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ORIGINAL RESEARCH

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Prevalence of upper extremity pain and disability in elite football, ice hockey and floorball players

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Abstract

In athletes, injuries and medical conditions affecting the upper extremities are quite common. However, there has been limited research on the occurrence of joint pain in the peripheral upper extremities among elite athletes. Thus, this study aimed to determine how prevalent upper limb pain and disability are among team sports players, particularly in football, ice hockey and floorball. We also aimed to compare the severity of pain and disability among these sports and assess the risk of developing upper limb pain in athletes. This cross-sectional study was conducted between June 2021 and September 2022, involving 388 male elite athletes from national-level sports clubs. The prevalence of shoulder pain and disability was determined using the Shoulder Pain and Disability Index (SPI). Assessment of elbow pain and disability was conducted using the Oxford Elbow Score (OES), while wrist pain and disability were evaluated through the Patient-Rated Wrist Evaluation (PRWE). Significant differences in total SPI, OES and PRWE scores were observed among all groups. Ice hockey players experienced the highest levels of shoulder and wrist pain. Compared to football and floorball players, ice-hockey players had a 2.13 times higher risk of shoulder pain, with a pain incidence of 40.8%. Ice hockey also had a 1.71 times higher risk of wrist pain than football, with a pain prevalence of 26.3%. Notably, floorball players exhibited the most pronounced elbow pain, with a 13.18-fold higher risk than football and ice-hockey players and a pain prevalence of 67.2%. The study findings suggest that ice hockey players experience the highest pain levels in their right limbs, whereas football players have the lowest pain levels, underscoring the importance of dedicating more attention to developing innovative, effective and advanced preventive programs for athletes.

Keywords

Shoulder joint pain; Disability index; Oxford elbow score; Wrist evaluation; Male athletes

1. Introduction

Upper extremity joint pain is common among team sports players and professional athletes, and injuries and conditions related to the upper extremities are some of the most frequently encountered problems in sports. Despite this prevalence, there has been a lack of comprehensive research focusing on the occurrence of peripheral joint pain in the upper extremities among elite athletes. The shoulder joint is the most frequently affected area within the upper extremities, often presenting with acromioclavicular sprains and shoulder dislocations [1]. Shoulder pain is estimated to occur in 10–21% of cases and is particularly prominent among youth athletes, accounting for a substantial 45% of all injuries in this group [2], is closely related to repetitive overhead movements and can involve atrophy of the infraspinatus muscle, with rates ranging from 12.5% to 33%. Additionally, athletes in specific sports like volleyball, basketball and handball are more susceptible to experiencing shoulder, elbow and wrist pain. Shoulder issues can arise due to the rapid transition from external rotation in extension to internal rotation in flexion, a common movement in ball-hitting activities [3]. Elbow pain affects around 7% of the general population, while wrist pain is reported in approximately 7–8% of cases. These types of pain are frequently associated with sports such as tennis, hockey and baseball. Lateral epicondylitis, a condition characterized by pain on the outer part of the elbow, occurs in more than 50% of athletes, and medial epicondylitis, which involves ligament and nerve injuries, is also a common ailment in this population [4, 5].

Football, ice hockey and floorball are three of the most popular team sports in Slovakia, known for their high-speed gameplay, tactical maneuvers, and the potential for significant physical contact, which can lead to various injuries.

In football, players primarily focus on lower limb training during their training sessions, often neglecting upper limb conditioning. However, it's essential to note that upper limb injuries do occur in football, though less frequently, accounting

for approximately 7% of total injuries [6], while in ice hockey, this percentage is much higher (25.5% [1]). In terms of location, the shoulder is the most injured body part. The overall incidence of match injuries is higher compared to training injuries [7]. As reported by deSouza Lima *et al.* [6], upper limb injuries are promoted by sudden changes in the direction and speed of a play and forces that cause collisions between attacking and defending players and opponents.

Ice hockey is a team contact sport known for its potential for high-energy collisions with other players [1]. Despite the use of well-developed protective equipment, ice hockey players are at risk of experiencing these high-energy collisions and resulting traumas.

While upper limb pain is commonly associated with sports involving throwing or frequent upper limb movements, football players, regardless of their playing position, can also be susceptible to upper limb injuries [6]. To better understand how the training process and frequent matches affect players' injuries, we examined different sports, namely football, ice hockey and floorball, which are among the most popular sports in Slovakia.

Successful performance in sports relies on various factors, with early injury identification and subsequent interventions being crucial among them. Velarde-Sotres *et al.* [8] have highlighted these as key factors in preventing and treating sports injuries.

The primary objective of this study was to assess the prevalence of upper limb pain and dysfunction in elite male athletes participating in football, ice hockey and floorball using standardized questionnaires. Additionally, we aimed to compare the severity of pain and disability among these sports and investigate the risk of developing upper limb pain in athletes.

2. Materials and methods

2.1 Participants and settings

We approached all team sports clubs competing in the top two leagues of the three most popular team sports in Slovakia: football, floorball and ice hockey.

Upon obtaining the cooperation of the individual clubs, the research team collected the athletes' basic anamnestic data (year of birth, highest educational attainment) and basic training characteristics (type of sport, frequency and duration of training, years of sport participation, and any additional sports activities performed alongside their main sport) during an initial interview. Subsequently, the subjects' body height and weight were measured and recorded. Once these baseline characteristics were gathered, a short briefing session was held to provide instructions for completing the questionnaire. The athletes completed the questionnaire online at home using a Google form. Each participant received a link to log in and complete the questionnaire, which took approximately 30 minutes to finish. The questionnaires were administered in the Slovak language. The collected data was then transferred to a database and checked for completeness by members of the research team. All information and data were handled in accordance with General Data Protection Regulation (GDPR).

Before being enrolled in the study, all participants provided written informed consent. They were verbally briefed on the study's primary objectives, the procedures involved, the confidentiality of their information, and the voluntary nature of their participation. The initial interviews were conducted in person by a trained interviewer following individual sports training sessions. Data collection was anonymized, and the data collectors were not involved in other aspects of the study. All participants completed all sections of the questionnaires, and any inconsistent or missing responses were rectified on-site.

2.2 The inclusion and exclusion criteria

The inclusion criteria for this study comprised adult males aged between 18 and 35 years who were members of team sports clubs competing in the top two leagues in Slovakia, engaged in at least 90-minute training sessions conducted at least four times a week, possessed a minimum of four years of training experience, and reported engaging in physical activities with a Metabolic Equivalent of Task (MET) score exceeding 8 according to the International Physical Activity Questionnaire (IPAQ). On the other hand, the exclusion criteria comprised individuals with irregular training patterns, those who failed to respond to all questionnaire items, participants with a sporting career interruption exceeding two months at the time of the research, and individuals with a Body Mass Index (BMI) exceeding 30 (in kg/m^2).

2.3 Sample size

Among the 1875 registered athletes actively involved in football, hockey and floorball at the requisite level, a systematic random sampling approach was implemented, selecting one out of every four athletes, leading to a pool of 469 prospective participants. The randomization process was conducted independently using Microsoft Office Excel 2016. Finally, the study enrolled 388 athletes, while 81 were excluded from participation as they declined to participate in the research.

The minimum required sample size was determined following the approach outlined by Daniel *et al.* [9] using the formula: $n = Z^2p(1 - p)/d^2$ ($Z = 1.96$—the 95% confidence level; $p = 0.5$—the expected sample proportion of 50%, $d = 0.05$ for a 5% margin of error). Based on this calculation, a minimum sample size of 384 athletes participating in team sports was established.

2.4 Procedures

A questionnaire survey was used to conduct the research. Data collection began in March 2022 and was completed in September 2022. To assess shoulder, elbow and wrist joint pain and disability, three established, standardized and internationally recognized questionnaires were employed:

2.4.1 Shoulder joint pain and disability

The Shoulder Pain and Disability Index (SPI) comprises 5 questions assessing pain severity and 8 questions addressing disability. Scores on this index range from 0, indicating the absence of pain and disability, to 100, indicating severe pain and disability. Higher scores are indicative of more

severe symptoms [10]. A systematic review conducted by Roy *et al.* [11] in 2009 reported reliability coefficients with an intraclass correlation coefficient (ICC) of $\geq$0.89 across various patient populations. Internal consistency was also high, with Cronbach's alpha typically exceeding 0.90 [11, 12].

2.4.2 Pain and disability of the elbow joint

The assessment of elbow pain and disability was conducted using the Oxford Elbow Score (OES), a questionnaire consisting of 12 items designed to evaluate upper limb dysfunction and elbow function. In this scoring system, higher scores indicate better outcomes. Respondents assign scores to their answers based on the following criteria: no difficulty (4 points), moderate difficulty (3 points), minor difficulty (2 points), major difficulty (1 point), or inability to perform the activity (0 points). The interpretation of OES results categorizes them into four groups: 0–19 points indicating a severe problem, 20–29 points indicating a moderate problem, 30–39 points indicating a minor problem, and 40–48 points indicating good function. Here, a higher score on the OES reflects improved elbow function [13].

In a study conducted by Jonsson *et al.* [14] in 2023, the properties of the Oxford Elbow Score (OES) were examined. The study found that the Cronbach's alpha coefficient for the various OES domains was 0.83 for elbow function, 0.91 for pain, and 0.90 for the social-psychological domains. Additionally, the overall OES score demonstrated a high level of agreement, with an interclass correlation coefficient of 0.96. These results indicate the reliability and consistency of the OES as a tool for assessing elbow-related function and pain.

2.4.3 Wrist joint pain and disability

Wrist pain and disability were assessed using the Patient-Rated Wrist Evaluation (PRWE), a 15-question questionnaire designed to evaluate wrist-related issues. The PRWE comprises two subscales: pain and function, which include specific and normal activities. Participants provide ratings on a scale ranging from 0 (indicating no pain or problem) to 10 (representing maximum pain or problem). A higher score on the PRWE indicates a more unfavorable outcome [15]. In a study conducted by Eliašová *et al.* [16] in 2014, the internal consistency of the PRWE was assessed on a sample of 177 Slovak patients, resulting in a Cronbach's α coefficient of 0.96, indicating a high level of validity.

These three questionnaires used in our study are well-established and validated patient-reported instruments for assessing the specific body parts.

2.5 Statistical analysis

All statistical analyses were conducted using IBM SPSS for Macintosh, Version 28.0 (IBM Corp., Armonk, NY, USA). The data obtained in this study were analyzed using both descriptive and analytical statistical methods. Descriptive statistics were employed to present the data in terms of mean and standard deviation (SD). Additionally, percentages were calculated to assess the incidence and prevalence of pain and disability within the study population. The Shapiro-Wilk W test was used to evaluate the normality of data distributions, and the results indicated that the data followed a normal distribution. Logistic regression analysis was employed to estimate the risk (with a 95% confidence interval, 95% CI), and p-values were determined using an Analysis of Variance (ANOVA) test. The significance level was set at $p < 0.05$.

3. Results

The basic characteristics of the investigated cohort are presented in Table 1.

3.1 Shoulder

In the assessment of shoulder pain and the shoulder disability index, ice-hockey players exhibited significantly higher levels of pain compared to football players, whereas no significant differences were observed between football and floorball players. This pattern was also reflected in the pain section of the evaluation. When examining the comparability section, significant differences were found among all three groups. Specifically, ice hockey players experienced the highest degree of disability, while floorball players exhibited the lowest disability levels.

3.2 Elbow

Floorball players reported significantly higher pain levels in terms of elbow pain and disability index scores compared to ice-hockey players. In addition, significant differences in pain levels were also observed among all three groups.

3.3 Wrist

Ice hockey players experienced significantly higher pain levels than football players in both the total score and the pain and disability section of the wrist pain and disability index scores. However, there were no significant differences in the total score between football and floorball players. Additionally, significant differences were found between ice hockey players and athletes in other sports. The mean values and statistical comparisons of upper limb pain in the different sports assessed are presented in Table 2.

3.4 Risk of shoulder pain

Regarding shoulder pain risk, football showed a risk estimation (RE) of 0.46, indicating a 0.46 times lower risk of shoulder pain compared to ice hockey and floorball. The incidence rate of shoulder pain was 22.3 percent in football players. Ice hockey players had an RE of 2.13, signifying a 2.13 times higher risk of shoulder pain than soccer and floorball, and demonstrated a pain incidence rate of 40.8%. Comparatively, floorballers exhibited an RE of 0.52, indicating a 0.52 times lower risk of shoulder pain than football and ice hockey, with a pain incidence rate of 21.3%.

3.5 Risk of elbow pain

Regarding the risk of elbow pain, football players had an RE of 0.52, signifying a 0.52-fold lower risk of developing elbow pain compared to ice hockey and floorball players, with an incidence rate of 15.5 percent. Ice-hockey players had an RE of

TABLE 1. Basic characteristics of the athletes.

Parameters (x ± SD)	Total (N = 388)	Football (N = 148)	Ice hockey (N = 179)	Floorball (N = 61)
Age	27.26 ± 4.69	26.87 ± 5.58	28.24 ± 3.85	25.31 ± 3.83
Weight	81.04 ± 9.44	77.88 ± 7.81	84.88 ± 8.99	77.46 ± 7.81
Height	181.27 ± 6.93	181.35 ± 7.57	181.59 ± 6.48	180.16 ± 6.57
BMI (body mass index)	24.66 ± 2.45	23.73 ± 2.29	25.72 ± 2.18	23.80 ± 2.32
Training practice (yr)	17.01 ± 6.04	17.23 ± 5.62	17.00 ± 6.10	16.81 ± 4.57
Weekly sport frequency	4.12 ± 1.42	4.23 ± 2.39	4.02 ± 1.22	4.11 ± 0.66
Training duration/min	96.79 ± 11.01	97.84 ± 10.87	95.70 ± 11.31	96.83 ± 10.86

SD: standard deviation.

TABLE 2. Mean values and statistical comparison of upper limb pain.

Upper limb	1-Football (N = 148)	2-Ice-hockey (N = 179)	3-Floorball (N = 61)	*p* 1–2	*p* 1–3	*p* 2–3
Shoulder—pain	2.02 ± 5.43	7.97 ± 14.70	2.49 ± 14.70	0.001	0.31	0.001
Shoulder—disability	1.08 ± 4.12	2.52 ± 7.55	0.43 ± 1.30	0.001	0.01	0.001
Shoulder—total score	1.44 ± 4.33	4.62 ± 9.82	1.22 ± 2.60	0.001	0.48	0.001
Elbow—total score	39.95 ± 17.13	46.40 ± 2.87	4.21 ± 11.93	0.001	0.05	0.001
Wrist—pain	0.87 ± 3.71	2.80 ± 5.93	1.46 ± 4.07	0.001	0.05	0.001
Wrist—function	0.52 ± 2.40	2.43 ± 6.68	0.58 ± 1.65	0.001	0.71	0.001
Wrist—total score	1.45 ± 5.68	5.23 ± 12.11	1.98 ± 5.61	0.001	0.18	0.001

p: statistical significance between: 1–2 = ice-hockey and football; 1–3 = football; 2–3 = hockey and floorball.

0.03, indicating a 0.03 times lower risk of elbow pain compared to football and floorball players, and their pain incidence rate was 2.2 percent. In contrast, floorball players had an RE of 13.18, indicating a 13.18-fold greater risk of elbow pain compared to football and ice-hockey players, and their pain incidence rate was 67.2 percent.

3.6 Risk of wrist pain

In terms of wrist pain, football players exhibited a 0.55 times lower risk compared to ice hockey and floorball players, with a pain incidence rate of 15.5 percent. Ice-hockey players, conversely, had a 1.71 times greater risk of wrist pain compared to their football and floorball counterparts, and their pain incidence rate was 26.3 percent. In contrast, floorball players showed no significant difference in risk (RE of 0.50) compared to football and ice-hockey players, with a pain incidence rate of 13.1 percent. The results of the relative risk of upper limb pain and disability are presented in Table 3.

4. Discussion

The objective of this study was to assess the prevalence of upper extremity pain and disability among elite team sports athletes, specifically in football, ice hockey and floorball, using standardized questionnaires and to compare the levels of pain and disability across these sports. We also investigated and compared the risk of developing upper extremity pain in these athletes.

Many studies addressing upper limb injuries and pain tend to concentrate on sports involving overhead movements or throwing, such as handball [17–20], tennis [21, 22], volleyball [18, 19, 23], baseball [24, 25], judo [20], boxing [26, 27] or water polo [28, 29].

However, these studies exhibit variations in their research methodologies and diagnostic tools. Limited research has addressed sports in which upper limb involvement is not direct. Nevertheless, several studies have shed light on disability and injuries in sports where upper limb engagement is not primary but where the intensity of play and common collisions still elevate the risk of upper limb injury. The results derived from the Shoulder Pain and Disability Index indicate that ice-hockey players endure the most intense pain, while football players report the least. In the assessment of the Elbow Pain and Disability Index, floorball players report the most intense pain, whereas ice hockey players report the least. Regarding the Wrist Pain and Disability Index, both the overall score and the pain and disability section demonstrate that ice-hockey players experience significantly more intense pain, whereas football players experience the least.

In general, ice hockey players report the highest pain intensity, which aligns with other studies that deal with these athletes.

Jonasson *et al.* [4] conducted a study involving 75 athletes participating in various sports, including ice-hockey players, and a control group of 12 non-athletes. They used a specialized self-assessment questionnaire to evaluate spinal pain and upper extremity joint discomfort (involving the shoulders, elbows and wrists), and their findings did not reveal any statistically significant distinctions in the prevalence of spinal

TABLE 3. Percentage and estimate of the relative risk of upper limb pain and disability.

Upper limb	Shoulder	Elbow	Wrist
Total	148	179	61
Football			
RE	0.46	0.52	0.55
95% CI	0.29 to 0.74	0.31 to 0.89	0.32 to 0.93
p	0.001	0.010	0.020
%	22.3	15.5	15.5
Ice-hockey			
RE	2.13	0.03	1.71
95% CI	1.38 to 3.29	0.01 to 0.10	1.04 to 2.79
p	0.001	0.001	0.030
%	40.8	2.2	26.3
Floorball			
RE	0.52	13.18	0.50
95% CI	1.38 to 3.29	7.08 to 24.55	0.23 to 1.11
p	0.050	0.001	0.090
%	21.3	67.2	13.1

RE: risk estimation; CI: confidence interval; p: significance.

and joint pain, whether among elite athletes from diverse sports or in comparison to non-athletes. Interestingly, they identified a correlation between spinal pain and discomfort in the shoulders, elbows and wrists. In contrast, our research noted the highest levels of upper extremity pain among ice hockey players. In a separate study by Ornon *et al.* [1], which focused on professional ice hockey players competing in the Swiss National League over seven years, ligament injuries were found to be the most frequent, with shoulder dislocations being the most prevalent diagnosis.

White *et al.* [5] conducted a study to investigate the epidemiology, treatment approaches, and return-to-play outcomes concerning common orthopedic upper extremity injuries in ice hockey players. According to existing literature, the risks of upper extremity injuries tend to increase with the athlete's skill level, are more prevalent among male athletes, and predominantly occur during sporting activities. Notable upper extremity injuries in ice hockey include acromioclavicular joint dislocations, humeral instability and fractures related to clavicular dislocations. While our findings exhibit some similarities with these patterns, it's important to note that our study identified a relatively low number of injuries among the athletes, limiting our ability to conduct extensive follow-up examinations. Nevertheless, the shoulder joint pain results observed in our study may be directly associated with injuries sustained during ice hockey play.

Tedesco *et al.* [30] investigated upper limb injuries in ice hockey players, classifying them into two categories: those resulting from direct trauma and those from overuse. However, there is still a lack of comprehensive data on hand, wrist and elbow injuries in this sport. Until now, no off-season programs for strengthening and preventing injuries in these areas have been published for ice hockey. Healthcare professionals, including physicians and physiotherapists, need to be more aware of prevalent upper extremity injuries in ice hockey players and offer prompt diagnosis and treatment for player well-being.

Sonesson *et al.* [31] found that greater sports exposure was associated with a decreased risk of injury and illness the following week in footballers. Moreover, maintaining a chronic workload ratio between 0.8 and 1.3 appeared crucial in preventing illness, underscoring the importance of a well-structured and consistent training regimen for safeguarding athletes' health. Additionally, they noted that the likelihood of a new injury occurring the following week increased in players who reported higher stress levels, poorer sleep quality and diminished well-being.

Bowers *et al.* [32] examined the effectiveness of protective gloves in preventing hand injuries during stick-handling sports, such as ice hockey, men's lacrosse and women's lacrosse, using data from the National Collegiate Athletic Association (NCAA) Injury Surveillance System over a 16-year period, encompassing 1036 hand and finger injuries recorded during 3,752,547 exposures in stick-handling athletes. The study analyzed various injury types, including total injuries, fractures, ligament injuries, contusions and lacerations, calculating injury rates per 1000 exposures. Rates were compared across the four sports involving stick handling. The odds ratio (OR) for sustaining a hand injury, hand fracture, finger injury, and finger fracture was significantly higher in athletes who did not wear gloves (field hockey) than those who did wear gloves. Overall, the odds of experiencing a hand or finger injury or fracture were significantly greater in players without gloves than those who wore gloves.

In general, taking preventive measures is essential for reducing injury rates and minimizing healthcare costs. Additionally,

it's important to recognize that athletes often suffer from joint pain, particularly in their upper limbs, which can become a significant long-term health concern, as demonstrated in Palmer *et al.* [33]'s research involving retired Olympians at the age of 45.

Nevertheless, further research is warranted to comprehensively understand the mechanisms underlying upper extremity injuries, which could be instrumental in offering effective guidance to coaches, physicians and athletes for injury prevention.

5. Conclusions

Ice hockey players exhibited the highest incidence of shoulder and wrist pain and were at the highest risk for experiencing such pain. Conversely, floorball players had the highest incidence of elbow pain and risk of developing elbow pain. Interestingly, floorball players showed the lowest incidence of shoulder pain and disability but the highest rates of wrist pain and disability. In contrast, ice hockey players had the lowest incidence of elbow pain and disability.

Given these findings, it could be advisable to incorporate upper extremity pain prevention programs as a regular component of the training regimen for elite athletes who are prone to experiencing high rates of upper extremity pain. This collaborative effort between physicians, physiotherapists and coaches could focus on developing new, effective and progressive prevention programs tailored to the specific needs of elite athletes and integrated into their daily training routines.

6. Limitations

Our study relied solely on questionnaire-based methods to identify pain and disability among participants. We did not utilize test batteries to evaluate upper extremity joint function under different loading conditions, such as deep push-ups. Additionally, we did not specifically measure pain intensity. However, the overall questionnaire scores suggested mild levels of pain and disability. Further, the subjective assessment of pain levels in athletes, which can vary among different groups, represents a potential limitation of our study. Another limitation is that we examined only athletes actively participating in training sessions during the study period, and athletes who were injured or temporarily unable to train could not participate in the study.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

AB, MH and PT—designed the research study. MH and PT—performed the research and analyzed the data. AB and MH—wrote the manuscript. LK—provided help and advice on data interpretation and final adjustments. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The procedures in the present research were in accordance with the ethical standards set by the 1964 Declaration of Helsinki and its later amendments. Participants were verbally informed of the main aim of the study, the procedures, confidentiality, and the voluntary nature of their participation. The Pavol Jozef Šafárik University in Košice's Ethics Committee approved the study (approval number: PJSU-1/2020).

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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