Hamstring Injuries in Major League Soccer

A 10-Year Analysis of Injury Rate, Return to Play, and Performance Metrics by Player Position

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Background: Hamstring injuries are common in athletes performing high-intensity sports, such as soccer, impacting performance and return to play (RTP) times. This study aimed to evaluate the effect of hamstring injuries on RTP and performance among Major League Soccer (MLS) players over 10 years.

Purpose: To evaluate the effect of hamstring injuries on RTP times and performance metrics among MLS players over 10 years, with a focus on injury characteristics, rehabilitation practices, and positional differences.

Study Design: Cohort study; Level of evidence, 3.

Methods: From 2010 to 2021, 2715 MLS players with hamstring injuries were identified by the MLS Injury Surveillance Database and analyzed. RTP times, injury rates, and reinjury rates were compared between the 2010-2015 and 2016-2021 cohorts. Performance metrics (games, minutes, goals, and assists) were extracted. Uninjured controls were matched 2 to1 by position, age, and experience. *T* tests were used to assess postinjury performance differences.

Results: Game-related injuries required longer RTP than practice injuries (27.8 vs 21.9 days; $P = .023$), and acute noncontact injuries took more time to recover than chronic injuries (24.9 vs 13.2 days; $P < .0001$). RTP times increased in the 2016-2021 cohort compared with the 2010-2015 cohort for minimal/first-degree injuries (15.09 $\pm$ 31.29 vs 10.13 $\pm$ 28.53 days; $P = .018$) and overall (20.26 vs 13.60 days; $P = .002$), despite stable injury rates ($P = .405$). Reinjury rates decreased nonsignificantly ($P = .603$); however, RTP after reinjury was longer in the 2016-2021 cohort (25.05 vs 10.03 days; $P = .025$). Defenders saw reduced minutes played 2 years after injury compared with controls (–221.60 $\pm$ 833.66 vs -34.80 ± 792.11; $P = .007$). RTP times were unaffected by playing surface grass versus turf ($P = .620$) or player position (forward, midfielder, defender, and goalkeeper) ($P = .900$).

Conclusion: Injury rates were unchanged in the 2010-2015 and 2016-2021cohorts; however, RTP times increased in the latter cohort, especially for recurrent injuries. Game-related and acute noncontact injuries required longer RTP, and defenders showed the greatest performance decline. Future studies are needed to further highlight mechanisms of injury and treatment for preventative protocols.

Keywords: hamstring injury; player performance; reinjury; return to play; soccer

Hamstring injuries are among the most prevalent musculoskeletal injuries encountered in athletes participating in high-intensity sports.[1,18] These injuries, particularly common in sports requiring explosive sprints and rapid directional changes, such as soccer,[9,14] can significantly affect an athlete's performance and career longevity. In professional leagues, such as Major League Soccer (MLS), hamstring injuries not only pose challenges in the short term, such as delays in return to play (RTP), but they also raise concerns regarding long-term performance metrics and career progression.[4,14]

The implications of hamstring injuries extend beyond the physical healing period.[3,25] Athletes may experience lingering deficits in performance, affecting critical in-game contributions, such as minutes played, goals, assists, and overall match participation. These injuries can

The Orthopaedic Journal of Sports Medicine, 13(8), 23259671251360422
DOI: 10.1177/23259671251360422

potentially alter a player's role within a team and their ability to meet preinjury performance expectations,[22] thereby influencing overall team dynamics and outcomes. With hamstring injuries being common, there must also be consideration for the financial repercussions,[15] especially regarding the long-term outcomes of these patients. Despite the high incidence of hamstring injuries,[7] there remains a paucity of comprehensive data that systematically evaluates the long-term effect of these injuries on professional soccer players,[12,24] specifically within the MLS.

This study aimed to address these gaps by conducting a retrospective matched-cohort analysis to (1) characterize RTP timelines after hamstring injury; (2) assess long-term performance outcomes across multiple seasons after injury; and (3) evaluate the potential influence of contextual factors, such as playing surface, injury mechanism, and player position. In doing so, we aimed to quantify the multifactorial burden of hamstring injuries in MLS athletes and generate clinically relevant insights for injury prevention, rehabilitation, and RTP decision-making.

By examining the performance trends over a 3-year postinjury period, this study sought to quantify the lasting effect of hamstring injuries across different player positions, providing valuable insights into player recovery, management, and prognosis after these common injuries. In addition, this study aimed to determine whether the prevalence of hamstring injuries changed over the studied period. We hypothesized that players who sustain hamstring injuries would demonstrate prolonged RTP times and would experience statistically significant declines in key performance metrics over a 3-year follow-up period when compared with matched controls without hamstring injuries.

METHODS

A retrospective cohort study was performed on MLS players who sustained hamstring injuries between 2010 and 2021. The players were identified utilizing the MLS Injury Surveillance database, and all injuries, along with their severity, were diagnosed and documented by the respective team physician. Hamstring injuries were defined as injuries affecting $\geq$1 of the muscles or tendons that comprise the hamstring muscle group (semimembranosus, semitendinosus, and biceps femoris). The study compared 2 distinct periods, 2010-2015 and 2016-2021, to evaluate trends in injury rates, RTP times, and reinjury rates.

Injured players were identified from the MLS Injury Surveillance database, which records injury details across all MLS teams. To qualify for inclusion, players must have participated in at least 1 full MLS season before their injury and 1 full season after their injury. Players who suffered reinjury were counted once for analysis purposes. Noninjured controls were selected from the same database, matched in a 2 to 1 ratio to injured players based on playing position.

Matching criteria were as follows:

- Minutes played: For players averaging >1000 minutes per season, matching was performed within $\pm$10%; for those <100 minutes, the best available judgment was used.
- Age: $\pm$2 years of the injured player.
- Goals scored: $\pm$1 goal.

Two independent reviewers (F.H. and H.S.) manually entered and cross-referenced injuries and player performance metrics to ensure data accuracy. There were no conflicts between the 2 reviewers; however, any discrepancies that might have arisen would have been resolved by consultation with a third reviewer (C.H.).

Player characteristics, injury specifics, and performance metrics were extracted from official MLS records. Demographic variables included age, playing position, team affiliation at the time of injury, and MLS experience. Injury details captured included year of injury, field type (natural grass or artificial turf), context of injury (match or training), field location (home or away), player age at the time of injury, weather conditions at the time of injury, and RTP date. RTP duration was stratified by injury severity, categorized as "Minimal/First Degree" or "Moderate/Second Degree," and compared between the 2010-2015 and 2016-2021 cohorts to assess temporal trends in recovery duration across injury grades.

For each injured player, RTP was defined as the date of return to competitive play, measured in days from the date of injury. Reinjury rates were calculated as the percentage of players who experienced a second hamstring injury within 2 months of the initial injury, in alignment with the Ekstrand et al[8] definition, separated into 2 cohorts:

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Final revision submitted April 4, 2025; accepted April 25, 2025.
One or more of the authors has declared the following potential conflict of interest or source of funding: B.F. has received consulting fees from Stryker. K.B. has received consulting fees from Xiros Inc, DePuy Synthes Products, and Medical Device Business Services; hospitality payments from Arthrex Inc and International Life Sciences; and support for education from Medinc of Texas. R.F. has received consulting fees from Arthrex; speaking fees from Arthrex, Bodycad USA, and Synthes GmbH; hospitality payments from Aesculap Biologics; and support for education from Gemini Mountain Medical and Pinnacle Inc. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.
Ethical approval was not sought for the present study.

2010-2015 and 2016-2021. Recurrent injuries were defined as reinjuries to the same muscle group within a specific timeframe.

Injury rates were calculated as the number of unique players who sustained a hamstring injury during the specified year (cohorts: 2010-2015 and 2016-2021), divided by the total number of MLS players in each year. The injury rate was expressed as a proportion rather than using athletic exposures or playing hours because the original data file did not include information on athletic exposures or total playing hours. To address this limitation and ensure comparability, the injury rate was calculated by accounting for year-to-year changes in roster sizes, using the total number of unique players each year as the denominator. The total number of players was not the same between the 2 time periods, which was accounted for in the proportion-based calculation. The mean injury rate was then calculated for each cohort. RTP times were analyzed by calculating the mean number of days missed due to injury for players in each cohort, with comparisons drawn between the 2010-2015 and 2016-2021 periods.

Our retrospective matched-cohort study also examined the long-term effect of hamstring injuries on performance metrics—including games played, minutes played, goals, and assists—to understand the variations across player positions and rehabilitation practices. Performance metrics were assessed 1 season before injury as a baseline and up to 3 years after injury, encompassing games played, games started, minutes played, goals scored, assists, pass accuracy, interceptions, clean sheets, and goals conceded, depending on player position.

Injury rates, RTP times, and reinjury rates were compared between the 2 cohorts (2010-2015 and 2016-2021). Performance metrics were compared between injured players and their matched noninjured controls using independent *t* tests for normally distributed continuous variables. Injury and RTP times were expressed as means ± standard deviations, and statistical significance was set at $P < .05$. All statistical analyses were performed using STATA (StataCorp), with statistical significance set at $P < .05$.

TABLE 1
Baseline Characteristics for the Hamstring Cohort[a]

	Mean Time to RTP, Days	*P*
Field type		.620
Grass, n = 2241	21.19 ± 12.48	
Artificial turf, n = 474	20.13 ± 11.72	
Player age, years		.368
≤26, n = 683	17.99 ± 10.27	
>26, n = 549	16.09 ± 9.83	
Position		.900
Midfielder, n = 503	24.04 ± 13.57	
Forward, n = 288	23.92 ± 12.94	
Defender, n = 504	22.83 ± 11.39	
Competitive setting		**.023**
Game/match, n = 835	27.81 ± 14.18	
Practice, n = 600	21.87 ± 11.32	
Injury onset		**.0001**
Acute, noncontact, n = 1665	24.89 ± 13.08	
Chronic/gradual, noncontact, n = 758	13.17 ± 9.06	
Field location		.850
Home, n = 419	21.01 ± 10.96	
Away, n = 416	20.78 ± 10.73	
In-game time of injury, min		.670
0-30, n = 143	31.04 ± 15.34	
30-60, n = 175	22.03 ± 11.97	
60-90, n = 205	26.11 ± 13.52	
Weather conditions		.776
Sunny/clear, n = 1874	21.3 ± 11.62	
Cloudy/rainy/snowy, n = 793	20 ± 11.18	

[a]Data are presented as mean ± SD or n (%). Bold *P* values indicate significance. RTP, return to play.

RESULTS

Between 2010 and 2021, a total of 2715 players with hamstring injuries were identified and matched to noninjured controls. The competitive setting was found to have a significant effect, with injuries sustained during games resulting in a longer RTP (27.8 days) compared with practice injuries (21.9 days; $P = .0230$). Injury onset was also highly significant. Acute noncontact hamstring injuries led to a mean RTP of 24.9 days, which was significantly longer compared with chronic/gradual noncontact injuries, which averaged 13.2 days ($P < .0001$).

The RTP times for athletes who sustained hamstring injuries were analyzed based on various factors (Table 1). There were no significant differences in the effect of field type on RTP ($P = .620$). The RTP durations were comparable between players aged ≤26 years and those aged >26 years. Player position was also not significantly associated with RTP. Midfielders, forwards, and defenders had similar RTP times of 24%, 23.9%, and 22.8%, respectively ($P = .900$).

Other factors—such as field location, in-game time of injury, and weather conditions—did not significantly affect RTP times. Athletes injured at home took a mean of 21 days to return, while those injured away returned in 20.8 days ($P = .85$). In-game injury timing showed no significant differences, with RTP times of 31 days for injuries occurring in the first 30 minutes, 22 days for injuries between 30 and 60 minutes, and 26.1 days for injuries after 60 minutes ($P = .670$). However, there was a significant difference between the first 30 minutes and the second 30 minutes ($P = .048$). Weather conditions did not significantly alter RTP, with sunny or clear conditions associated with a mean of 21.3 days, compared with 20 days for cloudy or rainy conditions ($P = .776$).

In a comparison of hamstring injury data between the 2 distinct periods (2010-2015 and 2016-2021), the injury rates decreased nonsignificantly, from 16.93% in the 2010-2015 period to 15.67% in the 2016-2021 period ($P = .405$). A statistically significant increase in the time to RTP was observed in the 2016-2021 cohort, with a mean RTP time of 20.26 ± 37.55 days compared with 13.60 ±

TABLE 2
Comparison of Injury Rates, Reinjury Rates, and Time to RTP Between the 2010-2015 and 2016-2021 Cohorts[a]

Details Comparing the 2010-2015 Cohort With the 2016-2021 Cohort	RTP	*P*
Injury rate, %		.405
2010-2015 cohort	16.93	
2016-2021 cohort	15.67	
Time to RTP, days		**.002**
2010-2015 cohort	13.60 ± 37.47	
2016-2021 cohort	20.26 ± 37.55	
Reinjury rates, %		.603
2010-2015 cohort	9.30	
2016-2021 cohort	7.64	
Time to RTP after second injury, days		.025
2010-2015 cohort	10.03 ± 21.02	
2016-2021 cohort	25.05 ± 36.46	
Severity		.018
First degree, 2010-2015 cohort, n = 427	10.13 ± 28.53	
First degree, 2016-2021 cohort, n = 397	15.09 ± 31.29	
Second degree, 2010-2015 cohort, n = 125	25.08 ± 58.89	.326
Second degree, 2016-2021 cohort, n = 134	32.04 ± 54.46	

[a]Data are presented as mean ± SD. The bold *P* value indicates significance. RTP, return to play.

37.47 days in the 2010-2015 cohort (*P* = .002). Reinjury rates showed a modest reduction from 9.30% in the 2010-2015 cohort to 7.64% in the 2016-2021 cohort (*P* = .603), but this was not statistically significant. Furthermore, the time to RTP after a second injury demonstrated a significant increase in the 2016-2021 cohort, with a mean of 25.05 ± 36.46 days compared with 10.03 ± 21.02 days in the 2010-2015 cohort (*P* = .025).

Severity of hamstring injuries was an important determinant of RTP times. When comparing the 2 cohorts, the "Minimal/First Degree" severity group demonstrated a significant increase in RTP duration in the 2016-2021 cohort (15.09 ± 31.29 days) compared with the 2010-2015 cohort (10.13 ± 28.53 days; *P* = .018). The "Moderate/Second Degree" severity group had a nonsignificant increase in mean RTP time in the 2016-2021 cohort (32.04 ± 54.46 days) versus the 2010-2015 cohort (25.08 ± 58.89 days) (*P* = .326) (Table 2).

Performance metrics for players who sustained hamstring injuries were evaluated compared with uninjured controls, with the performance changes reported in delta values. The results are categorized by player position: forwards, midfielders, defenders, and goalkeepers (Table 3, A-D).

Forwards who experienced hamstring injuries did not show significant changes in games played per season when compared with controls across all time points. One year after injury, injured forwards had a change of −03.77 ± 10.13 games per season compared with controls (–2.38 ± 10.78; *P* = .466). Similarly, no significant difference was observed in goals per season, with injured forwards showing

TABLE 3A
Forward Metrics Compared With 1 Year Before the Index Year[a]

Player Metrics	Control	Hamstring Injury	*P*
Games played per season			
Index year	–0.09 ± 8.68	0.05 ± 8.07	.189
1 Y after injury	–3.77 ± 10.13	–2.38 ± 10.78	.466
2 Y after injury	–3.58 ± 9.33	–2.14 ± 9.15	.479
3 Y after injury	–2.58 ± 9.69	–0.46 ± 7.90	.595
Minutes played per season			
Index year	–93.94 ± 831.3	–37.29 ± 799.46	.397
1 Y after injury	–429.16 ± 91.11	–390.72 ± 116.52	.351
2 Y after injury	–366.52 ± 912.91	–401.92 ± 757.28	.257
3 Y after injury	–342.61 ± 859.57	–351.07 ± 871.85	.317
Goals per season			
Index year	–0.91 ± 5.78	–0.21 ± 5.85	.889
1 Y after injury	–2.91 ± 4.02	–2.05 ± 5.78	.957
2 Y after injury	–2.32 ± 4.49	–2.22 ± 5.64	.740
3 Y after injury	–2.30 ± 4.16	–2.05 ± 4.99	.782
Assists per season			
Index year	0.62 ± 4.08	–0.48 ± 3.07	.110
1 Y after injury	–0.44 ± 3.51	–1.38 ± 2.25	.112
2 Y after injury	–0.33 ± 3.83	–1.50 ± 2.32	.117
3 Y after injury	–0.59 ± 3.79	–2.39 ± 1.84	.030

[a]Data are presented as mean ± SD. Y, year.

TABLE 3B
Midfielder Metrics Compared with 1 Year Before the Index Year[a]

Player Metrics	Control	Hamstring Injury	*P*
Games played per season			
Index year	0.38 ± 8.41	1.14 ± 200.93	.925
1 Y after injury	–0.70 ± 9.54	1.07 ± 202.16	.932
2 Y after injury	0.38 ± 9.34	–21.15 ± 9.88	.137
3 Y after injury	–0.58 ± 9.12	–20.91 ± 8.94	.395
Minutes played per season			
Index year	–7.50 ± 59.32	62.93 ± 78.03	.596
1 Y after injury	–119.01 ± 890.65	–29.87 ± 862.83	.654
2 Y after injury	1.97 ± 76.13	–101.73 ± 113.72	.134
3 Y after injury	–146.63 ± 800.80	–105.68 ± 894.80	.487
Goals per season			
Index year	–0.01 ± 3.30	–1.27 ± 55.89	.924
1 Y after injury	–0.32 ± 3.24	12.53 ± 195.95	.922
2 Y after injury	0.30 ± 3.05	–7.67 ± 2.84	.851
3 Y after injury	–0.75 ± 2.64	–8.06 ± 2.13	.231
Assists per season			
Index year	–0.14 ± 3.75	–0.01 ± 3.20	.817
1 Y after injury	–0.07 ± 3.74	–0.53 ± 3.28	.336
2 Y after injury	–0.36 ± 3.04	–0.67 ± 3.23	.471
3 Y after injury	–0.26 ± 2.87	–0.99 ± 2.76	.195

[a]Data are presented as mean ± SD. Y, year.

TABLE 3C
Defender Metrics Compared With 1 Year Before the Index Year[a]

Player Metrics	Control	Hamstring Injury	*P*
Games played per season			
Index year	0.87 ± 8.59	1.69 ± 8.48	.458
1 Y after injury	–0.22 ± 9.17	–0.28 ± 8.58	.183
2 Y after injury	0.43 ± 8.73	0.43 ± 9.43	.011
3 Y after injury	0.73 ± 8.62	0.73 ± 9.40	.052
Minutes played per season			
Index year	61.50 ± 808.45	101.43 ± 812.56	.398
1 Y after injury	–34.23 ± 855.82	–60.94 ± 779.35	.183
2 Y after injury	34.80 ± 792.11	–221.60 ± 833.66	.007
3 Y after injury	18.20 ± 824.46	–145.21 ± 862.75	.079
Goals per season			
Index year	–0.10 ± 1.11	0.29 ± 1.36	.944
1 Y after Injury	–0.11 ± 1.23	0.21 ± 1.18	.862
2 Y after injury	–0.14 ± 1.15	–0.04 ± 1.03	.373
3 Y after injury	–0.42 ± 0.72	0.12 ± 1.27	.982
Assists per season			
Index year	0.24 ± 2.09	0.31 ± 2.32	.893
1 Y after injury	–0.01 ± 1.66	–0.05 ± 1.63	.860
2 Y after injury	0.21 ± 1.95	–0.22 ± 2.12	.291
3 Y after injury	–0.05 ± 1.42	–0.17 ± 2.02	.671

[a]Data are presented as mean ± SD. Y, year.

TABLE 3D
Goalkeeper Metrics Compared With 1 Year Before the Index Year[a]

Player Metrics	Control	Hamstring Injury	*P*
Games played per season			
Index year	–1.20 ± 11.36	1.30 ± 12.02	.562
1 Y after injury	–2.85 ± 11.85	0.40 ± 12.83	.620
2 Y after injury	–3.44 ± 14.27	2.43 ± 13.14	.751
3 Y after injury	–3.62 ± 9.98	–4.57 ± 10.32	.268
Minutes played per season			
Index year	–110.45 ± 1021.26	105.80 ± 1084.95	.571
1 Y after injury	–243.20 ± 1075.46	27.70 ± 1160.61	.616
2 Y after injury	–289.10 ± 1284.06	200.63 ± 1190.25	.739
3 Y after injury	–322.22 ± 904.19	–421.25 ± 922.76	.273
Clean sheets per season			
Index year	–0.30 ± 3.59	1.50 ±4.65	.932
1 Y after injury	–0.30 ± 5.03	–1.20 ± 4.18	.426
2 Y after injury	0.11 ± 5.02	–1 ± 4.11	.393
3 Y after injury	–1.01 ± 3.44	–2.50 ± 3.07	.261
Conceded goals per season			
Index year	–1.90 ± 17.19	–0.80 ± 12.88	.234
1 Y after injury	–3.90 ± 15.83	4.10 ± 14.79	.651
2 Y after injury	–4.36 ± 20.18	9.65 ± 19.07	.834
3 Y after injury	–6.19 ± 12.43	–1.22 ± 16.07	.454

[a]Data are presented as mean ± SD. Y, year.

a nonsignificant decrease of −2.32 ± 4.49 two years after injury ($P = .740$). However, there was a significant reduction in assists per season 3 years after injury (injured: –0.59 ± 3.79; control: –2.39 ± 1.84; $P = .030$).

Midfielders exhibited no significant changes in games played per season between the injured and control cohorts. The 1-year postinjury delta for games played was −0.70 ± 9.54 for injured players, compared with 1.07 ± 202.16 for controls ($P = .932$). Similarly, midfielders showed no significant differences in goals or assists per season at any time point. Three years after injury, injured midfielders had a decrease in assists per season (–0.26 ± 2.87) compared with controls (–0.99 ± 2.76; $P = .195$), although this difference was not statistically significant.

Defenders demonstrated more pronounced performance declines, particularly in minutes played per season. Two years after injury, defenders showed a significant reduction in minutes played (–221.60 ± 833.66) compared with controls (–34.80 ± 792.11; $P = .007$). Games played per season also showed a significant decline 2 years after injury, with injured defenders playing −0.43 ± 8.73 fewer games per season compared with controls ($P = .011$). Assists per season, goals per season, and other performance metrics did not show significant changes for defenders at any time point.

For goalkeepers, no statistically significant differences were observed in key performance metrics—such as games played, clean sheets, or conceded goals—between the injured and control groups. For instance, 3 years after injury, goalkeepers with hamstring injuries conceded −1.22 ± 16.07 goals per season, compared with −1.19 ± 12.43 for controls ($P = .454$). Clean sheets and other relevant metrics similarly showed no significant differences.

DISCUSSION

This study provides an in-depth analysis of RTP times in MLS athletes who sustained hamstring injuries between 2010 and 2021. Our findings demonstrate that while overall injury rates remained relatively stable between the 2 cohorts (16.93% in 2010-2015 vs 15.67% in 2016-2021; $P = .405$), RTP times increased significantly in the 2016-2021 period (20.26 ± 37.55 days vs 13.60 ± 37.47 days; $P = .002$). This trend was particularly notable for game-related injuries (27.81 ± 14.18 days vs 21.87 ± 11.32 days for practice injuries; $P = .023$) and acute noncontact injuries (24.89 ± 13.08 days vs 13.17 ± 9.06 days for chronic noncontact injuries; $P < .0001$). While field type ($P = .620$) and player position ($P = .900$) did not significantly affect RTP, severity and reinjury status did: minimal/first-degree injuries showed a significant increase in RTP in the latter cohort (15.09 ± 31.29 vs 10.13 ± 28.53 days; $P = .018$), and RTP after a second injury was significantly longer in the 2016-2021 cohort (25.05 ± 36.46 vs 10.03 ± 21.02 days; $P = .025$). These findings highlight a potential shift toward more conservative rehabilitation approaches and emphasize the importance of considering injury context and mechanism in recovery protocols.[21,26]

In addition, comparing the current MLS data with other soccer-playing populations, such as collegiate soccer

players, highlights several parallels that reinforce the broader applicability of our findings. Notably, these results align with previously reported trends in other soccer-playing populations. Cross et al[5] observed similar patterns in American collegiate athletes, where recurrent and in-game injuries were associated with significantly longer RTP durations. Their findings demonstrated that recurrent injuries, often due to incomplete recovery or underlying predispositions, significantly extended the recovery period in collegiate athletes, mirroring the heightened caution and extended RTP times seen in our study for recurrent hamstring injuries. Likewise, game-related injuries, which typically occur at higher intensity and with greater unpredictability, were consistently associated with longer RTP durations across both professional and collegiate cohorts, suggesting a shared biomechanical and situational risk factor and a universal trend across competitive soccer levels.[5]

The observed slight decrease in overall injury rates (16.93% to 15.67%; $P = .405$) and reinjury rates (9.30% to 7.64%; $P = .603$) between the 2 periods may suggest improvements in injury prevention strategies, potentially because of enhanced conditioning protocols, more robust monitoring systems, or advancements in sports medicine interventions.[26] The observed reduction in minutes played by defenders after injury may stem from several plausible explanations beyond the direct effect of the injury itself. While this reduction may partially reflect the demands of rehabilitation and a cautious RTP approach, alternative explanations should be considered. For instance, defenders may transition out of starting roles or rotations because of evolving team dynamics, changes in coaching strategies, or the emergence of younger players. These factors could disproportionately affect defenders, whose roles consistently involve high physical demands with respect to frequent sprinting, making them potentially more vulnerable to reinjury or performance decline.[11,13] However, the statistically significant increase in RTP times in the 2016-2021 period, with a mean of 20.26 $\pm$ 37.55 days compared with 13.60 $\pm$ 37.47 days in the 2010-2015 period ($P = .002$), suggests a more conservative approach to rehabilitation in recent years.[26] This aligns with a significant rise in RTP times for minimal/first-degree injuries during the later period, suggesting that even milder injuries are also possibly managed with caution. This shift may reflect a growing emphasis on ensuring full recovery before resumption of competitive play, driven by the recognition that premature RTP could lead to worse long-term outcomes, including a higher risk of reinjury. The adopted approach to extend the RTP timeline may be responsible for the decreased reinjury rate.[28]

Moreover, the significant increase in time to RTP after a second injury in the 2016-2021 cohort (25.05 $\pm$ 36.46 days vs 10.03 $\pm$ 21.02 days; $P = .025$) underscores the heightened caution applied to managing recurrent injuries. This extended recovery period likely reflects the prioritization of long-term athlete health over short-term performance gains,[29] to prevent chronic injury patterns and mitigate the risk of long-term disability.

Injury rates observed in this MLS cohort also fall within the range reported in the systematic review by Diemer et al,[6] which analyzed hamstring injuries across multiple soccer populations. Diemer et al reported consistent injury patterns with incidence rates that corroborate the trends observed in the MLS cohort. This broader consistency supports the generalizability of our findings and affirms that hamstring injury incidence and RTP timelines in MLS are reflective of trends seen globally, including in collegiate and professional settings.

Field type, specifically grass versus artificial turf, was not associated with significant differences in RTP, with athletes returning after approximately 21 days regardless of the surface. This is consistent with previous studies that have found minimal differences in recovery times based on playing surfaces in professional soccer.[20] Core performance metrics—including games played, minutes played, goals scored, and assists—were not significantly different between the hamstring injury and control cohorts across most positions. However, forwards demonstrated a significant reduction in assists 3 years after injury. Despite this, other metrics such as games played and goals scored did not show statistically significant differences across the postinjury period, indicating minimal long-term effect on overall offensive performance for forwards. Midfielders with hamstring injuries also showed no significant differences in performance metrics compared with controls across the 3 years after injury. A nonsignificant trend toward decreased minutes played was observed 3 years after injury, although this was not statistically significant. Goalkeepers did not exhibit significant changes in any core performance metrics—including games played, clean sheets, or goals conceded. Metrics such as goals conceded 3 years after injury remained comparable between injured and uninjured, suggesting that hamstring injuries had little long-term effect on goalkeeping performance.[9]

Defenders exhibited the most notable declines in performance. Two years after injury, defenders experienced a significant reduction in minutes played, with a similar trend seen for games played during the second year after injury, suggesting a substantial and lasting effect on defensive players' participation in matches. These findings highlight the need for position-specific rehabilitation strategies, especially for defenders, to mitigate the long-term effects of hamstring injuries on their performance.[8,19] Given that defenders are involved in a significant amount of high-speed running and sprinting during matches, particularly wide defenders who frequently engage in defensive and offensive transitions, hamstring injuries may disproportionately affect their ability to perform these critical high-intensity actions. This reliance on sprinting underscores the importance of tailored rehabilitation for defenders to ensure their recovery and ability to return to match demands.[11,13] Overall, the data indicate that while hamstring injuries do not drastically affect performance metrics for most MLS players, the effect on defenders, particularly in terms of minutes played and games participated in, may have long-lasting effects.

Despite these similarities, the unique aspects of the MLS environment, such as the league's growing roster sizes, varied playing surfaces, and diverse player characteristics, distinguish it from collegiate or other professional soccer settings. These factors may contribute to nuances in

injury mechanisms, management practices, and recovery timelines. For example, the inclusion of older international players in MLS may influence injury risk and rehabilitation strategies compared with younger collegiate athletes. Moreover, the MLS's extended season, higher rate of transcontinental travel because of the substantial geographical expanse of the United States and Canada, and higher frequency of matches could increase cumulative fatigue, potentially altering injury dynamics and recovery outcomes. These comparisons not only validate our findings within a broader soccer context but also highlight the need for tailored approaches that consider the specific demands and challenges of the MLS environment.[5,6]

The setting in which the injury occurred was a key determinant of RTP.[23] Athletes injured during games required significantly more time to RTP (27.8 days) compared with those injured during practice (21.9 days; $P = .0230$). This finding could reflect the higher intensity and greater physical demands of competitive match play, which may result in more severe or complex hamstring injuries that require longer rehabilitation. The data emphasize the need for more specific rehabilitation strategies for game-related injuries to optimize recovery timelines.[27]

Moreover, the mechanism of injury onset played a critical role in recovery.[2] Acute noncontact hamstring injuries led to significantly longer RTP times (24.9 days) compared with chronic or gradual noncontact injuries (13.2 days; $P < .0001$). These results align with the general understanding that acute injuries often involve more significant damage to muscle fibers, necessitating a longer healing process.[16] Conversely, chronic injuries may be the result of overuse and often benefit from shorter, targeted rehabilitation.[17] This highlights the importance of early detection and intervention in the management of chronic hamstring injuries to prevent progression to more acute states.[22]

Other factors—including the location of the injury (home vs away), in-game timing of the injury, and weather conditions—were not found to significantly influence RTP. While minor variations in RTP times were observed—for instance, injuries occurring in the first 30 minutes of a game were associated with longer recovery times—none of these factors reached statistical significance when all 3 were compared; however, there was a significant difference when the first 30 minute of a game was compared with the second 30 minutes of the game. This may suggest that external conditions, such as weather or field location, may have a limited effect on the severity and recovery from hamstring injuries.[16]

Our findings on hamstring injury outcomes in MLS players can be compared with several studies on professional football (soccer) players. In a study by Ekstrand et al,[10] which compared injury rates on artificial turf versus natural grass, the overall risk of injury was similar across both surfaces, although muscle injuries were more common on artificial turf. Our study differentiates by playing surface, and the slight decrease in injury rates we observed from the 2010-2015 period to the 2016-2021 period (16.93% to 15.67%) may reflect improvements in conditioning and injury prevention that transcend surface-specific risks. In addition, Ekstrand et al[8] highlighted that less significant hamstring injuries did not notably affect goalkeepers' performance or recovery time, while our data showed a statistically significant increase in RTP times across all positions, suggesting a more cautious rehabilitation approach for all athletes in recent years. Finally, Ekstrand et al[9] reported a high prevalence of muscle injuries, including hamstring injuries, in professional football, with muscle injuries accounting for a significant portion of total injuries. While our study also reported hamstring injuries as a major concern, we observed a trend toward lower reinjury rates over time (9.30% to 7.64%), potentially reflecting advancements in rehabilitation protocols in MLS compared with European football leagues during the same time frame.

LIMITATIONS

This study has several limitations. First, the retrospective nature of the analysis relies on historical data, which may introduce inaccuracies in injury reporting and RTP timelines. The calculation of injury rate did not control for hours of exposure or the number of games per player each year, potentially impacting injury incidence estimates. However, by focusing on the total number of unique injuries per year, our analysis captures broader trends in injury occurrence and recovery over time, offering insights that are still useful despite the lack of individualized exposure data. The analysis of injury rate accounted for the growing size of the league and the increasing number of players each year by calculating injury rates based on the total number of unique injured players relative to the overall player pool per year, ensuring that the reported trends reflect injury incidence within the context of league expansion. Calculating the injury rate as a proportion using the total number of unique players as the denominator aligns conceptually with how reinjury rates are typically calculated (eg, the proportion of players who experienced a reinjury within the at-risk population). This consistency simplifies comparisons between injury and reinjury rates because both metrics are expressed relative to the total player population rather than being dependent on exposure time, which may not be uniformly available.

However, it is important to note that while this method facilitates internal comparisons within the study (eg, between injury and reinjury rates or across cohorts), it may limit external comparability with other studies that use exposure-based metrics, such as injuries per 1000 athletic exposures or playing hours.

In addition, databases, while comprehensive, may lack granular details regarding the severity of injuries, rehabilitation protocols, or player compliance with recovery recommendations. Data on the exact location of reinjury (eg, proximal vs distal) or imaging confirmation (eg, ultrasound or magnetic resonance imaging) were not available in the dataset; however, laterality was available and used. This limitation may influence the interpretation of reinjury rates, as the exact recurrence could not be verified.

The study also focused solely on MLS players, which may limit the generalizability of the findings to other leagues or sports with different physical demands or injury

management practices. Last, although the matching process was designed to minimize confounding factors, unmeasured variables—such as team medical resources, player fitness levels, or individualized rehabilitation strategies—could still influence the outcomes. Future prospective studies are needed to validate these findings and provide more precise data on injury severity, rehabilitation, and long-term performance effects.

In summary, our study underscores the multifactorial nature of recovery from hamstring injuries in MLS athletes.[18] While some factors—such as field type and player position—appear to play a minimal role, the competitive setting and injury mechanism are significant predictors of RTP.[9] These findings have important implications for the development of position-specific and context-specific rehabilitation protocols that may expedite recovery and enhance long-term outcomes for professional soccer players.[19]

CONCLUSION

Our study demonstrates that hamstring injury rates were unchanged between the 2010-2015 and 2016-2021 cohorts; however, RTP times increased in the latter cohort, especially for recurrent injuries. Game-related and acute noncontact injuries required longer RTP, and defenders showed the greatest performance decline. Future studies are needed to further highlight mechanisms of injury and treatment for preventative protocols.

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