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SPORTS TRAUMATOLOGY

Soccer players show the highest seasonal groin pain prevalence and the longest time loss from sport among 500 athletes from major team sports

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Abstract

Purpose Groin pain is a widely recognized medical issue among athletes. Groin pain can affect both player and team performance and sometimes can be a career-ending injury. The aim of this study was to assess seasonal groin pain prevalence and the average seasonal time loss from sport for each injury in different team sport athletes. The hip and groin functionality at the beginning of the following season was also investigated.

Methods A cross-sectional study was undertaken on 600 team sport athletes (soccer, futsal, basketball, volleyball, and water polo players). The seasonal prevalence of groin pain, level of competition (professional and non-professional), time loss, and concomitant injuries in addition to groin pain were reported and analyzed. The Copenhagen Hip and Groin Outcome Score (HAGOS) was used to assess hip and groin pain and function related to sport and activity.

Results Among the 506 (84%) players included, 123 players (24.3%) reported groin pain. Overall, soccer players reported the highest groin pain prevalence (32.5%) followed by futsal (25.5%), basketball (25.2%), water polo (17.6%) and volleyball players (13.6%). Professional soccer, futsal and basketball athletes showed higher groin pain prevalence in comparison with non-professional athletes ($p = 0.02$, $p = 0.005$ and $p = 0.004$, respectively). The mean time loss from sport due to groin pain was 60.3 ± 66 days in soccer, 41.1 ± 16.6 days in futsal, 31.5 ± 18 days in water polo, 37.2 ± 14.2 days in basketball and 50.8 ± 24.6 days in volleyball. Significantly lower HAGOS values were found in athletes with groin pain for all sports evaluated compared to athletes with no groin pain history ($p = 0.0001$). Longer time loss from sport was correlated with lower HAGOS values in soccer ($p = 0.002$) and futsal ($p = 0.002$) players with groin pain. Concomitant injuries were correlated with lower HAGOS values in water polo players ($p = 0.03$).

Conclusions Seasonal groin pain occurs in as many as one in four team sport athletes. Soccer players show the highest groin pain prevalence and the longest time loss from sport. Professional athletes report higher prevalence of groin pain in comparison with non-professional athletes. HAGOS appears to be a valid outcome instrument to measure groin pain, correlating with both time loss from sport and concomitant injuries in athletes.

Level of evidence Level IV.

Keywords Groin pain · Athletes · Sports injuries · Time loss · HAGOS · Team performance

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Introduction

Groin pain is a widely recognized physical issue among athletes [3, 34]. According to the Doha agreement meeting on terminology and definitions in groin pain in athletes, the classification system includes defined clinical entities as follow: adductor-, iliopsoas-, inguinal-, pubic-, and hip-related groin pain [11, 52]. The increased demands and training loads on athletes combined with individual risk factors may contribute to groin injuries [24, 30, 40]. Groin pain can affect both player and team performance and sometimes can be a career-ending injury [15, 40]. Some sports such as soccer have been extensively studied with a seasonal incidence of groin pain reaching 50% among soccer players [8, 46] and approximately 30% of injuries recur [15]. A group of international experts on the topic [6] stated that the available literature is mainly based on heterogeneous studies with low methodological quality. As far as we know, there are few studies on groin pain in team sport athletes such as basketball [9], volleyball [4], ice hockey [53, 54] and water polo [42] other than soccer [2, 10, 12, 17, 27, 28, 42–44, 46, 51]. Traditional epidemiological sports injury research on groin injuries has mainly focused on time loss injuries [51], defined as injuries resulting in a player not being able to participate fully in soccer training or match play [13]. However, groin pain is often long-standing with an insidious onset due to overuse and fluctuates over time [33, 49]. Often, affected athletes continue to play despite their symptoms; thus, Thorborg et al. [46] suggested that groin pain should not be evaluated using the traditional time loss definition [12]. As a result, the previous epidemiological soccer studies [16, 47] could not reflect the true prevalence and severity of groin pain. Self-reported questionnaires measuring aspects of pain, function related to sport, and activity have been developed to ensure a more detailed description of hip and groin injury [21, 45, 48].

The aim of this study was to assess seasonal groin pain prevalence and the average seasonal time loss from sport for each injury in different team sport athletes. Differences in groin pain prevalence and time loss among team sport and between professional and non-professional athletes were investigated. The hip and groin functionality at the start of the following season was also investigated.

It is recommended that groin pain epidemiology studies aim to include different relevant sports to improve comparisons between them, but this type of investigation is still lacking.

Material and methods

A cross-sectional study was undertaken on 600 team sport athletes that were asked to complete a survey regarding the experience of hip and groin problems during the previous season as well as self-reported hip and groin function at the beginning of the new season. The study protocol was approved by the local Ethics Committee (Institutional Review Board approval was obtained from Magna Græcia University of Catanzaro, ID number 87/18), and the research was conducted in compliance with the Declaration of Helsinki. All respondents provided informed consent at the beginning of the survey with a yes–no question confirming their willingness to participate. Athletes were surveyed on only one occasion between July 2019 and September 2019. An online questionnaire was built using Google Forms (Google LLC, Mountain View, CA, USA), a free open-source software survey tool.

Participants

Athletes were recruited through mailing lists associated with the 40 teams/sports clubs involved in the research to represent professional and non-professional male athletes from major Italian team sports [20] The level of competition was defined by the respective national federations for each sport. They received a detailed description of the study along with an email invitation to participate in the survey. Non-responders were sent an email reminder. The survey was initially anonymous and only groin pain cases were identified for cross-checking with medical records; a random code associated with each participant's email was used to send the email reminder only to non-responders.

All active soccer, futsal, basketball, volleyball, and water polo male players in the professional and non-professional sports clubs involved in the research were eligible to participate in the study. Exclusion criteria were (1) use of analgesic medication at least twice a week in the last 3 months before the initiation of the survey, (2) concurrent lower limb pain (other than groin pain), and (3) hip, pelvic or lumbar surgery to these regions in the last 12 months.

The reporting of the study follows the Strengthening the Reporting of Observational studies in Epidemiology (STROBE statement) [50].

Survey instruments

A pilot study was completed as part of the survey's development with 20 athletes asked to answer the surveys twice with a 7-day interval to assess the test–retest reliability of the Copenhagen Hip and Groin Outcome Score (HAGOS) section of the pilot study. The intraclass correlation coefficient of this pilot study section was 0.9 (i.e., excellent). The definitive survey took approximately 10–15 min for completion and the face and content validity were also tested. As suggested by the previously reported studies [54], data gathered included demographics and background information. Prevalence of groin pain was assessed by asking athletes

the following question: "did you, at any occasion during the previous season, have an injury, pain or symptoms in the hip/groin region, that prevented you from participating or affected your performance in training/match play?". In case of a positive answer, information provided by the athletes were cross-checked with the medical record staff. Only groin pain cases confirmed by the medical staff were considered valid in the current study.

Quantitative variables

Players were also asked to report concomitant injuries and the overall time loss (in days) from sport due to groin pain problems during the last season. Information provided by the athletes were cross-checked with the medical record staff. Non-time loss problems were considered those that did not lead to absence from sporting activity or that led to a minimum absence up to 7 days. The 7-day cutoff was established considering the weekly frequency matches.

The HAGOS was administered to the athletes as part of the survey. The HAGOS follows the full COSMIN checklist [26] for the development and testing of a patient-reported outcome measures (PROMs) instrument and it consists of six separate subscales assessing: (1) pain; (2) symptoms; (3) physical function in daily living (ADL); (4) physical function in sport and recreation (Sport/Rec); (5) participation in physical activities (PA) and (6) hip and/or groin-related quality of life (QoL). It is a valid [5, 45], reliable [18], responsive [48] and recommended [6, 7, 48] PROMs questionnaire for groin pain. Each subscale is scored as a percentage of the total possible score, ranging from 0 to 100, where 0 indicates severe hip and/or groin-related problems and 100 indicates no problems.

Statistical analysis

Data are reported as the percentages and absolute numbers, as the means and standard deviation (SD), or as the median and interquartile range (IQR), whenever applicable. The differences in groin pain prevalence among different team sport and between professional and non-professional athletes in each sport were tested by χ^2 (Chi-squared) test. For further analysis, time loss was also categorized in time frames as: 0–7 days, 8–30 days, 31–60 days and > 60 days. Scores for each sport was reported in number (proportion) and the differences between different sports was tested by χ^2 (Chi-squared) test. The normal distribution was determined by the Shapiro–Wilk test for all variables analyzed. As the dependent variables (HAGOS value) were not normally distributed, non-parametric statistics were used for all analyses. Continuous variables were reported as median and IQR [25th–75th percentiles], and differences of these values among different sports were tested by Mann Whitney *U* test. Parametric testing was used instead for normally distributed time loss variable to compare differences among sports and between professional and non-professional athletes. The influence of age, body mass index (BMI), dominant limb, playing surface and concomitant injuries (yes/no) on HAGOS value were analyzed by Spearman's rho correlation. Correlation coefficients of 0.1–0.3 are considered small, 0.3–0.5 moderate, and > 0.5 strong.

Post hoc power was calculated by considering the sample size, the observed effect size, and an α-value of 0.05; a post hoc power superior to 80% was considered appropriate. The difference was considered to be statistically significant when the *p* value was less to 0.05. All analyses were performed using the IBM SPSS (version 26, IBM Corp., Armonk, NY, USA).

Results

Of the 600 athletes invited to participate in the study, 506 (84%) respondents were included. Seventy-two (12%) athletes did not participate in the survey and 22 (4%) participants failed to meet the inclusion criteria. Demographic data of included players are provided in Table 1.

Seasonal groin pain prevalence in different sports and level of competition

In total, 123 players (24.3%) reported groin pain during the last season. groin pain prevalence in different sports and among professional and non-professional athletes was reported in Table 2. Significant differences in the prevalence of the groin pain among different sports were found only between soccer and volleyball players (32.5% vs 13.6%, respectively; $p = 0.01$). Moreover, significant differences in the prevalence of groin pain were found among professional and non-professional athletes in soccer ($p = 0.02$), futsal ($p = 0.005$) and basketball ($p = 0.004$) players with a higher prevalence in professional athletes.

Time loss from sport

Athletes who experienced groin pain in the last season reported a mean time loss of 60.3 ± 66 days in soccer, 41.1 ± 16.6 days in futsal, 31.5 ± 18 days in water polo, 37.2 ± 14.2 days in basketball and 50.8 ± 24.6 days in volleyball. Significant differences in time loss among different sports were found between water polo and volleyball ($p = 0.02$) players and between basketball and volleyball ($p = 0.04$) players; in both the comparisons, the volleyball players showed a longer time loss from sport. Non-professional athletes reported longer time loss compared to professional athletes in soccer and futsal ($p = 0.05$ and

Table 1 Demographic data of included players

Sport	Age (years) (Mean ± SD)			Height (cm) (Mean ± SD)			Weight (kg) (Mean ± SD)			BMI (kg/m^2) (Mean ± SD)			Dominance *N* (%)					
	Overall	Pro	Non-Pro	Overall	Pro	Non-Pro	Overall	Pro	Non-Pro	Overall	Pro	Non-Pro	Pro			Non-Pro		
													A	*R*	*L*	*A*	*R*	*L*
Soccer	26.9 ± 7.4	25.0 ± 5.9	26.6 ± 7.5	180.3 ± 8.8	181.3 ± 9.4	179.5 ± 7.6	75.3 ± 7.8	73.8 ± 6.9	73.9 ± 8.2	23.2 ± 2.5	22.5 ± 2.0	22.9 ± 2.6	5 (8.9)	40 (71.4)	11 (19.6)	5 (5.6)	43 (48.8)	15 (17)
Futsal	26.5 ± 5.6	26.8 ± 5.7	26.0 ± 5.3	178.6 ± 7.0	178.6 ± 6.7	173.8 ± 9.2	75.4 ± 7.7	76.1 ± 7.0	73.8 ± 9.2	23.6 ± 1.6	23.8 ± 1.6	23.2 ± 1.6	4 (16)	14 (56)	7 (28)	3 (4.9)	47 (77)	11 (18)
Water polo	25.9 ± 5.2	24.4 ± 4.5	27.7 ± 5.3	188.4 ± 8.2	190.3 ± 6	186.0 ± 10	84.1 ± 8.7	86.2 ± 6.5	81.4 ± 10.3	23.6 ± 1.4	23.7 ± 0.7	23.4 ± 1.9	6 (14.2)	17 (40.4)	19 (45.2)	2 (4.6)	29 (67.4)	12 (27.9)
Basketball	23.0 ± 4.1	22.8 ± 4.2	23 ± 3.9	196.3 ± 9.3	198.1 ± 8.8	195.2 ± 9.5	91.4 ± 10.8	94.6 ± 10.3	89.2 ± 10.9	23.6 ± 1.4	24 ± 1.0	23.2 ± 1.7	0	13 (54.1)	11 (45.8)	0	40 (80)	10 (20)
Volleyball	26.3 ± 5.4	25.0 ± 5.2	27.1 ± 5.4	198.6 ± 8.3	202.0 ± 8.5	196.5 ± 7.7	94.7 ± 10.7	99.5 ± 10.8	91.7 ± 9.7	23.9 ± 1.4	24.3 ± 1.2	23.7 ± 1.5	1 (7.1)	8 (57.1)	5 35.7)	2 (9)	20 (91)	0

SD standard deviation, *BMI* body mass index, *Pro* professional, *Non-Pro* non-professional, *A* ambidextrous, *R* right, *L* left

Table 2 Prevalence of groin pain

Sport	Prevalence			χ^2
	Overall	Professional	Non-Professional	*p* value
Soccer	52/160 (32.5%)	25/56 (44.6%)	27/104 (25.9%)	**0.02**
Futsal	22/86 (25.5%)	12/25 (48%)	10/61 (16.3%)	**0.005**
Basketball	22/87 (25.2%)	13/29 (44.8%)	9/58 (15.5%)	**0.004**
Water polo	15/85 (17.6%)	10/42 (23.8%)	5/43 (11.6%)	ns
Volleyball	12/88 (13.6%)	7/33 (21.2%)	5/55 (9%)	ns

Boldface values indicate statistical significance ($p < 0.05$)

χ^2 (Chi-square) test between professional and non-professional groups

Ns means non-significant

Table 3 Differences in the average time loss from sport between professional and non-professional players experienced groin pain

Sport	Time loss (days) (Mean ± SD)			*p* value
	Overall	Professional	Non-professional	
Soccer	60.3 ± 66	54.4 ± 59.8	78 ± 98.9	**< 0.05**
Futsal	41.1 ± 16.6	31.6 ± 15.5	49 ± 14.4	**0.01**
Water polo	31.5 ± 18	41.2 ± 13.5	17.6 ± 14.1	**0.04**
Basketball	37.2 ± 14.2	41.8 ± 13.9	23.6 ± 5.5	**0.01**
Volleyball	50.8 ± 24.6	36.6 ± 12.5	30 ± 9.1	ns

Boldface values indicate statistical significance ($p < 0.05$)

Ns means non-significant

$p = 0.01$, respectively) while professional athletes showed longer time loss in water polo and basketball ($p = 0.04$ and $p = 0.01$, respectively) as reported in Table 3. Data on time loss was also reported in Table 4 according to the time frames identified.

HAGOS values

Significantly lower HAGOS values were found at the beginning of the new season in players who reported groin pain in the previous season compared with players who did not report groin pain in the previous season in all sports ($p = 0.0001$) (Table 5). Significant differences in the HAGOS values between professional and non-professional players with groin pain in the previous season were found in futsal ($p = 0.0007$), basketball ($p = 0.0002$) and volleyball ($p = 0.002$). Lower scores were observed in non-professional futsal players compared to professional ones and in professional basketball and volleyball players compared to non-professional ones.

Table 4 Time frames in time loss from sport

	0–7 days *N* (%)	8–30 days *N* (%)	31–60 days *N* (%)	> 60 days N (%)
Soccer	10 (19)	13 (25)	16 (31)	13 (25)
Futsal	2 (9)	5 (23)	14 (64)	1 (4)
Water polo	3 (20)	5 (33)	7 (47)	–
Basketball	–	10 (45)	12 (55)	–
Volleyball	–	5 (42)	5 (42)	2 (16)

N number

Correlations with HAGOS value in players with groin pain history

Longer time loss from sport was correlated with lower HAGOS values, and the correlation was moderate in soccer players (Spearman's rho = − 0.4, $p = 0.002$) and strong in futsal players (Spearman's rho = −0.6, $p = 0.002$) who experienced groin pain in the last season. Concomitant injuries were strongly correlated with lower HAGOS values in water polo players (Spearman's rho = − 0.6, $p = 0.03$) who reported groin pain in the last season. Age, BMI, dominant leg, and playing surface were not correlated with HAGOS values among other injured players.

Discussion

The most important finding of the present study was that soccer players reported the highest seasonal groin pain prevalence among team sport athletes examined, with a mean overall time loss of 60 days. Professional soccer, futsal and basketball athletes showed a significantly higher prevalence of groin pain than non-professionals athletes. Overall, athletes experiencing groin pain during the previous season had significantly worse hip and groin function as measured by the HAGOS questionnaire at the beginning of the following season. Longer time loss from sport was correlated with lower HAGOS values in soccer and futsal players who experienced groin pain in the last season.

A systematic review [29] performed to record the incidence of groin region injuries in sports, recommended the use of the same methodology in order to help address the issues of epidemiological comparison between different sports. Only one study [39] directly compared two sports using the same methodology and found that Australian football has a higher rate of groin injuries than rugby. To our knowledge, the current study is the first study to specifically measure the burden of the groin pain among different team sport athletes with the same methodology, reporting the prevalence and the time loss from sport and analyzing the results of the HAGOS questionnaire.

Soccer

In the current study, soccer players showed the highest prevalence of groin pain (32.5%) among the team sports examined. Soccer involves a regular combination of kicking and change of direction that may explain this higher incidence of groin injuries [35, 40]. Orchard et al. [29] reported that the sport with the highest rates of groin pain was non-professional men's soccer. In the current study, professional soccer players showed a higher prevalence of groin pain (44.6%) than non-professional ones (25.9%), but no differences were found in the HAGOS values between these groups among the athletes with a history of groin pain during the previous season. The mean time loss due to the groin pain was 60 days. Indeed, groin pain has been reported as a source of significant time loss in soccer. Hölmich et al. [19] reported that recovery from groin injury takes at least 1 week in 40% of cases, and more than a month in 10% of players. Thorborg et al. [46] found that 49% of sub-elite players reported groin pain during the last season and 31% of them reported pain for more than 6 weeks; furthermore, lower HAGOS subscale scores were found in the beginning of the new season in players who reported groin pain in the previous season compared with players who did not report it [38]. These findings are in line with those reported in the current study. Professional soccer players who did not report groin pain in the previous season, showed a median HAGOS value of 95.9; for HAGOS subscales a median value of 96.4 for pain, and a median value of 100 for symptoms, ADL, sport and recreational activities physical activities and QoL were reported, in line with the established reference ranges for HAGOS in injury-free male soccer players [44].

Futsal

Futbal players reported 25.5% of groin pain prevalence. Professional futsal players showed a higher prevalence of groin pain (48%) than non-professional ones (16.3%), but non-professional players experiencing groin pain in the previous season reported lower HAGOS values compared to professional players. To our knowledge, this is the first study assessing groin pain in futsal. These results are in line with those found among soccer players; likely, similar athletic maneuvers such as ball skills and multiplanar movement in single stance may explain, at least partially, the comparable results between futsal and soccer athletes. However, court athletes may never achieve similar high speeds or distances as field athletes, while being stressed by different mechanical forces such as limited-space, high intensity cutting maneuvers [25].

Table 5 Differences in the HAGOS values between players who reported groin pain and who did not and between professional and non-professional players who reported groin pain

			Symptoms median (IQR)	Pain median (IQR)	ADL median (IQR)	Sport/recreation median (IQR)	Physical activities median (IQR)	Quality of live median (IQR)	Total median (IQR)	*p* value [a]	*p* value [b]
Soccer	Pro (N. 56)	Injured (N. 25)	64.2 (57.1–74.3)	72.5 (62.5–78.7)	85 (70–92.5)	59.3 (39–75.7)	75 (50–87.5)	55 (45–75)	64.7 (56–79.44)	**0.0001**	ns
		Control (N. 31)	96.4 (89.2–100)	100 (90–100)	100 (100–100)	100 (87.5–100)	100 (87.5–100)	100 (95–100)	95.9 (84.9–100)		
	Non-Pro (N. 104)	Injured (N. 27)	71.4 (50–85.7)	72.5 (55–87.5)	80 (60–90)	68.7 (46.8–78.1)	50 (37.5–75)	70 (45–90)	68.6 (55.7–81.7)	**0.0001**	
		Control (N. 77)	94.4 (82.1–100)	100 (87.5–100)	100 (90–100)	96.8 (78.5–100)	87.5 (75–100)	100 (85–100)	92.9 (82.2–100)		
Futsal	Pro (N. 25)	Injured (N. 12)	57.1 (54.4–75.9)	62.5 (60–73.7)	70 (52.5–87.5)	45.3 (32.8–62.5)	62.5 (50–84.3)	62.5 (56.2–73.7)	60.3 (52.6–73.6)	**0.0001**	**0.007**
		Control (N. 13)	96.4 (83.9–100)	95 (83.9–100)	100 (87.5–100)	96.7 (81.7–100)	100 (87.5–100)	100 (90–100)	97.7 (84.5–100)		
	Non-Pro (N.61)	Injured (N.10)	57.1 (57.1–57.1)	57.5 (57.5–57.5)	50 (50–55)	31.2 (31.2–40.6)	50 (50–50)	55 (55–60)	50.1 (50.1–55.5)	**0.0001**	
		Control (N. 51)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (84.3–100)	100 (100–100)	100 (90.6–100)		
Water polo	Pro (N. 42)	Injured (N. 10)	57.1 (53.5–60.7)	60 (52.5–70)	65 (50–75)	40.6 (31.2–50)	50 (50–62.5)	55 (45–65)	57.4 (45.7–58.4)	**0.0001**	ns
		Control (N. 32)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)		
	Non-Pro (N. 43)	Injured (N. 5)	71.4 (51.7–80.3)	72.5 (61.2–86.2)	75 (52.5–85)	56.2 (42.9–75)	62.5 (28.1–75)	62.5 (45–78.7)	65.7 (53.9–71.8)	**0.0001**	
		Control (N. 38)	100 (98.2–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (97.6–100)		
Basketball	Pro (N. 29)	Injured (N. 13)	50 (35.7–53.5)	47.5 (42.5–60)	55 (50–65)	28.1 (18.7–37.5)	50 (50–50)	55 (35–60)	41.1 (38.3–55.5)	**0.0001**	**0.0002**
		Control (N. 16)	100 (87.5–100)	100 (96.2–100)	100 (100–100)	100 (96.8–100)	100 (100–100)	100 (100–100)	100 (94.6–100)		
	Non-Pro (N. 58)	Injured (N. 9)	64.2 (64.2–67.8)	72.5 (72.5–72.5)	80 (65–80)	53.1 (53.1–53.1)	62.5 (50–62.5)	70 (55–70)	67 (60.5–67)	**0.0001**	
		Control (N. 49)	92.8 (92.8–100)	100 (100–100)	100 (95–100)	100 (100–100)	87.5 (87.5–100)	100 (100–100)	95.8 (95.8–100)		
Volleyball	Pro (N. 33)	Injured (N. 7)	28.5 (28.5–64.2)	50 (50–70)	50 (50–65)	21 (21.8–37.5)	37.5 (37.5–50)	30 (30–60)	36.2 (36.2–57.8)	**0.0001**	**0.002**
		Control (N. 26)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)		
	Non-Pro (N. 55)	Injured (N. 5)	78.5 (78.5–78.5)	85 (85–85)	90 (90–90)	84.3 (84.3–84.3)	75 (75–75)	75 (75–75)	81.3 (81.3–81.3)	**0.0001**	
		Control (N. 50)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)	100 (100–100)		

Boldface values indicate statistical significance ($p < 0.05$). Ns means non-significant

HAGOS Copenhagen Hip and Groin Outcome Score, *IQR* interquartile range, *ADL* activities of daily living, *IQR* interquartile range *Pro* professional players, *Non-Pro* Non-professional players

[a]Mann–Whitney *U* test between players who reported groin pain in the previous season and control group for HAGOS total score

[b]Mann–Whitney *U* test between professional and non-professional players who reported groin pain in the previous season for HAGOS total score

Basketball

Basketball players reported 25.2% of groin pain prevalence reaching up to 44.8% among professional athletes with a mean of 37 days lost due to groin pain. Ekhtiari et al. [9] assessed the epidemiology of groin pain in the National Basketball Association (NBA) and reported that 39% of players sustained hip or groin injuries during career. Another study [22] reported a mean number of 6.3 ± 10 days missed per injury to the pelvis, hip, or thigh in the NBA athletes; the study also reported that the vast majority of injuries were related to the musculature around the hip and only 1.6% of all injuries were attributed to intra-articular etiology. However, there is some evidence that hip injuries are being increasingly diagnosed in the subset of groin pain in recent years [29].

Water polo

In the current study, the groin pain prevalence among water polo players was 17.6% without significant differences between professional and non-professional athletes. Significantly lower HAGOS scores were found in water polo players experiencing groin pain compared to those who did not report a history of groin pain. Recently, Girdwood et al. [14] found that 28.8% and 60.4% of water polo players reported current and past history groin pain, respectively. Water polo combines technical ball skills, agile swimming and explosive speed [14]. The sport is made up of a unique set of movements. It is theorized that the high amount of time spent eggbeater kicking, resulting in a repetitive internal and external rotation at the hip in combination with hip flexion and abduction, may be implicated in development of symptoms [37, 41].

Volleyball

Volleyball players showed the lowest groin pain prevalence (13.6%) with comparable findings between professional and non-professional athletes. No differences were found in the HAGOS values between these groups among the athletes with a history of groin pain during the previous season. Bortolotto et al. [4] reported that the hip and the rectus femoris are commonly affected in volleyball professional athletes. The quadriceps muscle is involved in hip and knee joints and it is overstretched in the landing phase of the jump when the hip is extended and the knee is flexed; the muscle is therefore contracted and extended, and this increases the risk both of acute injury and of microtrauma leading to degenerative changes [31].

Longer time loss from sport was correlated with lower HAGOS values in soccer and futsal players who experienced groin pain in the last season and this data concurs with those previously reported [49]. These findings together suggest that it would be reasonable to evaluate groin pain using the traditional time loss definition.

This study has several limitations. First, given the study's cross-sectional design, we were unable to perform clinical or radiological examination [32, 36] to assess strength, hip joint range of motion, and discriminate among the five major subheadings for athletes with groin pain of the Doha system [52]. Second, we also did not report information on any conservative or surgical treatments performed. Third, inclusion and selection (nonresponse) bias cannot be excluded because 16% of contacted players did not respond to the survey, but as reported elsewhere [23], a response rate of 60% has been used as the threshold of acceptability; moreover, the sample size was appropriate. Furthermore, in the current study, all participants were male and gender bias should also be considered when evaluating the generalizability of results considering the anatomic differences in the anterior pelvis and inguinal region in men and women and the possible overlap with gynecological pain [55]. Larger prospective studies should be conducted to confirm data on prevalence and time loss from sport; however, the reported HAGOS values in players with and without history of groin pain will allow a better interpretation of the results in future groin pain studies. The intraclass correlation coefficient in our study's survey instrument was excellent. Moreover, the current study is characterized by a high methodological quality resulting from reporting of participant characteristics, sport and level participated in, duration of symptoms and HAGOS questionnaire values as recommended by the guidelines relating to minimum reporting standards for clinical research on groin pain in athletes [1, 6] and STROBE statement for cross-sectional studies [50].

Conclusion

Seasonal groin pain occurs in as many as one in four team sport athletes. Soccer players show the highest groin pain prevalence and the longest time loss from sport. Professional athletes report higher prevalence of groin pain in comparison with non-professional athletes. HAGOS appears to be a valid outcome instrument to measure groin pain, correlating with both time loss from sport and concomitant injuries in athletes suffering from this disease.

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Author contributions Each author fulfilled each of the authorship requirements. MM designed the study, performed data collection and interpretation, wrote the paper, and drafted the final manuscript as submitted; KC performed statistical analysis, contributed to the interpretation of data, wrote the paper, and drafted the final manuscript as submitted; OG conceptualized and designed the study, and critically

revised the manuscript as submitted; SC contributed to the interpretation and analysis of data, wrote the paper and drafted the final manuscript as submitted; BJM made critical revisions of the manuscript for important intellectual content; GG contributed to the interpretation and analysis of data, wrote the paper, and drafted the final manuscript as submitted; GG conceptualized and designed the study, coordinated data collection, and critically reviewed the manuscript. All authors read and approved the final manuscript as submitted.

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Availability of data and materials The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest None declared.

Ethics approval and consent to participate The study protocol was approved by the local Ethics Committee (Mater Domini Ethics committee), and the research was conducted in compliance with the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study.

Consent for publication Informed consent for publication was obtained from all individual participants included in the study.

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