Injury profile in professional handball players during four consecutive seasons according to playing positions: a longitudinal study

Abstract

Background: The injury profile of each playing position in handball is a key factor in being able to improve the injury risk management process. Therefore, the aim of this study was to longitudinally analyze the differences in professional handball players' injury profile according to their playing position (i.e., goalkeeper, back, wing and line).

Hypothesis: Injury incidence and burden would be higher in back players compared to the other playing positions, while ligament and knee would be the most common injury type and location.

Study Design: prospective cohort design

Level of evidence: Level 4

Methods: Sixty-eight male handball players belonging to the same professional team participated in this study over four consecutive seasons. Injury incidence and injury burden were recorded as well as the severity, type and location following the International Olympic Committee consensus statement.

Results: Although non-significant differences in injury incidence were found according to playing position (rate ratios [RR] from 0.43 to 2.47; $p > 0.05$), backs reported the highest burden (60.65 absence days/1000 h; RR from 0.12 to 7.75; $p < 0.05$), with wings showing a greater burden (54.29 absence days/1000 h; RR from 0.09 to 4.91; $p < 0.05$) in comparison with goalkeepers (12.19 absence days/1000 h) and lines (13.10 absence days/1000 h). Muscle/tendon injuries and sprains presented higher incidence and burden than other type of injuries, and a greater incidence and burden was reported for knee injuries in all playing positions.

Conclusions: The highest injury incidence and injury burden is in back players in professional handball.

Clinical relevance: This study provides comprehensive information on the injury profile of professional handball players, which can be useful for strength and conditioning coaches when developing specific injury risk management programs.

Keywords: injury and prevention; epidemiology; burden; team-sports; health

INTRODUCTION

Handball is a team sport characterized by high playing tempo, rapid changes of direction, jumps with abrupt landings, repetitive throws and frequent contact and collisions among players[12,24] which makes it a demanding, high injury risk sport.[8] Since injuries negatively impact professional players and teams in terms of sport performance and economic status,[7] it is necessary to implement effective strategies to reduce the injury risk.[27] It is well recognized that epidemiological analysis must be the first step in developing effective strategies,[20] which has led to a substantial increase in the number of studies exploring injury incidence in handball.[26] However, several authors have suggested that a discrepancy in definitions used in previous epidemiological injury research, and data collection procedures, may have clouded our understanding.[1,17] Furthermore, there has been an increased recognition that injury burden (e.g the number of absence days per 1000 h of exposure time) is an important parameter to report, especially in relation to specific positions within team sports.[2,29] Despite the fact that this valuable information could help to develop successful risk management strategies, burden has not been previously reported in professional handball players.

In order to plan a successful weekly training programme to optimize handball players' performance, and consequently to reduce the injury risk, understanding the specific match demands is considered of key importance.[15] In this regard, Póvoas et al.[13] observed that wing players covered the highest relative distances at high-intensity velocities in comparison to back and line players. Conversely, backs covered 15 and 21% more total distance than wings and lines, respectively. In addition, backs performed a higher number of jumps, throws, and changes of direction, whereas lines performed more one-on-one situations. These highly demanding and specific locomotor and activity profiles of professional handball players have led to differing injury profiles depending on playing

position.[5] A recent systematic review conducted by Raya-González et al.[26] has shown that outfield players suffer more injuries than goalkeepers, with backs and wings being the players with the greatest injury incidence. However, these authors claimed that few studies have analyzed the injury profile of each specific playing position and the heterogeneity of criteria observed when classifying handball players according to playing position makes the comparison between studies difficult. Specifically, Mónaco et al.[15] observed that professional handball players who composed the first line suffered a higher incidence during training, while the injury incidence during matches was greater in second line players. Similarly, Piry et al.[22] and Rafnsson et al.[17] reported the highest injury incidence in back players. Despite this, the aforementioned studies only present the injury incidence or even absolute values (i.e., number of injuries), so future studies including burden are necessary to obtain a comprehensive injury profile for each playing position.

Some authors have highlighted the pitfall of solely considering injury incidence to describe the injury profile of professional athletes, so the absence days generated by each injury must be considered in order to better understand the real impact injuries.[4] Thus, the severity contributes to help understand the meaningfulness of the injury episodes, although it does so through absolute values. It has been suggested that the best way to optimize this information is by reporting injury burden, since this concept combines the rate of disease (i.e., incidence) and a measure of loss (i.e., severity).[4] Previous epidemiological studies have analyzed the severity of injuries in professional handball players.[6,9,25] Specifically, in a systematic review conducted by Raya-González et al.[26], the authors determined that injuries with a duration of less than 7 days (i.e., 1–7 absence days) are most common in professional handball players, with the prevalence of less severe injuries (i.e., 1–3 absence days) observed during international championships. Despite the

valuable information provided by burden, only one study has previously reported this data with professional handball players,[28] demonstrating values between 13.33 and 25.92 absence days/1000 h of training and between 1271.01 and 2594.10 absence days/1000 h of match. As previously stated, knee and ankle sprain injuries seem to be the most common injuries in professional handball players,[26] however the burden related to these injuries has not been studied. Therefore, it is important to add the injury burden profile to each playing position, whilst considering location and type of injuries, to provide more in-depth information to aid the design and implementation of individualized risk management programs.

Considering the scarce literature focused on injury profile within playing positions and the lack of data available related to burden in relation to type and location of injuries, the aim of this study was to analyze the differences in professional handball players' injury profile according to playing position (i.e., goalkeeper, back, wing and line). We hypothesized, based on previous studies,[9,22,25] that the injury incidence and burden would be higher in back players compared to the other playing positions, and ligament and knee injuries would be the most common type and location.

METHODS

Participants

Sixty-eight professional handball players, who belonged to the same team, which participated in the Asociación de Clubes de Balonmano de España (ASOBAL) league (i.e., First Division) took part in this study. The investigation lasted four consecutive seasons, and players must have been part of the team in at least one of the four seasons. All players performed 6–7 in-court training sessions, 1–3 strength training sessions and 1–2 official matches per week. Players were classified by their primary playing position

as follows: 9 goalkeepers, 30 backs, 17 wings and 12 lines. Those players who were injured at the beginning of the study (i.e., two players) participated in this study, however, these injuries were not recorded. All participants were informed of the objectives of the research, were told that involvement was voluntarily, and had the possibility to withdraw at any time without any consequence. In addition, club officials' assent was obtained, and written consent was provided from the participants. This investigation was performed in accordance with the Declaration of Helsinki and the protocol was fully approved by the Ethics Committee of the Isabel I University (PUi1-008).

Experimental design

A prospective cohort design was carried out to determine the characteristics of injuries in professional male handball players over four consecutive seasons. During this period, each injury was recorded following the consensus on definitions and data collection procedures outlined by the International Olympic Committee consensus statement,[3] with the same medical staff of the club responsible to diagnose, treat, and record all time-loss injuries. Information about number of absence days, severity, type (in terms of damaged tissue), location and whether the injury occurred during training or match-play were registered according to the International Olympic Committee consensus statement.[3]

Definitions

An injury was defined as "a tissue damage or other derangement of normal physical function due to participation in sports, resulting from rapid or repetitive transfer of kinetic energy.",[3] while a re-injury was defined as "subsequent injuries to the same location and tissue as the index injury if the index injury was healed/fully recovered".[3] Injury burden was presented as the numbers of days lost per 1000 hours of exposure.[4] Exposure is considered to be "the time (in hours, h), both in training and match-play, during which the player is exposed to injury risk, and incidence refers to the number of injuries

sustained during practice, both in training and match-play, for every 1000 h of exposure".[16] Match-play exposure was calculated when playing against teams from different clubs and training sessions were considered those in which a coach directed physical activity carried out with the team (i.e., on-court and strength training sessions). A player was considered fully recovered (i.e., return to play) after an injury when he was given clearance by the medical staff to participate fully in team training and match-play.[30]

Statistical analysis

Normal distribution of data was tested by the Shapiro–Wilk test. Differences in players' characteristics and exposure time according to playing position were calculated using a One-way analysis of variance (ANOVA) with Bonferroni post hoc tests where required. Injury incidence (number of injuries/1000 h) and burden (number of absence days/1000 h) were calculated with 95% confidence intervals (CI) for each playing position.[4] Rate ratios (RR) with a 95% CI and the Z-test score[11] were also calculated for injury incidence and burden in order to determine the differences among playing positions (i.e., goalkeepers, backs, wings and lines). Statistical analysis was performed using a custom Microsoft Excel 2011 spreadsheet (Microsoft, Redmond, W, USA) and the software GraphPadPrism v.6.0 c (GraphPad Software, La Jolla, CA, USA). Significant level was set at $p \leq 0.05$

RESULTS

Table 1 presents players' characteristics and exposure time, while the injury incidence by playing positions is shown in Table 2. Total, training, and match-play exposure time were higher for backs compared to other playing positions ($p < 0.05$). Although no significant differences in injury incidence during total, training and match-play were observed

among playing positions, greater injury incidence during match-play was found in comparison to training in all playing positions ($p < 0.05$).

Table 1 Characteristics and exposure time of handball players attending to playing positions.

	Total (n = 68)	**Goalkeeper (n = 9)**	**Back (n = 30)**	**Wing (n = 17)**	**Line (n = 12)**
Characteristics					
Age (y)	26.8 ± 2.2	29.1 ± 0.7	27.7 ± 0.6	24.9 ± 0.5	26.3 ± 0.5
Stature (cm)	189.5 ± 2.3	188.6 ± 2.3	187.1 ± 2.1	181.5 ± 2.8	188.2 ± 1.1
Body mass (kg)	89.2 ± 3.0	89.5 ± 2.0	87.3 ± 4.2	80.3 ± 2.1	91.2 ± 3.7
Body mass index ($kg \cdot m^{-2}$)	23.9 ± 1.2	24.3 ± 1.7	23.5 ± 2.2	22.7 ± 1.6	25.5 ± 1.7
Exposure time					
Total exposure (h)	41636	4922	19554[abc]	10978	6182
Training exposure (h)	40719	4791	19161[abc]	10716	6051
Match exposure (h)	917	131	393[abc]	262	131

Values are mean ± SD; n = sample.

[a] Ratio significantly higher than it is for Goalkeeper ($p < 0.05$).

[b] Ratio significantly higher than it is for Wing ($p < 0.05$).

[c] Ratio significantly higher than it is for Line ($p < 0.05$).

Table 2 Injury incidence of each playing position during training, match-play and total sessions.

Playing position	**Total**		**Training**		**Match-play**	
	Nº	**Incidence (95% CI)**	**Nº**	**Incidence (95% CI)**	**Nº**	**Incidence (95% CI)**
Total	144	3.46 (2.94-4.07)	100	2.46 (2.02-2.99)	44	47.98 (35.71-64.48)*
Goalkeeper	13	2.64 (1.53-4.55)	9	1.88 (0.98-3.61)	4	30.53 (11.46-81.36)*
Back	82	4.19 (3.38-5.21)	56	2.92 (2.25-3.80)	26	66.16 (45.04-97.17)*
Wing	32	2.91 (2.06-4.12)	22	2.05 (1.35-3.12)	10	38.17 (20.54-70.94)*
Line	17	2.75 (1.71-4.42)	13	2.15 (1.25-3.70)	4	30.53 (11.46-81.36)*

CI: Confidence Intervals. Nº: number of.

* Ratio significantly higher than it is for training ($p < 0.05$).

Information about absence days and burden for each playing position is presented in table 3. Significantly greater injury burden (60.65 absence days/1000 h; RR from 0.12 to 7.75;

Table 3 Absence days and severity of each playing position during training, match-play and total sessions.

	Burden							
Playing position	**Total absence days**	**Total burden (95% CI)**		**Training absence days**	**Training burden (95% CI)**		**Match absence days**	**Match burden (95% CI)**
Total	1923	46.19 (44.17-48.30)		606	14.88 (13.74-16.12)		1317	1436.20 (1360.69-1515.91)
Goalkeeper	60	12.19 (9.46-15.70)		30	6.26 (4.38-8.96)		30	229.01 (160.12-327.54)
Back	1186	60.65 (57.30-64.20)[abc]		406	21.19 (19.22-23.35)[abc]		780	1984.73 (1850.22-2129.02)[ac]
Wing	596	54.29 (50.10-58.83)[ac]		123	11.48 (9.62-13.70)[ac]		473	1805.34 (1649.76-1975.60)[ac]
Line	81	13.10 (10.54-16.29)		47	7.77 (5.84-10.34)		34	259.54 (185.45-363.24)
Playing position	**Severity**							
	Slight (1-3 days)		**Minor (4-7 days)**		**Moderate (8-28 days)**		**Major (>28 days)**	
Total	47	1.13 (0.85-1.50)[23]	55	1.32 (1.01-1.72)[23]	27	0.65 (0.44-0.95)[3]	13	0.31 (0.18-0.54)
Goalkeeper	7	1.42 (0.68-2.98)	5	1.02 (0.42-2.44)	1	0.20 (0.03-1.44)	-	-
Back	25	1.28 (0.86-1.89)[3]	32	1.64 (1.16-2.31)[123]	15	0.77 (0.46-1.27)	8	0.41 (0.20-0.82)
Wing	6	0.55 (0.25-1.22)	13	1.18 (0.69-2.04)	8	0.73 (0.36-1.46)	5	0.46 (0.19-1.09)
Line	9	1.46 (0.76-2.80)	5	0.81 (0.34-1.94)	3	0.49 (0.16-1.50)	-	-

CI: Confidence Intervals; Burden: absence days/1000 h

[a] Ratio significantly higher than it is for Goalkeeper ($p < 0.05$).

[b] Ratio significantly higher than it is for Wing ($p < 0.05$).

[c] Ratio significantly higher than it is for Line ($p < 0.05$).

[1] Ratio significantly higher than it is for Slight ($p < 0.05$).

[2] Ratio significantly higher than it is for Moderate ($p < 0.05$).

[3] Ratio significantly higher than it is for Major ($p < 0.05$).

$p < 0.05$) was observed in the back group compared to the other playing positions. In addition, wings showed a significantly higher burden than goalkeeper and line groups (54.29 absence days/1000 h; RR from 0.09 to 4.91; $p < 0.05$). Also, slight, minor and moderate injuries were significantly higher than major injuries (RR from 2.08 to 4.23; $p < 0.05$). Specifically in backs, there were significantly higher slight and minor injuries compared to moderate and major injuries (RR from 3.13 to 4.00; $p < 0.05$).

Table 4 shows the injury incidence and burden of each type of injuries for each playing position, while injury incidence and burden in each location is presented in Table 5. Muscle/tendon injuries are the most common type in all groups, while the greatest burden was caused by ligament sprain, mainly in outfield players. For all the playing position groups, the highest injury incidence is observed in the knee, which is also the location of one of the greatest areas for injury burden.

DISCUSSION

The aim of this study was to longitudinally analyze the differences in professional handball players' injury profile according to their playing position (i.e., goalkeeper, back, wing and line). Greater injury incidence during match-play was found in comparison to training in all playing positions. Although non-significant differences in injury incidence were found, back players reported higher burden values compared to the other playing positions and wing players showed a greater burden than goalkeepers and lines. In terms of injury type, muscle/tendon injuries were the most common, while the highest burden was observed for ligament sprains for outfield players. Finally, the highest injury

Table 4 Injury incidence and burden in each type of injuries for each playing position.

		Total		Goalkeeper		Back		Wing		Line	
		Nº	**Incidence (95% CI)**	**Nº**	**Incidence (95% CI)**	**Nº**	**Incidence (95% CI)**	**Nº**	**Incidence (95% CI)**	**Nº**	**Incidence (95% CI)**
Type	**Ligament sprain**	35	0.84 (0.60-0.17)	1	0.20 (0.03-1.44)	19	0.97 (0.62-1.52)	12	1.09 (0.62-1.92)*	2	0.48 (016-1.50)
	Cartilage injury	4	0.10 (0.04-0.26)	2	0.41 (0.10-1.62)	2	0.10 (0.03-0.41)	-	-	-	-
	Bone fracture	9	0.22 (0.11-0.42)	-	-	5	0.26 (0.11-0.61)	1	0.09 (0.01-0.65)	3	0.49 (0.16-1.50)
	Muscle/tendon injury	96	2.31 (0.70-1.31)*	10	2.03 (0.42-2.44)*	56	2.86 (0.74-1.71)*	19	1.73 (0.30-1.34)*	11	1.78 (0.44-2.16)*
		Absence days	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**
	Ligament sprain	1119	26.87 (25.35-28.50)*	7	1.42 (0.68-2.98)	671	34.32 (31.81-37.01)*	409	37.26 (33.82-41.05)*	32	5.17 (3.66-7.32)
	Cartilage injury	56	1.34 (1.04-1.75)	14	2.84 (2.34-3.89)	42	2.15 (1.59-2.91)	-	-	-	-
	Bone fracture	237	5.69 (5.01-6.47)	-	-	172	8.80 (7.58-10.21)	59	5.37 (4.16-6.94)	6	0.97 (0.44-2.16)
	Muscle/tendon injury	498	11.96 (3.85-5.13)	39	7.92 (3.27-7.27)*	322	16.47 (4.57-6.67)	84	7.65 (1.84-3.80)	43	6.96 (2.60-5.79)*

CI: Confidence Intervals. Nº: number of.

* The most common type of injury ($p < 0.05$).

Table 5 Injury incidence and burden in each location of injuries for each playing position.

		Total		Goalkeeper		Back		Wing		Line	
		Nº	Incidence (95% CI)	Nº	Incidence (95% CI)	Nº	Incidence (95% CI)	Nº	Incidence (95% CI)	Nº	Incidence (95% CI)
	Ankle	22	0.53 (0.35-0.80)	-	-	14	0.72 (0.42-1.21)	6	0.55 (0.25-1.22)	2	0.32 (0.08-1.29)
	Head	5	0.12 (0.05-0.29)	-	-	2	0.10 (0.03-0.41)	1	0.09 (0.01-0.65)	2	0.32 (0.08-1.29)
	Leg	10	0.24 (0.13-0.45)	-	-	6	0.31 (0.14-0.68)	1	0.09 (0.01-0.65)	3	0.49 (0.16-1.50)
	Knee	40	0.96 (0.70-1.31)*	6	1.22 (0.55-2.71)*	17	0.87 (0.54-1.40)*	13	1.18 (0.69-2.04)*	4	0.65 (0.24-1.72)*
	Abdomen	3	0.07 (0.02-0.22)	-	-	2	0.10 (0.03-0.41)	-	-	1	0.16 (0.02-1.15)
	Lumbar	26	0.62 (0.43-0.92)	4	0.81 (0.31-2.17)	13	0.66 (0.39-1.14)	5	0.46 (0.19-1.09)	4	0.65 (0.24-1.72)
	Shoulder	23	0.55 (0.37-0.83)	1	0.20 (0.03-1.44)	18	0.92 (0.58-1.46)*	3	0.27 (0.09-0.85)	1	0.16 (0.02-1.15)
	Thigh	7	0.17 (0.08-0.35)	1	0.20 (0.03-1.44)	5	0.26 (0.11-0.61)	1	0.09 (0.01-0.65)	-	-
	Arm	4	0.10 (0.04-0.26)	1	0.20 (0.03-1.44)	2	0.10 (0.03-0.41)	1	0.09 (0.01-0.65)	-	-
	Wrist-hand	4	0.10 (0.04-0.26)	-	-	3	0.15 (0.05-0.48)	1	0.09 (0.01-0.65)	-	-
Location		**Absence days**	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**	**Absence days**	**Burden (95% CI)**
	Ankle	232	5.57 (4.90-6.34)	-	-	166	8.49 (7.29-9.88)	47	4.28 (3.22-5.70)	19	3.07 (1.96-4.82)
	Head	11	0.26 (0.15-0.48)	-	-	4	0.20 (0.08-0.55)	2	0.18 (0.05-0.73)	5	0.81 (0.34-1.94)
	Leg	55	1.32 (1.01-1.72)	-	-	42	2.15 (1.59-2.91)	7	0.64 (0.30-1.34)	6	0.97 (0.44-2.16)
	Knee	998	23.97 (22.53-25.50)*	25	5.08 (3.43-7.52)*	544	27.82 (25.58-30.26)*	407	37.07 (33.64-40.86)*	22	3.56 (2.34-5.40)*
	Abdomen	64	1.54 (1.20-1.96)	-	-	62	3.17 (2.47-4.07)	-	-	2	0.32 (0.08-1.29)
	Lumbar	92	2.21 (1.80-2.71)	11	2.23 (1.24-4.04)	42	2.15 (1.59-2.91)	20	1.82 (1.18-2.82)	19	3.07 (1.96-4.82)
	Shoulder	192	4.61 (4.00-5.31)	4	0.81 (0.31-2.17)	167	8.54 (7.37-9.94)	13	1.18 (0.69-2.04)	8	1.29 (0.65-2.59)
	Thigh	73	1.75 (1.39-2.21)	13	2.64 (1.53-4.55)	53	2.71 (2.07-3.55)	7	0.64 (0.30-1.34)	-	-
	Arm	63	1.51 (1.18-1.94)	7	1.42 (0.68-2.98)	22	1.13 (0.74-1.71)	34	3.10 (2.21-4.33)	-	-
	Wrist-hand	131	3.14 (2.65-3.73)	-	-	72	3.68 (2.92-4.64)	59	5.37 (4.16-6.94)	-	-

CI: Confidence Intervals. Nº: number of.

* The most common location of injury ($p < 0.05$).

incidence and burden rates were reported for knee injuries in all playing positions.

A recent systematic review[26] has established that senior male handball players suffer 7.8 injuries/h total exposure, with higher values observed in match-play (from 15 to 73.6 injuries/h match exposure) compared with training (from 0.96 and 4.1 injuries/1000 h training exposure). Our results are in line with those reported in the aforementioned systematic review, showing a greater incidence during matches compared to training for all playing positions ($p < 0.05$). This might be attributed to the fact that training sessions do not adequately prepare the player for competitive play.[28] In relation to playing positions, backs showed the highest incidence in all categories (i.e., total, training and match exposure) compared with other playing positions, possibly due to the specific defensive role of these players during the game. Often the need to avoid the goal can lead to the execution of actions at a supramaximal intensity, adding load to the anatomical structures, and increasing injury risk. Our findings are supported by previous studies performed with handball players during regular championship seasons.[9,22,25] These results suggest there is a need to individualize risk management programs based on playing positions, although other factors (e.g. context, burden and type or location of injuries) must also be considered.

Despite the valuable information provided by injury burden data, only one previous study has reported this in professional handball players,[28] albeit not for each playing position. The current study indicates that back players suffer the greatest burden ($p < 0.05$) compared to all other positions, in relation to total exposure, training sessions and match-play. Furthermore, wings reported a higher burden than goalkeepers and lines. Additionally, higher burden values were observed during matches compared to training sessions, indicating that more serious injuries are sustained during competitive play. Previous studies have reported that injuries in professional male handball players mainly

generate between 1-7 absence days, constituting about 65% of overall injuries.[9,14,22] Our results reinforce this as significantly more ($p < 0.05$) slight (1-3 days) and minor (4-7 days) injuries were reported (i.e., 72% of all injuries) compared to moderate (8-28 days) and major (> 28 days) injuries. However, when playing position was taken into account, only significant differences ($p < 0.05$) in burden was observed in backs, showing a higher incidence in slight and minor injuries ($p < 0.05$). This information must be considered when prescribing risk management programs in order to try and reduce injury burden.

Previous research has shown that sprains are the most common injuries in this population [26]. However, our results have reported muscle/tendon injuries as those with the highest prevalence. Conversely, when the consequence of these injuries is analyzed, sprain injuries showed the greatest burden in outfield players. This may be due to sprain injuries mainly occurring during landings, where optimal landing patterns are impaired by the interaction with other players.[21] This type of situation does not occur in goalkeepers since they have their playing area limited to other players,[10] so specific risk management programs based on plyometric actions and focused on chaotic landings should be implemented for outfield players.

Lower extremities are the body area where most injuries are sustained in all the playing positions, similar to previous studies[6,9,14] with the knee followed by the ankle the most affected areas in outfield players. This is maybe unsurprising given that the most common actions in handball (e.g., jumps, decelerations or landings) involve large loads being translated through these joints.[12,24] Additionally, injuries in the lumbar area, possibly due to weakness in the gluteal muscles,[27] and in the shoulder due to contacts and blows,[18] also present a high injury incidence in all the specific positions. Given that the greatest burden is also in injuries related to the knee, and the position specific data we have found,

reinforces the need to determine the etiology of injuries suffered by professional handball players based on playing position.

The main limitation of the current study is the case study approach employed (e.g., a single team), and although this design has been used previously in similar studies,[13,28] the findings obtained must be considered with caution.

CONCLUSIONS

Our study reported that injury incidence is higher during match play compared to training for all playing positions. Specifically, backs showed the highest injury incidence and burden, while wing players presented a greater incidence compared to goalkeepers and lines. Slight and minor injuries showed a higher prevalence than moderate and major injuries. Muscle/tendon injuries and sprains were the most common types and generated the highest burden values. Finally, the knee was the most injured area and reported the greatest burden in all playing positions, followed by ankle, shoulder and lumbar injuries.

PRACTICAL APPLICATIONS

In general terms, strength and conditioning coaches should focus on reproducing the demands of competition during the training sessions of professional handball players. Specifically, different risk management programs should be implemented for outfield players and goalkeepers to reduce not only the injury incidence, but the burden. In addition, preventive programs focused on the knee joint based on strength, landing mechanics and stability exercises seem necessary to reduce the injury risk in this location. In addition, the inclusion of risk management programs for muscle strain injuries must be considered. These recommendations should help to inform individualized risk management programs for every player.

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