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Functional knee stability in elite field hockey depends on playing class and gender

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Abstract:
Field hockey, a physically demanding Olympic sport, carries a high risk of lower limb injuries, yet data on injury risk in elite field hockey are limited. Functional knee stability is important for injury prevention and a safe return to sport. This study is the first to investigate functional knee stability in elite field hockey, considering gender and playing class, and establishes reference data for functional knee stability by using a standardized test battery that assesses one- and two-legged stability, jumping tests, speed, and agility. 72 elite field hockey players, 30 males and 42 females (age 19.82 ± 3.74 years) were divided into High Playing Class (HPC) and Moderate Playing Class (MPC). HPC players showed significant better performance in all functional tests except balance tests ($p < 0.01$-0.024). Females showed significantly better one- and two-leg stability ($p < 0.01$) with lower injury rates, indicating the relevance of gender considerations. The study emphasizes the importance of balance and stability in the prevention of lower limb injuries in Olympic field hockey and also highlights the importance of considering pre-existing deficits in functional knee capability when assessing athletes for return to sport. These results can help improve athletic performance, identify individual strengths and weaknesses, prevent injury or re-injury, and facilitate return to sport after injury.

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Functional knee stability in elite field hockey depends on playing class and gender

Field hockey, a physically demanding Olympic sport, carries a high risk of lower limb injuries, yet data on injury risk in elite field hockey are limited. Functional knee stability is important for injury prevention and a safe return to sport. This study is the first to investigate functional knee stability in elite field hockey, considering gender and playing class, and establishes reference data for functional knee stability by using a standardized test battery that assesses one- and two-legged stability, jumping tests, speed, and agility. 72 elite field hockey players, 30 males and 42 females (age 19.82 ± 3.74 years) were divided into High Playing Class (HPC) and Moderate Playing Class (MPC). HPC players showed significant better performance in all functional tests except balance tests (p <0.01-0.024). Females showed significantly better one- and two-leg stability ($p < 0.01$) with lower injury rates, indicating the relevance of gender considerations. The study emphasizes the importance of balance and stability in the prevention of lower limb injuries in Olympic field hockey and also highlights the importance of considering pre-existing deficits in functional knee capability when assessing athletes for return to sport. These results can help improve athletic performance, identify individual strengths and weaknesses, prevent injury or re-injury, and facilitate return to sport after injury.

Keywords: knee function, functional test battery, return to sport criteria, field hockey, reference data

Introduction

Field hockey is a physically demanding Olympic sport played by both men and women at recreational and professional levels. In Germany, the sport has gained more attention thanks to the men's team winning the 2023 World Cup. All studies conducted to date indicate that field hockey is an intermittent, high-intensity sport [1-7]. Elite male players cover an average total distance of 9.8 km during a field hockey game, while elite female players cover an average of 6.6 km [6]. Differences in total distance and highest maximum speed were found comparing genders as well as players' position on the field [1, 7]. Compared to other team sports, field hockey shows the highest running volume besides soccer [8]. Additionally, the posture required in field hockey is special, with players often adopting a crouched position and flexing their trunks and knees due to the ball being played predominantly on the ground [9, 10].

Barboza et al.'s review highlights the limited research on field hockey injuries, but current evidence suggests a significant problem [11]. Injuries are more prevalent at the professional level, resulting in higher rates than at the recreational level. The frequency of injuries ranges from 20.8 to 90.9 injuries per 1000 player hours at the professional level. The knee accounts for up to 32% of lower limb injuries [12]. Women's field hockey has shown the highest increase in anterior cruciate ligament (ACL) injuries in recent years compared to other team sports [13].

Several intrinsic risk factors for knee injuries, particularly ACL injuries, have been identified from investigations in other sports. These risk factors include leg asymmetries, valgus loading, sudden changes in direction, hard surfaces, muscular fatigue, or the menstrual phase for female athletes [14-16].

Functional knee stability is not only important for injury prevention but also for the return to sport decision-making and secondary injury prevention. For this purpose, balance, and mobility measurements such as the Y-balance test and the single-leg jump test have been proposed as predictors of safe return [17-20]. However, despite their widespread use, these tests have been criticized for lacking objectivity and being inadequate as predictors of safe return [21, 22]. The high re-injury rate of up to 20% for ACL injuries in athletes underscores the significance of addressing this issue [23]. Therefore, various test batteries have now been developed and tested [24-26]. One of these standardized test batteries is the Back in Action (BiA) test system (CoRehab, Trento, Italy. The BiA test comprises seven functional assessments, providing data on balance, speed, agility, and strength.

Normative data from 434 healthy individuals of similar age and gender are utilized for comparison via a software program. The test was developed in two phases: initially gathering data from participants without previous knee, hip, or ankle injuries, then applying the test battery clinically to 69 patients with unilateral ACL reconstruction. Test-retest reliability was determined using intraclass correlation [24, 25]
.

Several other studies have already used this test battery on healthy athletes in various sports [27-29]. However, existing studies have not explored sport-specific risk factors for field hockey athletes, nor is there sufficient objective data on functional testing in this population, particularly among healthy, uninjured players. Since there are differences in both performance parameters and injury rates in the different playing classes, it is hypothesized that knee function would also vary between the playing classes. In addition, the influence of anthropometry on physical performance was investigated [11, 12]. Therefore, this pilot study aimed to evaluate functional knee stability in elite field hockey players and establish sport-specific reference data for a safe return to sport with the help of the Back in Action (BiA) test system.

Methods

Athletes

72 field hockey players, consisting of 42 females and 30 males with an average age of 19.82 ± 3.74 years, participated in this study. Only athletes of the three highest playing classes in Germany, i.e. elite field hockey, were taken into account. Before participating in the study, players had to be injury-free for at least six months. Athletes were divided into two groups based on their playing class: High Playing Class (HPC; n = 30) consisted of Germany's "1. Bundesliga," while Moderate Playing Class (MPC; n = 42) included Germany's "2. Bundesliga" and "Regionalliga West." Table 1 summarizes the players' demographic data and field hockey-specific information based on their playing class and gender. The study was approved by the local ethics committee in compliance with the Declaration of Helsinki, and each player and legal guardian for minors gave informed consent.

Procedure

A questionnaire was used to collect demographic data and sport-specific characteristics (playing class, field hockey experience, and hourly training load). Additionally, body weight and height were measured using a digital scale (Body+, Withings France SA, Issy-les-Moulineuax, France).

The functional knee stability was evaluated with the Back in Action (BiA) test system (CoRehab, Trento, Italy) to assess objective measures.

The tests were always performed in the same gym with a stable, level floor to ensure accurate measurements and comparability of data. All one-legged tests were initiated with the dominant leg. All subjects were instructed and tested by the same team using standardized test instructions. Prior to testing, they were familiarized with a video on how to perform the tests. The test battery was conducted after an individual warm-up program to ensure optimal conditions for all athletes depending on their individual demands. The warm-up programs did not exceed 10 minutes and consisted mainly of sub-maximal running, individual dynamic stretching, and jumping exercises.

A separate description for the BiA test battery has been published elsewhere, test elements are briefly described below [24, 25, 27].

Postural control/balance (TL-ST, OL-ST)

All balance tests were performed with an MFT Challenge Disc (TST Trendsport, Großhöfflein, Austria). The disc was connected to a PC and provided visual feedback on the athletes' position while balancing. Athletes were instructed to hold the center of the disc two-legged (TL-ST) and then one-legged (OL-ST) for 20 s (Figure 1). The test parameter was the level of stability (1 = best; 5 = worst).

Jump tests (TL-CMJ, OL-CMJ, TL-PJ)

The jump tests were performed by using the Myotest sensor (Myotest S.A., Sion, Switzerland) [30]. The sensor was placed on the athletes´ waist with a belt. All jump tests had to be performed without arm swinging and jump height (cm) was recorded. In addition, the power output was calculated in watts according to the athlete's weight (W/kg). For the two-legged plyometric jumps (TL-PJ), participants had to perform four consecutive jumps as high as possible with minimal ground contact. Jump height (cm) and ground contact time (ms) was recorded.

Speed and agility (OL-SJ, QF)

Performing the speed and agility tests, the Speedy Basic Jump Set (TST Trendsport, Grosshöfelein, Austria) was used. For the one-legged speedy jump test (OL-SJ), athletes were asked to jump one-footed through a coordination course of red (forward-backward-forward jumps) and blue (sideway jumps) hurdles as fast as possible. The Quick Feet test (QF) consisted of stepping in and out of a rectangle 15 times as fast as possible. For both tests, time (s) was recorded.

Statistical analysis

All statistical analyses were performed using SPSS (IBM SPSS Statistics for Macintosh, V27.0; IBM Corp., Armonk, NY, USA). Findings are shown as means with standard deviations (SDs) and 95% confidence interval (95% CI). Normal distribution was tested using the Shapiro-Wilk test. Normally distributed data were tested with parametric t-tests. In case of violation of the assumption for parametric tests (i.e., normality and homogeneity of variances), the Mann-Whitney U test was used instead. The Kruskal-Wallis test was used if more than two groups were compared.

G*Power was post hoc calculated for t-test comparisons between playing classes (Power 0.66) and between playing class and gender (HPC: Power 0.37, MPC: Power 0.42).

A Spearman's correlation analysis was used to assess the correlations. Effect sizes (r= Spearman-Rho) were categorized as negligible (0.00 to 0.30), low (0.30 to 0.50), moderate (0.50 to 0.70), high positive (0.70 to 0.90), and, very high positive (0.90 to 1.00) [31]. For all analyses, the level of significance was set at $p \leq 0.05$.

Results

All athletes filled in the questionnaire and completed the test battery. No athlete had to be excluded and no injuries occurred. Means, standard deviations (mean ± SD), and significance levels of anthropometric and field hockey-specific data as well as the performance test results are presented below (Table 1-4).

Table 1 presents the anthropometric data of the athletes, which did not differ across playing classes. However, if an additional subdivision by gender was made, it was seen that in both playing classes, there were significant differences in weight and height in favor of the men ($p < 0.001$). The training load was significantly higher in the high playing class ($p < 0.001$). Significant differences regarding injury rates were found in the high playing class, where men had more injuries than women ($p = 0.019$).

Table 2 shows the test results of all athletes, divided by playing class. Except for the plyometric jump tests, significantly better results were found in favor of HPC in all test categories. In the balance tests, HPC athletes were significantly superior to MPC athletes only in the stability of the non-dominant leg.

In the two-legged stability and the one-legged stability of the dominant leg, HPC athletes also achieved better results than MPC athletes, but this difference was not significant.

Table 3 depicts the differences in performance between genders in the high playing class in detail. Female HPC athletes reached significantly higher results than male HPC athletes in balance tests for both two-legged and one-legged tests on both dominant and non-dominant legs.

For counter-movement jumps, male HPC athletes achieved better results in terms of height and power for both two-legged and one-legged tests on both dominant and non-dominant legs.

In the plyometric jumps, male HPC athletes again performed better in terms of height, but there was no significant difference in ground contact time between male and female HPC athletes as indicated by a p-value of 0.104. For the Speedy Basic Jump test and Quick Feet test, there were no significant differences between the two groups with p-values greater than 0.05.

Table 4 shows the differences in moderate playing class between genders. Again, the female athletes performed significantly higher than the male athletes in the balance tests on both the two-legged and one-legged tests on the dominant and non-dominant leg. In all other subtests, the male subjects achieved significantly better results. Only in the Quick Feet test no differences were detectable.

In addition, significant correlations were found between body characteristics and physical performance (table 5). In all balance tests, body height was positively correlated with leg stability. Taller athletes scored higher than shorter ones and therefore showed poorer results.

Discussion

The purpose of this study was to evaluate functional knee stability in elite field hockey players and to determine sport-specific reference data. Secondly, we investigated the differences in knee function in relation to playing class and gender.

By examining 72 elite field hockey players, a reference dataset for functional knee stability in field hockey players was established. As assumed, the test results revealed differences in balance, strength, speed, and agility between the genders and playing classes. Overall, better performance was observed in higher playing classes, while gender differences were noticed in some characteristics. As the BiA test has already been used in other team sports with uninjured athletes, it was also possible to identify sport-specific characteristics.

Regarding gender, males performed better than females in all parts of the test battery, except for all stability tests. Here, female athletes performed significantly better in both one-leg and two-leg stability.

Taking into account the biological differences between the genders, men in our study have a greater body height, and there is already a consensus in the literature that a larger body height worsens results of balance test on wobble boards. The higher center of gravity due to the longer mechanical lever arm leads to impaired balance [33]. This present study also found a moderate correlation between body height and one- or two-legged stability (Table 5).

However, male HPC athletes had a significantly higher injury rate compared to female HPC athletes, as shown in figure 2, where the injury rates and the one-leg stability of the non-dominant leg are displayed for both genders (Figure 2). This is in line with previous studies, which underline balance as an associated factor for lower limb injury [11, 34]. Surprisingly, there was a moderate correlation between the stability of the non-dominant leg and injury frequency, with r = 0.623 (p = 0.031) within this group. Nevertheless, our results are also consistent with previous studies on team sports [1, 35], that associate higher intensity of play with a higher risk of injury.

The frequency of stability training was assessed by questionnaire (frequency of stability exercises during training session 0: never; 4: always, mean 2.8 ± 1.13 pts.), but no significant correlation was found between weekly training load or frequency of stability training and stability measured. Remarkably, all athletes appeared to incorporate stability training regularly into their training. As described above, there were gender differences in measured stability, although males and females in both playing classes did not differ in the frequency of stability training.

Barboza et al. [36] designed a warm-up program for young field hockey players that included stability exercises to prevent lower limb injuries. They were able to show that the injury rate was lower in the intervention group, but the difference was not statistically significant. Additionally, they were unable to verify a reduction in the severity of injuries. Therefore, field hockey still lacks injury prevention programs and studies proving their effectiveness, as other sports already have developed injury prevention programs (such as the FIFA 11+) with significant reductions in injury incidence [37, 38].

Looking at ACL injuries throughout other sports in isolation, previous literature has found that females have a 4-6 times higher injury rate [13]. Increased dynamic valgus and high abduction load have been identified as possible causes [39]. Postural stability is assumed to be a protective factor for ACL injuries in other sports [34]. Our study shows that women perform better in all stability tests (Figure 2). Therefore, it is imperative to collect statistics on ACL injuries in field hockey to conclude if women still have a higher occurrence rate, although wobble board performance is superior to men.

When using the BiA test battery to make return-to-sport decisions after injury, a limb symmetry index (LSI) above 90%, i.e. a deviation of < 10% between the injured and uninjured side is required. A deviation of > 10% is considered incomplete rehabilitation and therefore a risk factor for re-injury [40, 41]. However, in this sample, 42 of 72 uninjured athletes had a side difference of > 10% in at least one test category. These side-to-side deviations could also be found in healthy athletes of other sports, for example, Judo and Taekwondo [42]. This was particularly noticeable in the strength tests, where the average LSI across the entire sample was well below 90% at 85.81 ± 9.382%.

These results indicate that uninjured athletes in field hockey tend to have lateral differences in knee functional, possibly due to the asymmetric movement profile of the sport. Such sport-specific side differences must be considered when assessing functional knee stability, as they may interfere with the return to sport clearance after injury. Ronden et al. [43] showed that 9 months after bone-patellar tendon-bone anterior cruciate ligament reconstruction, only 17.5% of athletes passed the BiA test. Studies that do not include the LSI as a criterion for a safe return show higher passing rates [44]. Therefore, screening regularly may identify pre-existing asymmetries and weaknesses. BiA test results are already compared with normative data from healthy, gender- and age-matched controls.

Compared to other team sports such as handball, by Ruehlemann et al. [27], it is striking that the HPC field hockey players achieved better results in all categories. This was especially surprising for the jump tests, as jumping plays a major role in handball [32], but. Ruehlemann et al. only collected data on “non-elite” athletes. Expectedly, field hockey players were faster in the Speedy Basic Jump test and Quick Feet test, as field hockey involves quick movement of feet and dribbling rather than in handball [1, 2].

However, sport-specific characteristics in knee stability, such as seen in this study should be taken into consideration when interpreting individual test results.

Unfortunately, this study is limited by the small number of athletes, which reduces the power of analysis, and the single time point of measurement. Standardizing warm-up protocols before testing could also be a consideration for future studies to minimize potential influences on test execution quality.

Despite its limitations, the test battery utilized in this study proved effective in highlighting disparities among athletes and pinpointing specific weaknesses, including imbalances exceeding 10% or deficits in balance, within the field test setting. The authors of the study propose that this test battery represents a valuable resource for screening and overseeing elite field hockey athletes, not only for establishing when they can return to sport after an injury but also for identifying weaknesses throughout the season and tracking progress throughout. Further studies with larger groups of participants could provide additional insight into the relationship between performance, knee function, and injury rates in field hockey players.

Conclusion

This study is the first to investigate functional knee stability of elite field hockey players, considering their gender and playing class. The results indicate that there are significant differences in functional knee stability between male and female players, as well as among athletes of different playing classes. The study also highlights the importance of balance and stability in preventing lower limb injuries and emphasizes the potential impact of sport-specific factors on functional knee stability. The study underscores the importance of considering pre-existing side deviations or other deficits in functional knee stability when assessing athletes for return to sport decisions. These findings can benefit sports coaches and physicians in improving athletic performance, identifying individual strengths and weaknesses, preventing injuries or re-injuries, and facilitating the return to sport after an injury.

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Graphic legends

Table 1:

Descriptive analysis (mean and SDs) and p-value of the anthropometric characteristics and field hockey-specific data regarding athletes' playing class for n = 72

Table 2:

Descriptive analysis (mean and SDs) and p-value of the Back in Action test results regarding athletes' playing class for n = 72

Table 3:

Descriptive analysis (mean and SDs) and p-value of the Back in Action test results regarding gender in high playing class

Table 4:

Descriptive analysis (mean and SDs) and p-value of the Back in Action test results regarding gender in moderate playing class

Table 5:

Correlations between anthropometrics and performance tests of the Back in Action test battery of 72 elite field hockey players

Figure 1:

Performing the one- (OL-ST) and two-legged stability test (TL-ST) of the Back in Action test battery on the MFT disc

Figure 2:

Comparison of one leg stability of the non-dominant leg and injury frequency in different participant groups

Table 1

Descriptive analysis (mean and SDs) and p-value of the anthropometric characteristics and field hockey-specific data regarding athletes' playing class for n = 72. The p-values describe significant differences between the playing classes. HPC: high playing class; MPC: moderate playing class.

	HPC m (n = 12)	**HPC f (n = 18)**	**MPC m (n = 18)**	**MPC f (n = 24)**	***p-value***
age (years)	20.17 ± 3.01	19.67 ± 2.97	20.67 ± 5.09	19.13 ± 3.46	0.599
height (cm)	183.67 ± 7.10	169.86 ± 6.04	185.61 ± 4.84	170.13 ± 4.34	**<0.001**
weight (kg)	76.50 ± 6.92	61.56 ± 5.03	76.06 ± 7.99	65.13 ± 7.44	**<0.001**
BMI (kg/m²)	22.66 ± 1.39	21.34 ± 1.30	22.07 ± 1.92	22.49 ± 2.44	0.129
field hockey experience (years)	15.92 ± 3.23	14.33 ± 2.40	16.39 ± 4.39	14.25 ± 3.64	0.386
training load (hours/week)	10.25 ± 2.99	9.50 ± 2.55	5.578 ± 1.00	6.88 ± 2.29	**<0.001**
injury rate (absolute number)	6.42 ± 4.68	3.11 ± 2.06	4.22 ± 4.11	3.83 ± 2.60	0.134

Table 2

Descriptive analysis (mean and SDs) and p-value of the Back in Action test results regarding athletes' playing class for n = 72. The p-values describe significant differences between the playing classes. HPC: high playing class; MPC: moderate playing class.

	HPC (n = 30)	**MPC (n = 42)**	***p-value***	**significant differences between playing classes**
Leg stability (points)				
Two-legged	3.06 ± 0.81	3.26 ± 0.65	0.181	
One-legged				
Dominant leg	2.89 ± 0.72	3.17 ± 0.60	0.095	
Non-dominant leg	2.77 ± 0.57	3.19 ± 0.65	0.008	**HPC > MPC**
Countermovement jumps				
Two-legged height (cm)	38.82 ± 8.24	34.55 ± 7.93	0.024	**HPC > MPC**
Two-legged power (W/kg)	48.83 ± 6.82	44.98 ± 6.56	0.021	**HPC > MPC**
One-legged height (cm)				
Dominant leg	27.10 ± 7.35	22.21 ± 4.98	0.008	**HPC > MPC**
Non-dominant leg	25.46 ± 6.12	22.44 ± 5.31	0.059	
One-legged power (W/kg)				
Dominant leg	38.33 ± 6.74	34.38 ± 4.94	0.019	**HPC > MPC**
Non-dominant leg	36.97 ± 5.56	34.43 ± 5.34	0.090	
Pylometric jumps				
Height (cm)	35.17 ± 7.73	31.41 ± 7.70	0.072	
Ground contact time (ms)	189.73 ± 32.01	213.31 ± 56.16	0.071	
Speedy jump test (s)				
Dominant leg	6.55 ± 0.68	7.72 ± 1.78	<0.001	**HPC > MPC**
Non-dominant leg	6.73 ± 0.68	7.82 ± 1.51	<0.001	**HPC > MPC**
Quick feet (s)	7.95 ± 0.94	9.03 ± 1.42	0.001	**HPC > MPC**

Table 3

Descriptive analysis (mean and SDs) and p-value of the Back in Action test results regarding gender in high playing class. The p-values describe significant differences between the playing classes. HPC m: high playing class male players; HPC f: high playing class female players.

	HPC m (n = 12)	**HPC f (n = 18)**	***p-value***	**significant differences between genders**
Leg stability (points)				
Two-legged	3.72 ± 0.63	2.62 ± 0.59	<0.001	**HPC f > HPC m**
One-legged				
Dominant leg	3.38 ± 0.56	2.56 ± 0.62	0.001	**HPC f > HPC m**
Non-dominant leg	3.17 ± 0.53	2.51 ± 0.45	0.001	**HPC f > HPC m**
Countermovement jumps				
Two-legged height (cm)	46.21 ± 6.17	33.89 ± 5.20	<0.001	**HPC m > HPC f**
Two-legged power (W/kg)	54.50 ± 5.04	45.06 ± 5.02	<0.001	**HPC m > HPC f**
One-legged height (cm)				
Dominant leg	31.80 ± 6.81	23.97 ± 6.01	0.006	**HPC m > HPC f**
Non-dominant leg	29.08 ± 6.03	23.04 ± 4.98	0.028	**HPC m > HPC f**
One-legged power (W/kg)				
Dominant leg	43.17 ± 5.31	35.11 ± 5.63	0.001	**HPC m > HPC f**
Non-dominant leg	41.00 ± 4.90	34.28 ± 4.25	0.001	**HPC m > HPC f**
Pylometric jumps				
Height (cm)	41.23 ± 6.87	31.13 ± 5.31	<0.001	**HPC m > HPC f**
Ground contact time (ms)	169.92 ± 25.38	184.94 ± 35.64	0.104	
Speedy jump test (s)				
Dominant leg	6.758 ± 0.77	6.42 ± 0.59	0.134	
Non-dominant leg	6.83 ± 0.56	6.66 ± 0.75	0.368	
Quick feet (s)	8.19 ± 1.06	7.79 ± 0.85	0.232	

Table 4

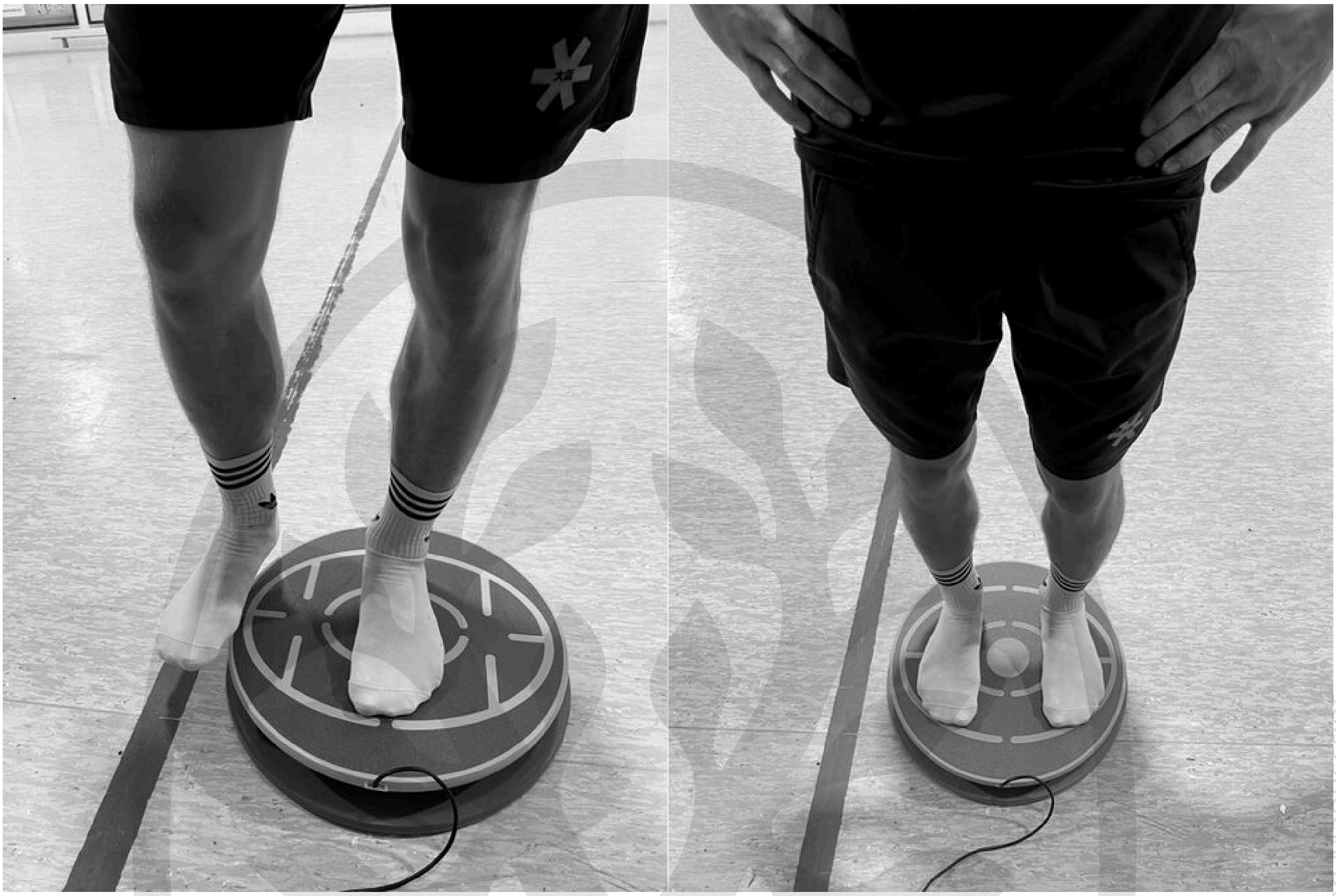
Descriptive analysis (mean and SDs) and p-value of the Back in Action test results regarding gender in moderate playing class. The p-values describe significant differences between the playing classes. MPC m: moderate playing class male players; MPC f: moderate playing class female players.

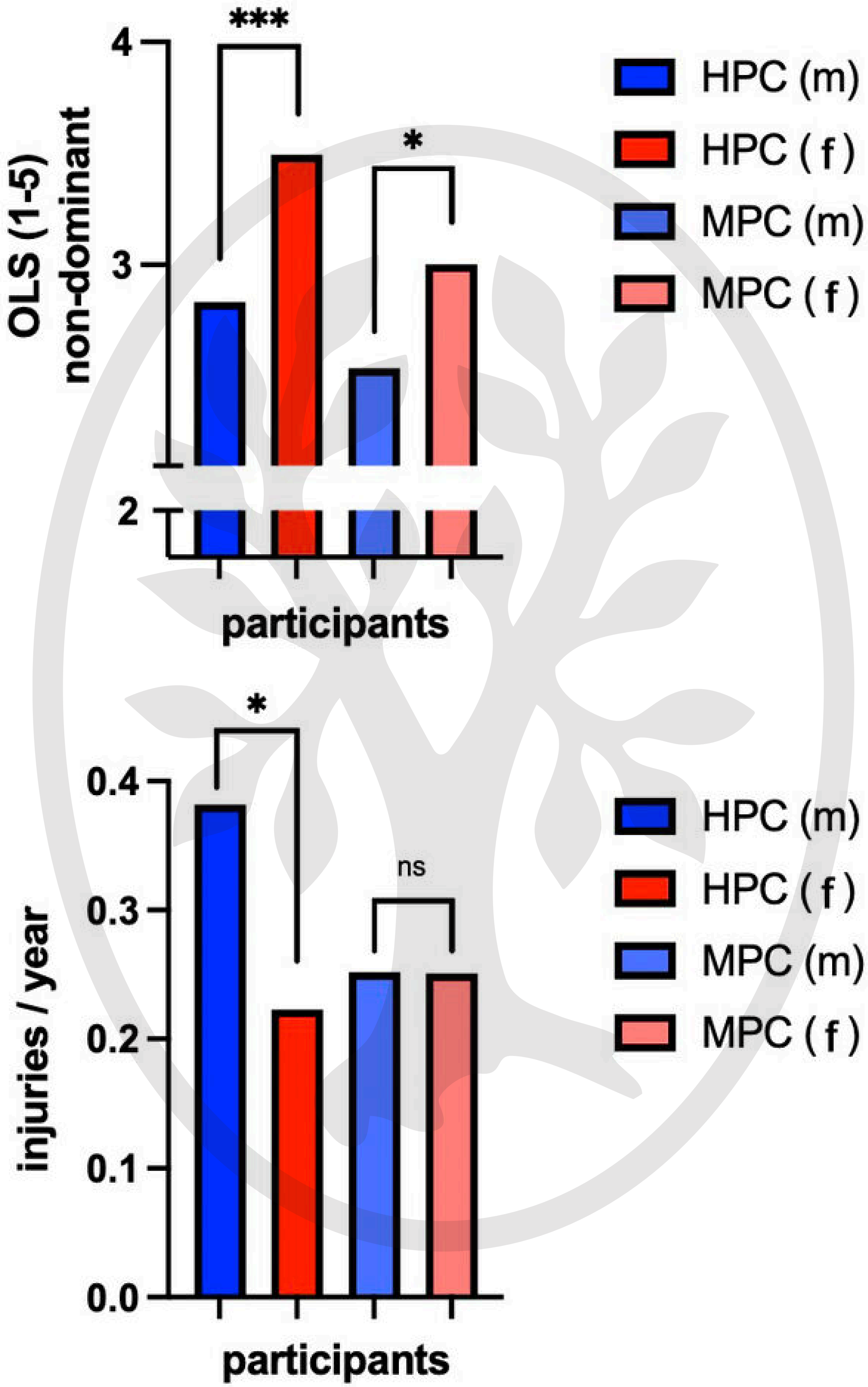
	MPC m (n = 18)	**MPC f (n = 24)**	***p-value***	**significant differences between genders**
Leg stability (points)				
Two-legged	3.68 ± 0.64	2.95 ± 0.47	<0.001	**MPC f > MPC m**
One-legged				
Dominant leg	3.52 ± 0.55	2.90 ± 0.49	0.001	**MPC f > MPC m**
Non-dominant leg	3.46 ± 0.64	2.99 ± 0.59	0.014	**MPC f > MPC m**
Countermovement jumps				
Two-legged height (cm)	40.90 ± 7.01	29.79 ± 4.54	<0.001	**MPC m > MPC f**
Two-legged power (W/kg)	50.22 ± 5.01	41.04 ± 4.37	<0.001	**MPC m > MPC f**
One-legged height (cm)				
Dominant leg	24.82 ± 4.21	20.26 ± 4.67	0.004	**MPC m > MPC f**
Non-dominant leg	26.07 ± 3.21	19.71 ± 4.95	<0.001	**MPC m > MPC f**
One-legged power (W/kg)				
Dominant leg	37.39 ± 3.91	32.12 ± 4.45	<0.001	**MPC m > MPC f**
Non-dominant leg	38.39 ± 2.79	31.46 ± 4.85	<0.001	**MPC m > MPC f**
Pylometric jumps				
Height (cm)	36.17 ± 6.74	27.84 ± 6.40	<0.001	**MPC m > MPC f**
Ground contact time (ms)	205.22 ± 34.06	219.38 ± 68.34	0.959	
Speedy jump test (s)				
Dominant leg	7.14 ± 0.96	8.15 ± 2.12	0.050	**MPC m > MPC f**
Non-dominant leg	7.22 ± 0.64	8.26 ± 1.81	0.035	**MPC m > MPC f**
Quick feet (s)	8.96 ± 1.45	9.08 ± 1.42	0.638	

Table 5

Correlations (r = Spearman-Rho) between anthropometrics and performance tests of the Back in Action test battery of 72 elite field hockey players

	body height		**body weight**	
	r	***p-value***	**r**	***p-value***
Leg stability (points)				
Two-legged	0.607	**<0.001**	0.621	**<0.001**
One-legged				
Dominant leg	0.572	**<0.001**	0.550	**<0.001**
Non-dominant leg	0.513	**<0.001**	0.592	**<0.001**
Countermovement jumps				
Two-legged height (cm)	0.432	**<0.001**	0.390	**<0.001**
Two-legged power (W/kg)	0.399	**<0.001**	0.365	**0.002**
One-legged height (cm)				
Dominant leg	0.254	**0.031**	0.185	0.121
Non-dominant leg	0.337	**<0.001**	0.248	**0.035**
One-legged power (W/kg)				
Dominant leg	0.408	**<0.001**	0.379	**<0.001**
Non-dominant leg	0.494	**<0.001**	0.458	**<0.001**
Pylometric jumps				
Height (cm)	0.460	**<0.001**	0.257	**0.030**
Ground contact time (ms)	0.052	0.667	0.226	**0.057**
Speedy jump test (s)				
Dominant leg	0.008	0.947	0.146	0.221
Non-dominant leg	0.015	0.901	0.127	0.287
Quick feet (s)	0.008	0.946	0.002	0.988





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*
4
3
2
OLS (1-5)
non-dominant
participants
HPC (m)
HPC (f)
MPC (m)
MPC (f)
*
ns
0.4
0.3
0.2
0.1
0.0
injuries / year
participants
HPC (m)
HPC (f)
MPC (m)
MPC (f)