of the football players as well as other variables. The data gathered are non-parametric. Therefore, to attempt to determine whether football leagues had differential instances of injury, post hoc pairwise comparisons (the Bonferroni correction was used to adjust the significance values in the pairwise comparisons and diminish the possibility of type I errors) were conducted after the Kruskal-Wallis test was used to assess the incidence and burden of knee injuries within the five leagues and 98 clubs. Based on the average rate of injuries sustained throughout the match, the SPSS study results for each league included the average burden and incidence of knee ligament injuries.

RESULTS

The frequency of moderate and mild injuries is more stable across leagues; in La Liga and the Bundesliga, moderate injuries fluctuate between 11 and 17, while mild injuries remain within a comparable range in almost all leagues as presented on the graph 1. under. The severity of knee injuries in five major football leagues is illustrated in this graph, which can be classified into four categories: severe, moderate, mild, and minimal. The Premier League (56), Ligue 1 (58), and Serie A have the highest overall number of knee injuries (59). All of the leagues have been characterized by severe injuries however the Premier League and Ligue 1 have a disproportionately high percentage of severe injuries. Compared to the Premier League, where mild injuries are noticeably less common, the Bundesliga and La Liga reveal higher rates of moderate and mild injuries. The lowest percentage by minimal injuries. The distribution of injury severities among the leagues is highlighted by this descriptive data.

Based on these descriptive data in the table 3. below for the severity of knee injuries throughout the five leagues, minimum injuries are the least prevalent, particularly across Ligue 1 (3.45%), while severe

injuries are most common in Ligue 1 (43.1%) and the Premier League (43.86%). Mild injuries remain relatively constant, with the exception of the Premier

Graph 1. Frequency of the severity patterns

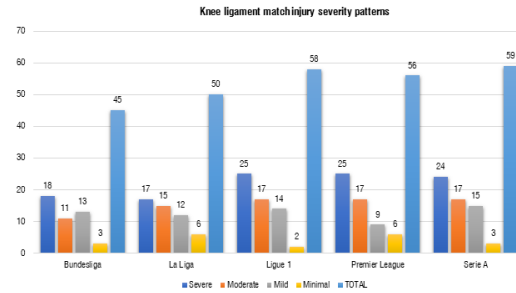
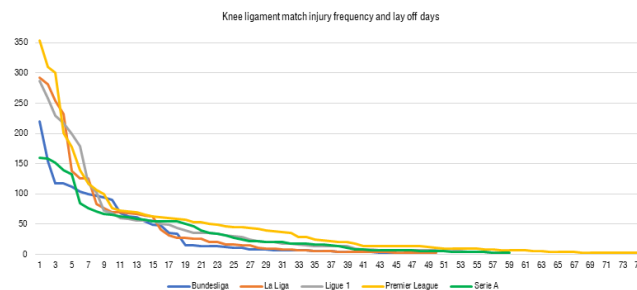


Table 3. Injury severity patterns expressed as %

Injury and severity	Bundesliga	La Liga	Ligue 1	Premier League	Serie A
Severe	40.00%	34.00%	43.10%	43.86%	40.68%
Moderate	24.44%	30.00%	29.31%	29.82%	28.81%
Mild	28.89%	24.00%	24.14%	15.79%	25.42%
Minimal	6.67%	12.00%	3.45%	10.53%	5.08%

League, where they are the least frequent (15.79%), while moderate injuries are more evenly spread, with the highest percentage occurring in La Liga (30%). The Bundesliga, La Liga, Ligue 1, Premier League, and Serie A are the five major leagues where table 4. displays the frequency of knee match injuries and the days off, while graph 3. displays data more visually in that sense. With values like 354, 310, and 300, the Premier League typically has the most days off due to injuries, but Serie A regularly has the fewest days (160, 159, and 152), suggesting that injuries are generally less severe or recover earlier, in other words, lower knee ligament injury burden. Whilst Ligue 1 has a higher frequency of more serious injuries than La Liga, both leagues exhibit intermediate trends. In contrast to the other leagues, the Bundesliga has more layoff days at the top but decreases gradually. This implies that the

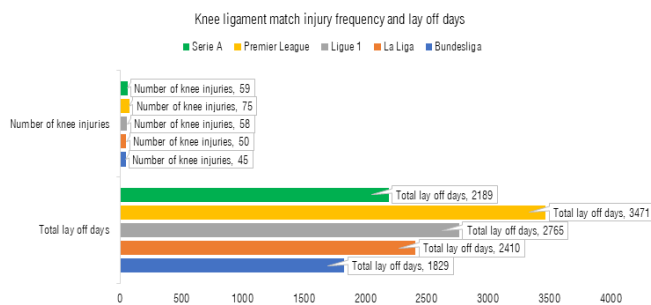
Graph 2. Distribution of knee ligament injury frequency and the lay-off days.



leagues differ in terms of injury severity and recuperation periods, given that recovery times in the Premier League are often more prolonged. The five leagues—Serie A, Premier League, Ligue 1, La Liga, and Bundesliga—are represented in the graph along

with the frequency of knee injuries and the number of days they cause players to be absent from playing and training (lay off days). Although having 75 knee injuries—slightly more than the other leagues—the Premier League had the highest number of 3,471 layoff days. With a total of 2,189 layoff days, Serie A has the highest number of 59 knee injuries, indicating that recovery time is shorter than the Premier League. La Liga has a lower incidence of 50 knee injuries than Ligue 1 (58), nevertheless, both leagues have comparable total layoff days such as 2,765 and 2,410, respectively. The Bundesliga has the lowest number of 1,829 layoff days and the fewest injuries (45), suggesting fewer recovery days and possibly less severe injuries compared to the other leagues. The variability in knee injury frequency and total layoff days across five major football leagues is displayed in this descriptive statistics graph.

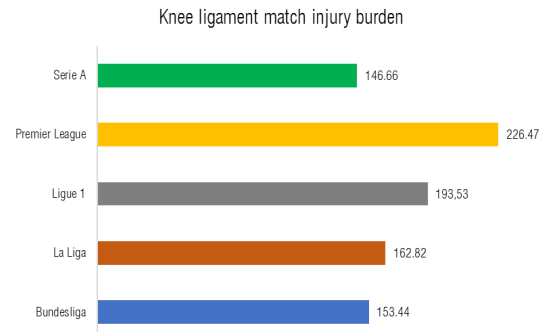
Graph 3. highlights the variability in knee ligament injury frequency and total lay-off days across five major leagues



The knee ligament injury burden for each league is presented as days per 1,000 hours of exposure in Figure 5 below. With 226.47 days per 1,000 hours of exposure, the Premier League has the highest injury burden among the leagues, indicating the significant impact of match knee ligament injuries on players. The Bundesliga and Serie A display lowered burdens of 153.44 and 146.66, respectively, suggesting that these leagues face a somewhat reduced risk and impact from injuries. In contrast, Ligue 1 has a burden of 186.67, followed by La Liga at 162.82, days per 1,000 hours of exposure. The number of days layoff as a result of knee ligament injuries per 1,000 player hours shows the burden of knee ligament match injuries in five European major football leagues as presented on Graph 5. below. With a burden of 226.47, the Premier League has the largest impact on knee ligament injuries in terms of recovery time. With a burden of 193.53, Ligue 1 comes in second, indicating a significant but lesser injury burden than the Premier League. With burdens of 162.82 and 153.44, respectively, La Liga and the Bundesliga show moderate injury impacts in terms of layoff days with approximately comparable values. Out of all the leagues examined, Serie A has the lowest knee

ligament match injury burden (146.66), reflecting the shortest period of recovery time.

Graph 4. Shows knee ligament match injury burden among the leagues



Inferential statistical techniques, including the Kruskal-Wallis test and post hoc comparisons, were used to further investigate and assess the data with the objective of identifying the degree of statistical significance. The Kruskal-Wallis test results for both knee injury incidence and knee injury burden across the five football leagues were calculated using the definitions of Injury Incidence (rate of injuries per 1000 player hours) and Injury Burden (number of lay-off days per 1000 player hours). The Hypothesis Test Summary reveals the results in table 4. below.

Table 4. Kruskal-Wallis Test summary for knee ligament match injury incidence and burden across leagues

Null Hypothesis	Test	P ^{a,b}	Decision
1 The distribution of Injury_incidence_knee_league is the same across categories of League.	KW test	.000	Reject
2 The distribution of Injury_burden_knee_league is the same across categories of League.	KW test	.000	Reject
<i>a. The significance level is .05</i>			
<i>b. Asymptotic significance is displayed.</i>			
	Injury_incidence_knee	Injury_burden_knee	
Kruskal-Wallis H	1144.000	1143.881	
df	4	4	
Asymp. Sig.	.000	.000	
<i>a. Kruskal Wallis Test</i>			
<i>b. Grouping Variable: League</i>			

Premier League has the highest mean rank (1017.50), suggesting it has the highest incidence of knee ligament injuries (Table 5.). Players in this league experience knee injuries more frequently compared to the other leagues. Ligue 1 also has a high mean rank (777.50), indicating a relatively high knee injury incidence. Serie A and Bundesliga show moderate knee injury incidence with the ranks 545.00 and 341.00 respectively. La Liga has the lowest mean rank (129.00), suggesting it has the lowest knee ligament injury incidence. This means players in La Liga suffer

fewer knee ligament injuries per 1000 player hours compared to the other leagues.

Table 5. SPSS Kruskal Wallis test ranks

Ranks			
	League	N	Mean Rank
Injury_incidence_knee	Bundesliga	167	341.00
	La Liga	257	129.00
	Ligue 1	224	777.50
	Premier League	256	1017.50
	Serie A	241	545.00
	Total		1145
Injury_burden_knee	Bundesliga	167	325.00
	La Liga	257	537.00
	Ligue 1	224	777.50
	Premier League	256	1017.50
	Serie A	241	121.00
	Total		1145
Injury_incidence_knee		Injury_burden_knee	
Kruskal-Wallis H		1144.000	1143.881
df		4	4
Asymp. Sig.		.000	.000
a. Kruskal Wallis Test			
b. Grouping Variable: League			

As shown in Table 5. above the Premier League again has the highest mean rank (1017.50), indicating it has the heaviest knee ligament injury burden. This suggests that knee ligament injuries in the Premier League result in more missed days per 1000 player hours compared to the other leagues, implying more severe or longer-lasting injuries. Ligue 1 follows closely with a high rank (777.50), indicating a significant injury burden as well. Serie A has the lowest mean rank (121.00), suggesting it has the lightest injury burden. Players in Serie A may suffer fewer severe knee ligament injuries, leading to less absence time (without training and paying) for injured players.

Table 6. Pairwise Comparisons between the leagues.

Total N	1145
Test Statistic	1144.000 ^a
Degree Of Freedom	4
Asymptotic Sig	.000
a. The test statistic is adjusted for ties.	

Sample 1-Sample 2	TS	SE	Std. TS	Sig.
La Liga-Bundesliga	212.000	32.163	6.591	<.000
La Liga-Serie A	-416.000	29.016	-14.337	.000
La Liga-Ligue 1	-648.500	29.579	-21.925	.000
La Liga-Premier League	-888.500	28.574	-31.095	.000
Bundesliga-Serie A	-204.000	32.581	-6.261	<.000
Bundesliga-Ligue 1	-436.500	33.083	-13.194	.000
Bundesliga-Premier League	-676.500	32.188	-21.017	.000
Serie A-Ligue 1	232.500	30.032	7.742	<.000
Serie A-Premier League	472.500	29.043	16.269	.000
Ligue 1-Premier League	-240.000	29.606	-8.107	<.000

Asymptotic significances (2-sided tests) are displayed.
The significance level is 0.05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

The Independent Groups Wallis-Kruskal The test statistic shown in Table 7. (1143.881) and p-value (.000), which are below the significance level of 0.05,

suggest that there are significant differences between the probability distributions of match knee ligament injury burden (severity) across the five football leagues. This implies that different leagues have distinctive injury probabilities. More details have been given by the Pairwise Comparisons, which highlight noteworthy distinctions among each pair of leagues. Whenever the Bonferroni modifications is applied to correct for multiple comparisons, each comparison between two leagues displays a significant p-value (.000). Serie A and the Premier League have the most disparities (test statistic of 896.500), where Serie A and the Bundesliga have the least variation (204.000), according to the test statistics and standard errors. The null hypothesis is rejected by every comparison, demonstrating the substantial differences in injury severity distributions among leagues. In conclusion, the Kruskal-Wallis test reveals that patterns of injury severity vary significantly among leagues, with the Premier League and Ligue 1 revealing the most significant tendencies with respect to the rest. Multiple internal as well as external factors or injury risks could potentially be accountable for these variations (McCall et al., 2015, Klačar et al., 2023, Verheijen, 2020).

Table 7. Pairwise Comparisons between the leagues.

Total N	1145
Test Statistic	1143.881 ^a
Degree Of Freedom	4
Asymptotic Sig (2-sided test)	.000
a. The test statistic is adjusted for ties.	

Sample 1-Sample 2	TS	SE	Std. TS	Sig.
Serie A-Bundesliga	204.000	32.582	6.261	<.001
Serie A-La Liga	416.000	29.017	14.336	.000
Serie A-Ligue 1	656.500	30.034	21.859	.000
Serie A-Premier League	896.500	29.045	30.866	.000
Bundesliga-La Liga	-212.000	32.165	-6.591	<.001
Bundesliga-Ligue 1	-452.500	33.085	-13.677	.000
Bundesliga-Premier League	-692.500	32.189	-21.513	.000
La Liga-Ligue 1	-240.500	29.580	-8.130	<.001
La Liga-Premier League	-480.500	28.575	-16.815	.000
Ligue 1-Premier League	-240.000	29.607	-8.106	<.001

Asymptotic significances (2-sided tests) are displayed.
The significance level is 0.05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

DISCUSSION

Every comparison investigated the null hypothesis, which states that there is no difference in the incidence or burden of injuries between two leagues. Since the p-values for knee ligament match injury incidence and knee ligament match injury burden are both 0.000, showing substantial differences across the leagues, we reject the null hypothesis for both tests. After performing the Bonferroni correction to adjust for multiple comparisons, the findings indicate significant differences across the majority of league pairs. Analysis of the knee ligament match injury incidence

as pairwise comparisons show the results, that the incidence in La Liga is far lower than in the Bundesliga, with the test statistic = 212.000, p-value = 0.000 (significant) for La Liga vs. Bundesliga. La Liga compared to Ligue with the 1: p-value = 0.000, test statistic = -648.500, La Liga has a considerably lower incidence. Premier League against La Liga and the p-value = 0.000, test statistic = -888.500. Indicates that The Premier League has a far higher incidence over La Liga.

Bundesliga as opposed to Serie A with the p-value = 0.000 and test statistic = -204.000. In comparison to Serie A, the Bundesliga has a substantially reduced incidence of knee ligament match injuries. There is a statistically significant difference in the incidence of knee ligament match injuries between the Bundesliga and Serie A, with the Bundesliga having substantially lower injury rates, according to the test statistic of -204.000 and p-value of 0.000. Comparing the Bundesliga to Ligue 1 and the Premier League proven exactly noteworthy differences, with the Bundesliga displaying a lower incidence of knee ligament match injuries. According to these results, knee injuries are less common in the Bundesliga than in these other major European leagues.

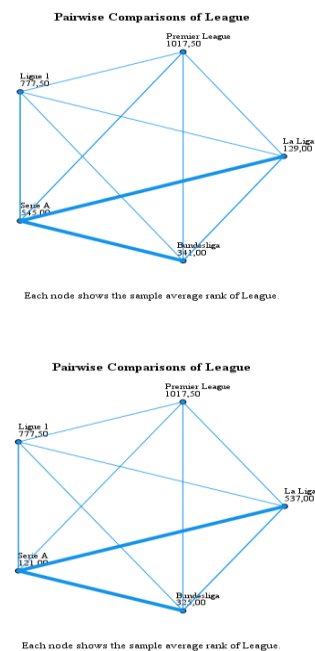
In a nutshell, several internal and external factors, such as differences in training load, methods, player conditioning, recovery time, injury mechanisms, and medical support, may have an impact on the noteworthy differences in knee ligament injury incidence between the Bundesliga and other big European leagues, such as Serie A, Ligue 1, and the Premier League (Ekstrand et al., 2021, Ekstrand et al., 2018). It's crucial to take into account that, in general, the risk of knee ligament injuries during games in football is ten to fifteen times higher than during training, reflecting on the earlier discussion of league differences in knee ligament match injury incidence (López-Valenciano et al., 2020, Robles-Palazón et al., 2022). Grassi and colleagues (2020) found that ACL injuries during matches are 14 times more prevalent in Serie A than during training. This demonstrates how match circumstances, irrespective of league, have a tendency to significantly increase injury risks, which contributes to the observed differences within leagues. Analysis of the knee ligament match injury burden as pairwise comparisons show the results, the Bundesliga in comparison to Serie A with a p-value = 0.000 (significant) and test statistic = 204.000, relative to the Bundesliga, Serie A has a much lower knee ligament match injury burden.

In contrast to La Liga, Serie A has a significantly lower injury burden (test statistic = 416.000, p-value = 0.000). In relation to Ligue 1, the injury burden in Serie A is substantially lower (test statistic = 656.500, p-

value = 0.000). In contrast to the Premier League, Serie A has a significantly decreased injury burden, (test statistic of = 896.500, p-value = 0.000). There are key differences between the Bundesliga, La Liga and Premier League, with the Bundesliga displaying a greater knee ligament match injury burden than La Liga but a lesser burden than the Premier League.

The ACL injury rate in male professional football players showed no declining trend during the 2000s (Lundblad, 2019). An overall ACL injury rate of 0.066 per 1000 hours of exposure, or 0.43 per squad of 25 players throughout a season, is reported by Walden and colleagues (2016). This suggests that each team will have one of these injuries generally every second season. Lundblad (2019) reported that a men's professional team can expect approximately two MCL injuries a season and one LCL injury every third season, while a PCL injury can be expected every 17th season. These knee ligament injuries typically occur during matches and are associated with a contact injury mechanism.

Graph 4 and 5. Knee ligament injury and injury burden incidence across League.



The group's average rank of injury incidence and burden across five major football leagues is shown in the two pairwise comparison charts (Graphs 6 & 7). The Premier League has the highest average rank in both graphs, suggesting that it has the largest knee-match injury burden and/or knee-match injury incidence among all leagues. While the Bundesliga and La Liga are continuously ranked lower, Serie A and

Ligue 1 are consistently on the lower side the findings of the hypothesis test summary, the Kruskal-Wallis test results demonstrate that there are substantial differences in the frequency and burden of knee injuries among the leagues ($p < 0.001$ for both tests). Following executing the Bonferroni correction to correct for multiple comparisons, pairwise comparisons validate that the differences between each pair of leagues are statistically significant ($p < 0.001$). All comparisons reveal highly significant results, highlighting significant differences in the injury profiles across these big 5 European leagues. Practically speaking, the Premier League stands out for having a significantly higher knee ligament match injury burden and incidence compared to other leagues.

Pairwise comparisons are shown by the lines linking the leagues, and the degree of discrepancy between the leagues may be shown by the lines' thicknesses (Graph 4. & 5.). Minor differences in average ranks may be indicated by narrower lines, whereas bigger disparities may be represented by thicker lines.

CONCLUSION

Knee ligament injuries during match play in the top 5 European leagues are not similar, and there is a statistically significant disparity in terms of both knee ligament injury burden and knee ligament injury incidence. Among all the big five European leagues, La Liga has the lowest knee ligament match injury incidence. The knee ligament match injury burden and incidence are continuously much higher in the Premier League and Ligue 1, revealing that knee injuries are both frequent and severe. Knee ligament injuries are less severe but have substantial incidence rates for Serie A, which tends to have a reduced injury burden. These findings suggest that the Bundesliga and La Liga have a lower risk of knee ligament match injury rates compared to these other top European leagues. In the end, La Liga shows a considerable knee ligament match injury burden but the lowest knee ligament match injury incidence, the Bundesliga has considerably reduced values across both categories, but the Premier League continuously exhibits higher knee ligament match injury incidence and knee ligament match burden. The notable distinctions between the leagues are further supported by these pairwise comparisons, especially concerning the frequency and severity of knee ligament injuries that affect the clubs and players of the big five European football leagues.

Further injury prevention strategies, recovery programs and specific models (play/rest/train ratios) should be introduced and developed in order to reduce the potential risks for knee ligament injuries (Krutsch et al.,

2016) and to decrease the severity of these specific career-threatening injuries (Bizzini et al., 2019, Klein et al., 2018b). A particular concern is the fact that teams frequently disregard the quality of training, and professional football players are currently spending significantly more time playing (Verheijen, 2020). According to an 18-year prospective cohort study, Ekstrand et al. (2021) revealed that while the burden of injuries did not decrease and has remained constant, the rate of ligament injuries during matches has decreased. A modest increase in ligament injury severity was observed in this study. In this regard, the scientific evidence is neither particularly encouraging nor optimistic.

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Conflict of Interest

The authors do not have any conflicts of interest to disclose. All co-authors have reviewed and concurred with the manuscript's content, and no financial interests need to be reported.