Original Article

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Prevalence, localisation, and contributing factors of injuries in team sports: a pilot analysis of Croatian football and handball

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Abstract: A paucity of data exists concerning musculoskeletal injuries in athletes participating in contact team sports, a situation that is particularly salient in the Croatian context. The present pilot study analyzed injury profiles in 203 Croatian male football and handball players (114 and 89, respectively). Item-level responses were executed without the utilization of skip logic, consequently yielding slight variations in sample sizes for each variable. Descriptive and non-parametric statistics, including effect size, were applied. The prevalence of injuries was found to be high, with 86.7% of athletes reporting a history of musculoskeletal injury. Lower extremity injuries were the most prevalent injury type, accounting for 79.3% of cases, and were particularly common among football players. In contrast, upper extremity injuries were more frequently reported by handball players, with a rate of 20.0%, which is significantly higher than the rate of 9.2% observed among football players. Despite the modest effect sizes observed, these sport-specific variations were found to be statistically significant ($V = 0.153–0.179$). A comparison of the injury rates revealed that football players exhibited a higher proportion of total injuries (97.0%) compared to handball players (72.7%), although this difference was insignificant ($p = 0.065$). A higher prevalence of injuries was observed during the competitive season phase (58.9%; $\chi^2(1) = 10.68$, $p = 0.001$, $V = 0.244$). A modest positive correlation was found between the duration of sports experience and the frequency of injuries ($\rho = 0.203$, $p = 0.006$). However, the rest period between training sessions was found to be unrelated to the occurrence of injuries ($\rho = 0.013$, $p = 0.882$). The prevalence of recurrent injuries among injured athletes was found to be 58.6%, with no significant association observed between this phenomenon and the availability of physiotherapists. The findings of this study underscore the need for prevention programs tailored to the specific risks associated with sports and the varying experience levels of athletes. To effectively address these issues, ongoing research and evaluation using statistical and practical effect estimates are imperative.

Keywords: Contributing Factors; Team Sports; Musculoskeletal Injuries; Prevalence

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INTRODUCTION

Football and handball are contact team sports that involve high-intensity movements, such as jumps, sprints, changes of direction, and sudden stops [1-3]. These dynamic and repetitive actions, combined with direct player-to-player contact, predispose players to frequent musculoskeletal injuries. Professional athletes face increased training and competition demands, often with insufficient recovery, which elevates injury risk despite the recognized benefits of physical activity [4]. Epidemiological data report an average injury incidence of 2.64 injuries per 1000 hours of sport exposure, with higher rates observed in high-impact team sports and lower rates in individual sports with less physical contact [5].

Football presents a higher incidence of injuries than other contact sports, with muscle injuries accounting for 31% of all injuries and 92% of musculoskeletal injuries affecting the lower extremities. Injury rates are 3.7 per 1000 hours during training and rise sharply to 36 injuries per 1000 hours in competition [6-7]. Similarly, handball is characterised by a high incidence of musculoskeletal injuries due to intense movement dynamics and direct contact. Injuries range from 0.9 to 2.6 during training and 9.9 to 41 injuries per 1000 hours during competition [8-10].

Both sports exhibit high injury rates across all levels, including professional, amateur, and youth, in both training and competition [6-7,10]. Increased competition, speed, physical fitness demands, and training intensity contribute to this trend, especially at the professional level [11]. Musculoskeletal injuries account for 80% of football injuries and about 67% in handball, with the remainder involving other body systems [12-13]. Injury risk is influenced by age, training load, level of play, and training standards [11].

Although the epidemiology of musculoskeletal injuries in contact team sports has been extensively studied internationally, there is a notable lack of systematically collected and analysed data on injury incidence, types, and contributing factors among Croatian football and handball players**.** The absence of national data hinders the development of evidence-based injury prevention and management strategies tailored to the specific training conditions, competition demands, and healthcare infrastructure in Croatia.

Given the growing intensity of professional and amateur sports, including the increased physical and psychological demands placed on athletes, addressing this gap is essential for protecting athlete health, optimizing performance, and aligning national practices with international standards**.** It is also relevant for strengthening institutional policies for injury prevention and long-term athlete development programs. This identified gap in the national context served as the impetus for conducting a pilot study to explore the occurrence and profiles of musculoskeletal injuries in Croatian football and handball players. The study also sought to identify potential factors associated with injury occurrence, providing a preliminary evidence base for future, more comprehensive research.

Considering the aim and structure of the study, the following hypotheses were formulated: (H1) football players experience a higher total number of injuries than handball players; (H2) lower extremity injuries are more frequent among football players than handball players; (H3) upper extremity injuries are more common among handball players than football players; (H4) athletes with more years of sports experience report a higher number of injuries; (H5) greater rest time between training sessions is associated with a lower injury frequency; (H6) injuries occur more frequently during the competitive phase of the season than in the preparatory phase; (H7) contact injuries are more prevalent than non-contact injuries; and (H8) the presence of a club physiotherapist is associated with a lower incidence of recurrent injuries.

This pilot study may provide valuable preliminary insights into injury patterns among Croatian football and handball players. Given the stated aims and hypotheses, the results have potential relevance within national sports. They may serve as a foundation for more detailed research using larger and more diverse athlete samples to expand and validate current knowledge based on international evidence.

MATERIAL AND METHODS

Participants

The target group for this study consisted of senior football and handball players aged 18 and above who competed in the First, Second, Third, or Fourth Croatian national leagues. Participants were selected using a purposive sampling method, with efforts to ensure that the sample of competitive athletes across different league levels was as representative as possible. Since skip logic was not applied in the online questionnaire, some participants responded to injury-specific items despite not reporting a general history of injury.

A total of 203 male senior athletes participated in the study, comprising 114 football players (56.2%) and 89 handball players (43.8%), all of whom were actively engaged in structured national-level competition. The full sample was used for descriptive analysis (Table 1). For inferential analyses, valid sample sizes varied depending on the completeness of responses for specific variables, with a pairwise deletion strategy applied. This sample reflects a cohort of physically active, competitively engaged athletes with substantial training experience across all four league levels.

Although not chosen randomly, the sample was considered a suitable starting population for a pilot study to gain preliminary insights into the prevalence, mechanisms, and management of musculoskeletal injuries within the Croatian context of team sports such as football and handball.

Table 1 presents the demographic, anthropometric, and training characteristics of the full sample of respondents (N = 203), before exclusions were applied for inferential analysis. Among these, 114 were football players (56.2%) and 89 were handball players (43.8%). The average age was 23.26 years (SD = 5.47; range, 16–42), with most participants falling between 18 and 25 years old. The mean height was 184.12 cm (SD = 6.76; range = 165–203), while the average body mass was 83.41 kg (SD = 10.76; range = 61–118), resulting in a mean body mass index (BMI) of 24.52 kg/m^2 (SD = 2.49; range = 19–35). These BMI values generally fall within the normal to slightly elevated range, which is expected in elite athlete populations.

All athletes were actively competing in one of the four Croatian national leagues: the Second League (n = 69; 34.0%), the First League (n = 57; 28.1%), the Third League (n = 43; 21.2%), and the Fourth League (n = 34; 16.7%). The majority had ≥9 years of sports experience (n = 159; 78.3%), with 13.8% having 7–9 years of experience, and only 7.9% having less than 6 years of experience.

Participants reported training an average of 5.25 times per week (SD = 1.29), each lasting approximately 2.46 hours (SD = 1.18). The average rest time between training sessions was 16.87 hours (SD = 9.26), with a median of 20 hours and a mode of 24 hours, suggesting adequate but individually variable recovery.

A total of 176 participants (86.7%) reported a history of musculoskeletal injuries sustained during their athletic careers, indicating a high prevalence of injury in this cohort. While the sample includes athletes from different leagues and experience levels, all were senior-level competitors actively engaged in structured, national-level competition.

Protocol

This pilot study was conducted in December 2022 using a self-administered, purpose-built online questionnaire developed specifically for the present research. The instrument consisted of 22 items and was delivered via Google Forms. It had not been previously standardised or piloted. To enhance response rates, the survey link was distributed through social media and relevant communication channels. A snowball sampling technique was employed, whereby initial respondents were invited to share the questionnaire with other eligible athletes.

The questionnaire included two sections. The first set of data gathered included sociodemographic and anthropometric data on age, height, body mass, and body mass index (BMI), all recorded as continuous variables. The second section focused on sport-specific and injury-related information, primarily categorical in nature. These included the type of sport (football or handball), years of sports experience, frequency of weekly training, average daily training duration, and rest intervals between sessions.

Injury-related items captured injury history and frequency, anatomical location (with multiple selections allowed: lower and upper extremities, spine, head, chest), seasonal timing (competitive vs. preparatory phase), and mechanism of injury (contact or non-contact). Injury outcomes were also assessed, including absence duration, recurrence in the same anatomical region, type of immediate medical assistance (physiotherapist, physician, coach, or none), treatment modality (physiotherapy, surgery, or none), and access to a physiotherapist within the athlete's club.

All submitted responses were reviewed for completeness and quality. The dataset was examined for missing or invalid entries, and any issues were addressed appropriately. Variables were organised and prepared for analysis.

Statistical analysis

The normality of the distribution was assessed using the Kolmogorov–Smirnov test. Descriptive statistics were calculated to characterize the sample and provide an overview of training patterns and injury characteristics. For continuous variables (e.g., age, body mass, height, training frequency), measures of central tendency (mean, median, mode), variability (standard deviation, interquartile range), and range were computed. For categorical variables (e.g., sport type, injury mechanism, body region affected), absolute and relative frequencies were reported. Descriptive summaries were stratified by sport (football vs. handball) where applicable.

Table 1. Descriptive characteristics of participants, training load, and injury history.

Variable	Mean (SD)	Median	Mode	Range / n (%)
Age (years)	23.26 (5.47)	22.0	18.0	16 – 42 (n = 203)
Height (cm)	184.12 (6.76)	185.0	185.0	165 – 203 (n = 203)
Body mass (kg)	83.41 (10.76)	83.0	80.0	61 – 118 (n = 203)
Body Mass Index (BMI, kg/m^2)	24.52 (2.49)	24.15	24.93	19 – 35 (n = 203)
Type of sport	—	—	—	Football: 114 (56.2%) / Handball: 89 (43.8%) (n = 203)
League	—	—	—	2: 69 (34.0%) / 1: 57 (28.1%) / 3: 43 (21.2%) / 4: 34 (16.7%) (n = 203)
Years of sports experience	—	—	—	<6: 16 (7.9%) / 7–9: 28 (13.8%) / ≥9: 159 (78.3%) (n = 203)
Weekly training frequency (sessions/week)	5.25 (1.29)	5.0	5.0	2 – 10 (n = 201)
Daily training duration (hours)	2.46 (1.18)	2.0	2.0	1 – 10 (n = 199)
Rest time between training sessions (h)	16.87 (9.26)	20.0	24.0	0 – 48 (n = 199)
History of injury during career	—	—	—	176 (86.7%) (n = 203)

Descriptive data from all 203 respondents. No participants were excluded. Sample sizes vary slightly per variable due to item-level nonresponse.

Inferential tests were conducted to evaluate predefined hypotheses regarding injury patterns, training factors, and demographic variables. The following statistical procedures were employed:

Inferential tests were conducted to evaluate predefined hypotheses regarding injury patterns, training factors, and demographic variables. The following statistical procedures were employed:

- H1: Football players experience a higher total number of injuries than handball players. A Mann-Whitney U test was used to compare the distribution of total injuries between football and handball players. This non-parametric test was appropriate due to the ordinal nature of injury frequency responses and the non-normal distribution of data. Midpoint values were assigned to categorical ranges to enable ranking. The test assessed differences in injury burden across sports, and the effect size was estimated using the r statistic.
- H2: Injuries to the lower extremities are more frequent in football than in handball players. A Chi-square test of independence was used to evaluate the relationship between sport and the most frequently injured body region, specifically lower extremity injuries. Categorical injury location data were extracted and recoded. Cramér's V was calculated to determine the strength of association.
- H3: Injuries to the upper extremities are more common in handball players than in football players. A second Chi-square test was applied to test the association between sport and upper extremity injury prevalence. This test followed the same procedure as in H2, with groupings based on self-reported regions most commonly injured.
- H4: Athletes with more years of competitive sports experience report a higher number of injuries. A Spearman rank-order correlation was conducted to examine the relationship between the length of competitive sports participation and the number of injuries. Ordinal experience data were transformed into numerical midpoints (e.g., "7–9 years" = 8), as were injury frequencies. This correlation was selected due to the non-parametric nature of both variables.
- H5: Greater rest time between training sessions is associated with fewer injuries. A second Spearman correlation was used to test the association between reported average rest time (in hours) between training sessions and the number of injuries sustained. Rest time was treated as a continuous variable, while injury counts were treated ordinally.
- H6: Injuries are more frequently reported during the competitive phase of the season than during the preparatory phase. A Chi-square test was employed to examine whether injury occurrence differed by training phase (competitive vs. preparatory). The most recent injury timing was used as the criterion, and the injury phase was treated as a binary categorical variable.
- H7: Contact injuries are more frequent than non-contact injuries. The proportions of contact versus non-contact injuries were compared using a Chi-square test. Self-reported mechanism of injury was used to categorize cases into contact and non-contact types.
- H8: Athletes whose clubs employ a physiotherapist experience fewer recurrent injuries. A final Chi-square test of independence was used to evaluate whether the presence of a club-employed physiotherapist was associated with a lower incidence of injury recurrence. Both variables were dichotomous, and the effect size was reported using Cramér's V.

The effect sizes were interpreted according to Cohen's guidelines [14]: values of 0.10 or less were considered small, 0.30 to 0.49 medium, and 0.50 or higher large. These thresholds are widely used in the health and behavioral sciences and are particularly relevant in injury contexts, where even minor effects can have significant implications for practice and policy. The significance level was set at $p < 0.05$. All analyses were conducted using appropriate statistical software (Statistica, Version 13.5.0.17, 1984-2018 TIBCO Software Inc.). Corresponding visual representations support key results.

Missing data handling

The data were collected via a self-administered online questionnaire, so a certain degree of item-level nonresponse was anticipated. The dataset was thoroughly examined before statistical analysis to identify any missing values. All variables were screened using descriptive statistics to detect empty cells or non-interpretable responses. Following the procedure below, these values were coded as missing and excluded from analyses.

A pairwise deletion strategy was employed, meaning that each statistical analysis was conducted using only those participants who provided complete data for the specific variables involved in that analysis. This method maximized the use of available data without artificially inflating the sample size or introducing bias through data substitution. For example, a participant who completed demographic and training-related items but skipped injury-related questions was included in analyses of anthropometric characteristics but excluded from injury-related statistical tests. The valid sample size (n) for each test is reported alongside the corresponding result to ensure transparency and traceability.

Given that many of the variables were categorical or ordinal in nature, and the overall proportion of missing responses was low, no imputation methods were applied. The decision not to impute values helped preserve the integrity and interpretability of the original data. Additionally, exploratory checks for missingness patterns were conducted. These results indicated no systematic association between missing data and participant characteristics, such as sport type or age, supporting the assumption that the data were missing randomly.

This conservative and transparent approach to handling missing data ensured the robustness and reliability of the statistical analysis while maintaining the validity of the study's findings.

Ethical considerations

Before the study commenced, approval was obtained from the Ethics Committee for Biomedical Research at the Faculty of Health Studies, University of Rijeka.

Before participation, respondents were fully informed about the study’s objectives and provided with necessary information concerning ethical considerations. Participation was voluntary, and respondents could withdraw at any time without justification.

The study adhered to the Helsinki Declaration and relevant national and European data protection regulations. Completing the questionnaire implied informed consent for the use of the data. The survey system required complete responses for submission, ensuring the validity and integrity of the data. The collected data have been securely stored on a protected drive, accessible solely to the research team, and will be destroyed five years after the study’s completion.

RESULTS

Injury patterns and contexts are summarized in Table 2. Nearly one-third of athletes (30.3%) reported experiencing six or more injuries throughout their careers, highlighting the recurrent nature of musculoskeletal trauma in competitive team sports. The lower extremities emerged as the most commonly affected region, accounting for 79.3% of reported injuries, consistent with the movement demands of football and handball. Upper extremity injuries followed, representing 16.6% of all cases, while injuries to the spine and head were rare, and no chest injuries were reported.

When considering the timing of injuries, a majority occurred during the competitive phase of the season (56.6%), lending support to the notion that match intensity and physical contact elevate injury risk during in-season play. Regarding mechanism, contact-related injuries were slightly more prevalent (51.7%) than non-contact injuries (48.3%), suggesting that while external collisions and duels play a significant role, intrinsic or load-related mechanisms are nearly as substantial.

Table 2. Injury site and circumstances.

Variable		n (%)
Most frequently injured body region	Lower extremities (including the hip, knee, ankle, and foot)	131 (74.4%) (n = 176)
	Upper extremities (including the shoulder, elbow, and hand)	38 (21.6%) (n = 176)
	Spine (including the cervical, thoracic, and lumbar spine)	0 (0.0%) (n = 176)
	Head (face included)	2 (1.1%) (n = 176)
	Chest	1 (0.6%) (n = 176)
Injury timing during the season	Competitive phase	106 (58.9%) (n = 180)
	Preparatory phase	74 (41.1%) (n = 180)
Mechanism of injury	Contact	99 (54.7%) (n = 181)
	Non-contact	82 (45.3%) (n = 181)
Number of injuries sustained	≥ 6 injuries	47 (26.7%) (n = 176)

Responses from all participants who answered at least one injury-related question. No automated skip logic was applied; thus, sample sizes vary and may exceed the number of participants who explicitly reported a prior injury.

Injury burden and management characteristics are summarized in Table 3. An overwhelming 98.6% of injured athletes reported missing training or matches due to injury, highlighting the substantial functional impact of musculoskeletal trauma in competitive team sports. The median time lost was 8.7 weeks (interquartile range: 4–16 weeks), with the most commonly reported absence being 4 weeks. Some athletes reported absences lasting up to 208 weeks; however, when trimmed to within one year, the range remained up to 52 weeks, with a mean recovery time of 12.3 weeks. This highlights significant variability in recovery duration, likely due to differences in injury severity and access to rehabilitation.

More than half of the injured athletes (58.6%) experienced recurrent injuries, most often affecting the same anatomical region, suggesting possible shortcomings in initial rehabilitation or ongoing exposure to unresolved risk factors.

In terms of initial post-injury management, physiotherapists were the most frequently involved healthcare providers (47.6%), followed by physicians (33.8%) and, to a lesser extent, coaches (15.2%). Alarmingly, 3.5% of respondents reported receiving no professional assistance following injury, raising concerns about medical oversight and access.

Regarding treatment strategies, physiotherapy emerged as the primary modality (70.3%), reinforcing its central role in athlete recovery and return-to-play protocols. However, 24.8% of athletes required surgical intervention, indicating a notable proportion of high-severity injuries. Only 4.8% reported not receiving any form of treatment.

Encouragingly, the majority of athletes (79.0%) had access to a physiotherapist within their club, although one in five (21.0%) lacked this support. This gap may affect long-term recovery outcomes and injury recurrence, aligning with broader concerns in the study regarding the variability of medical infrastructure across teams.

Table 3. Injury burden and management.

Variable		Median (IQR)	Mode	Range/n (%)
Injury burden	Absence from training or matches	—	—	143 (98.6%)
	Duration of absence (weeks)	8.70 (4–16)	4	0–208 (n = 137)
	Duration of absence (weeks), trimmed ≤ 1 year	8.70	—	0–52 (n = 134); Mean = 12.28 (SD = 12.06)
	Recurrent injury (re-injury of the same region)	—	—	85 (58.6%)
Type of medical help received after injury	Physiotherapist	—	—	69 (47.6%)
	Physician	—	—	49 (33.8%)
	Coach	—	—	22 (15.2%)
	No assistance	—	—	5 (3.5%)
Type of treatment applied	Physiotherapy	—	—	102 (70.3%)
	Surgical treatment	—	—	36 (24.8%)
	No treatment	—	—	7 (4.8%)
Club physiotherapist	Yes	—	—	139 (79.0%)
	No	—	—	37 (21.0%)

All available responses to injury-related items. Although 176 participants formally reported injury history, up to 181 respondents provided data on one or more injury-related items, in the absence of skip logic.

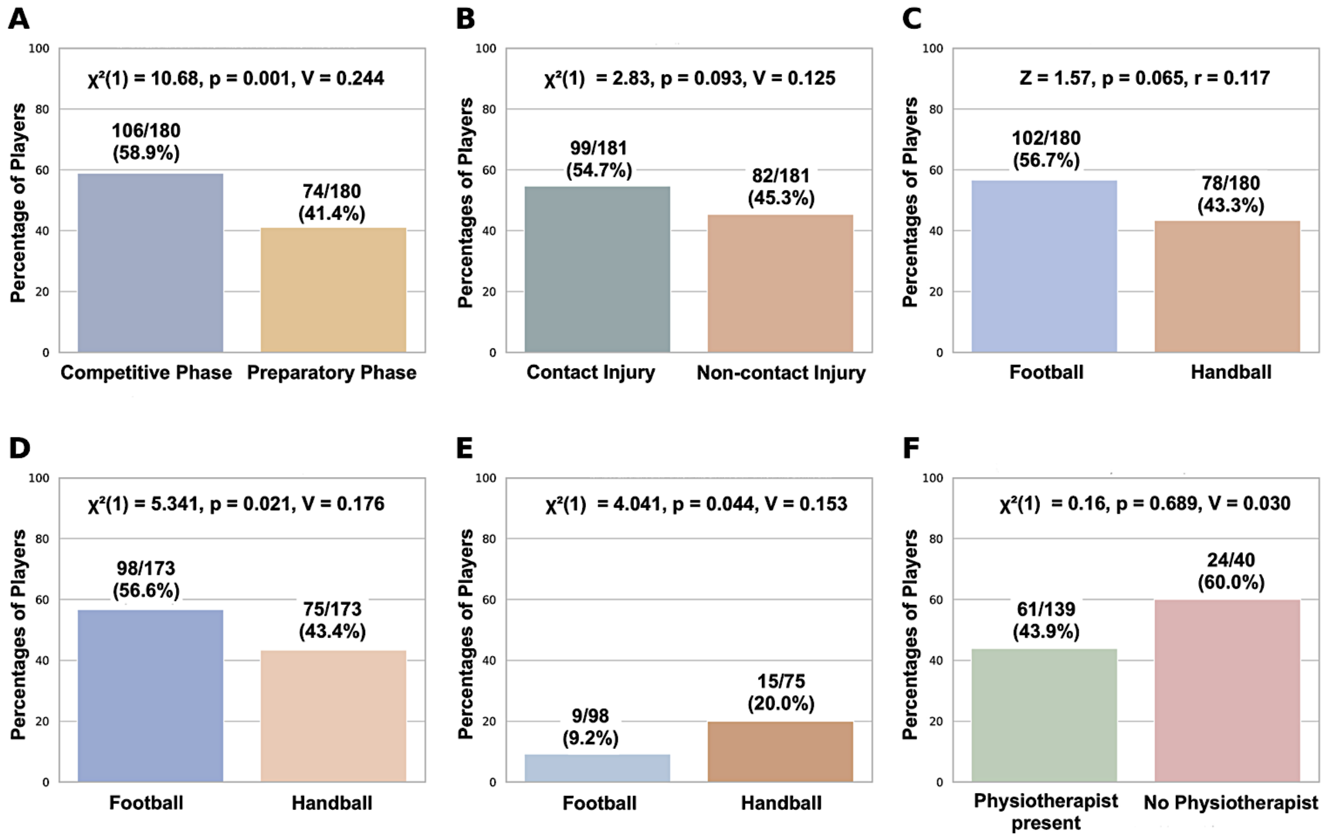

Figure 1. Graphical representation of selected injury patterns and differences between groups. A. Distribution of overall injuries by season phase, B. Proportion of contact and non-contact injuries, C. Overall injury distribution between football and handball players, D. Lower extremity injuries among football and handball players, E. Upper extremity injuries among football and handball players, F. Recurrent injuries concerning physiotherapist presence. Due to item-level nonresponse and the absence of skip logic, valid sample sizes differed slightly across analyses: A (n = 180), B (n = 181), C (n = 180), D–E (n = 173), F (n = 179).

Figure 1 (panels 1A–1F) presents selected injury patterns and group differences. In panel 1A, a greater proportion of injuries occurred during the competitive phase of the season (58.9%; 106 out of 180) compared to the preparatory period (41.1%; 74 out of 180). This difference was statistically significant ($\chi^2(1) = 10.68$, $p = 0.001$) with a small-to-moderate effect size (V = 0.244), supporting H6 and highlighting the elevated risk during periods of match play.

In panel 1B, contact injuries (54.7%; 99 out of 181) were somewhat more frequent than non-contact injuries (45.3%; 82 out of 181); however, this difference did not reach statistical significance ($\chi^2(1) = 2.83$, $p = 0.093$, V = 0.125), and H7 was not supported.

Panel 1C compares the proportion of injured athletes between sports. Although more football players reported injuries (56.7%; 102 out of 180) than handball players (43.3%; 78 out of 180), the difference was not statistically significant (Z = 1.57, $p = 0.065$, r = 0.117), and thus H1 was not confirmed.

In contrast, analyses of injury location revealed significant differences by sport. As shown in panel 1D, football players reported a higher prevalence of lower extremity injuries (56.6%; 98 out of 173) than handball players (43.4%; 75 out of 173), with a statistically significant difference ($\chi^2(1) = 5.341$, $p = 0.021$) and a small effect size (V = 0.176), in line with H2. Similarly, panel 1E shows that upper extremity injuries were more common among handball players (20.0%; 15 out of 75) than football players (9.2%; 9/98), again with statistical significance ($\chi^2(1) = 4.041$, $p = 0.044$) and a small effect (V = 0.153), confirming H3.

Finally, panel 1F addresses the potential impact of access to a physiotherapist on injury recurrence. Among athletes with a physiotherapist present, 43.9% (61 out of 139) reported recurrent injuries, compared to 60.0% (24 out of 40) among those without a physiotherapist present. Despite this numerical difference, the result was not statistically significant ($\chi^2(1) = 0.16$, $p = 0.689$, V = 0.030), and therefore, H8 was not supported.

Figure 2 (panels 2A–2B) presents associations between athlete characteristics and injury frequency. In panel 2A, a statistically significant positive correlation was observed between years of sport-specific experience and the number of injuries sustained ($\rho = 0.203$, $p = 0.006$). Although the effect size was small, the relationship suggests that athletes with more years of participation tend to accumulate more injuries over time. This finding supports H4, indicating that injury risk may compound with prolonged exposure to training and competition demands.

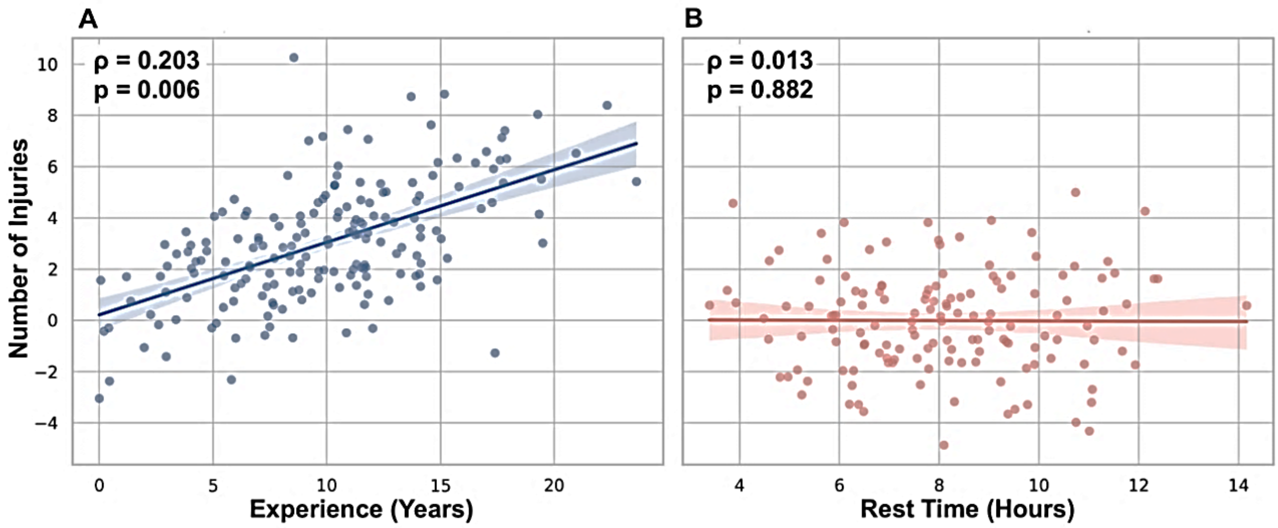

Figure 2. Linear regression between: A. years of experience and number of injuries among players (n=180), B. rest time and number of injuries (n=141). Sample sizes reflect the number of complete cases per variable pair.

In contrast, panel 2B shows no meaningful association between rest time and injury frequency (ρ = 0.013, p = 0.882). The correlation was negligible and statistically non-significant, indicating that self-reported rest duration between sessions was unrelated to the number of injuries in this sample. Accordingly, H5 was not supported.

DISCUSSION

There is an apparent lack of data on injury patterns among Croatian athletes, especially in football and handball, which makes it challenging to design effective prevention strategies and support long-term athlete development. Therefore, this pilot study aimed to investigate the prevalence, localization, and contributing factors of musculoskeletal injuries among Croatian senior football and handball players. The participants varied in age, anthropometric characteristics, and sport-specific experience, providing a representative cross-section of sub-elite team sport athletes (n = 203). The vast majority (86.7%) reported at least one musculoskeletal injury during their careers, allowing for meaningful comparison of injury patterns and contributing factors across sports.

With 86.7% of participants reporting a history of injury, the findings reaffirm the high injury burden in contact team sports, in line with prior international reports [6–7,10]. Although the overall injury frequency did not differ significantly between football and handball players, footballers exhibited a slightly higher proportion of injuries (97.0% vs. 72.7%), with a small effect size (r = 0.117), indicating a modest but practically relevant difference. While this does not confirm H1 statistically, it suggests that sport-specific demands may lead to divergent long-term injury burdens, particularly with larger samples.

Sport-specific injury localisation was more pronounced. Football players reported significantly lower extremity injuries than handball players ($\chi^2(1) = 5.341$, p = 0.021, V = 0.176), whereas handball players reported more upper extremity injuries ($\chi^2(1) = 4.041$, p = 0.044, V = 0.153). These differences, albeit accompanied by small effect sizes, confirm H2 and H3 and reflect the respective biomechanical and tactical demands of each sport. Such sport-specific distributions have been previously documented in elite populations [6, 16–18], emphasizing the need for targeted injury prevention strategies that prioritize limb-specific vulnerabilities.

The observed correlation between years of sports experience and injury frequency (ρ = 0.203, p = 0.006) was statistically significant, albeit small in magnitude, lending support to H4. This suggests a cumulative effect of prolonged exposure, consistent with existing sports injury models that highlight chronic load as a key factor in injury risk [11,19]. In contrast, rest time between training sessions was not associated with injury frequency (ρ = 0.013, p = 0.882), failing to support H5. This null finding, together with the negligible effect size, suggests that rest duration alone may not be a significant predictor of injury risk, especially in the absence of more detailed information on recovery quality, training load fluctuations, or periodization strategies [19,20].

The timing and mechanism of injury occurrence further illuminate high-risk contexts. As hypothesised in H6, a significantly higher proportion of injuries occurred during the competitive phase of the season ($\chi^2(1) = 10.68$, p = 0.001, V = 0.244). This small to moderate effect size supports the view that match intensity, psychological pressure, and shorter recovery periods increase injury susceptibility during competition, as also reported by Ekstrand et al. and others [6,10,18]. The contact vs. non-contact injury distribution, while leaning toward contact (54.7%), did not reach statistical significance ($\chi^2(1) = 2.83$, p = 0.093, V = 0.125), and thus H7 was not supported. The nearly equal proportions highlight the complex interplay of intrinsic (e.g., overuse, fatigue) and extrinsic (e.g., collisions, fouls) factors in injury causation.

One notable finding relates to recurrent injuries. While more athletes without access to a club physiotherapist reported recurrence (60.0%) compared to those with access

(43.9%), this difference was not statistically significant ($\chi^2(1) = 0.16$, $p = 0.689$, $V = 0.030$), and H8 was not supported. Still, the observed discrepancy suggests a potential role for structured rehabilitation and professional medical presence in mitigating the risk of reinjury. The fact that one in five athletes lack access to a club physiotherapist further underscores a potential gap in post-injury care infrastructure.

The results align with previous studies, indicating that both football and handball involve frequent lower limb trauma due to dynamic actions such as acceleration, deceleration, jumping, and pivoting [6–7, 16]. However, our findings also highlight a notable upper limb burden in handball players, possibly due to sport-specific mechanics such as throwing, blocking, and collisions during gameplay [18,21]. Compared to existing literature, our sample exhibited a slightly higher proportion of upper extremity injuries in handball, which may reflect regional differences in tactical play, training methodology, or access to physiotherapy.

While rest time was not significantly associated with injuries, the result should not be interpreted as diminishing the importance of recovery. Instead, it emphasises the multifactorial nature of injury risk. Authors such as Gabbett [19] and Meeusen et al. [20] argue that injury vulnerability is best understood through the interaction of workload, psychological stress, neuromuscular fatigue, and contextual demands. Our findings support this holistic view and indicate the need for integrated monitoring strategies, especially at the sub-elite level.

Recent research has confirmed that both football and handball players face significant injury risks, particularly during matches. Guaru et al. [21] found similar injury rates in professional and amateur footballers, with most injuries affecting the thigh, ankle, knee, and the lower extremity in general. Drole et al. [22] reported in 2025 that in Slovenian elite male handball players (23.3±4.4 years), there is a widespread weekly prevalence of mainly acute injuries to the knee, ankle, pelvis/lower back, and shoulder, which aligns with findings from our study, in terms of injury dominance location and athletes age similarity. Position-specific differences highlight the need for tailored prevention and rehabilitation.

Encouragingly, physiotherapy was the most commonly reported treatment modality (70.3%), and most athletes (79.0%) in our sample had access to a club physiotherapist. This reflects an improved awareness of rehabilitation protocols, but also highlights the need for broader implementation of professional support, particularly in lower-league clubs. The notable proportion of athletes requiring surgical intervention (24.8%) speaks to the severity of injuries sustained and calls for better preventive frameworks and post-injury surveillance.

Given the limited access to physiotherapists in a portion of the sample, implementing structured, evidence-based injury prevention strategies becomes even more critical. Strength training, increasingly recognised as a core physiotherapy-related intervention, has been shown in high-quality trials to significantly reduce the incidence of common injuries (e.g., hamstring and groin strains) while simultaneously enhancing performance metrics such as sprinting, jumping, and endurance [23]. In addition, comprehensive athletic development should extend beyond motor skills to include perceptual and decision-making processes, which are often underemphasized in team sport environments [24].

Sport-related injuries and illnesses harm athlete welfare across all levels of team sport participation. Injury and illness surveillance (IIS), supported by robust monitoring systems, is a critical first step in prevention. A standardised framework for IIS implementation guides stakeholders, including athletes, coaches, parents, governing bodies, and healthcare professionals, to conduct surveillance, address challenges, and interpret findings, thereby enhancing athlete health and safety [25]. Building on this foundation, recent efforts have focused on developing practical models tailored to real-world injury prevention in team sports, particularly in professional settings. While many existing models are research-oriented, the Team-sport Injury Prevention (TIP) [26] cycle offers a practitioner-focused approach. Designed for sports medicine and science professionals, the TIP cycle comprises three continuous phases: (Re)evaluate, Identify, and Intervene, that integrate established principles with practical implementation strategies. By moving through these phases, practitioners can create dynamic, context-specific injury prevention strategies that align with the evolving needs of their teams.

Limitations

This pilot study has several limitations that should be taken into account when interpreting the findings. First, its cross-sectional design prevents causal inferences between injuries and potential risk factors, underscoring the need for longitudinal studies to understand injury mechanisms over time better. The use of a non-standardised, self-reported questionnaire introduces the potential for recall bias and may affect the accuracy of reported injury frequency and severity. The lack of medical verification and prospective surveillance further limits the reliability of injury data.

Key contextual variables, such as club-level injury prevention programs or specific training practices, were not assessed, which reduced insight into modifiable protective factors. The sample consisted exclusively of senior male athletes, which limits the generalizability of the findings to other age groups, female athletes, or athletes competing at different levels. Additionally, information on injury types, league tier, or playing positions was not collected, restricting more detailed stratified analysis.

The study did not employ a standardised injury classification system such as OSIICS or ICD, which reduces comparability with existing literature. For hypotheses H2 and H3, analyses were limited to athletes who had sustained injuries in the relevant anatomical region (i.e., lower or upper extremities), which narrows the generalisability of findings to the broader athletic population. Finally, non-random sampling and the absence of formal survey validation may limit the representativeness and internal validity of the data. While these constraints are typical of pilot studies, they highlight the importance of adopting a more rigorous methodology and broader sampling in future research.

CONCLUSION

This pilot study highlights a high prevalence of musculoskeletal injuries among Croatian senior male football and handball players. Injury patterns differed by sport, with lower extremity injuries predominating in football and upper extremity injuries more common in handball. Although these sport-specific distributions were statistically significant, the associated effect sizes were small, indicating modest but consistent differences relevant to training and prevention planning. A small positive correlation between years of sports experience and injury frequency suggests that accumulated exposure may contribute to long-term injury risk. In contrast, rest time between training sessions showed no meaningful association with injury occurrence.

These findings underscore the importance of developing sport-specific injury prevention strategies that consider both the physical demands of each discipline and the athlete’s training history. Standardised injury classification and monitoring systems, such as OSIICS or ICD, should be adopted to improve data quality and enable cross-study comparisons. Moreover, ensuring equitable access to physiotherapy and medical support across all club levels remains a critical priority for effective injury management and rehabilitation. Future research should incorporate prospective designs, diverse athlete populations, and validated measurement tools to enhance generalisability and support the development of evidence-based interventions aimed at reducing injury burden in team sports.

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