Are Elite Soccer Teams' Preseason Training Sessions Associated With Fewer In-Season Injuries?

A 15-Year Analysis From the Union of European Football Associations (UEFA) Elite Club Injury Study

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Background: Preseason training develops players' physical capacities and prepares them for the demands of the competitive season. In rugby, Australian football, and American football, preseason training may protect elite players against in-season injury. However, no study has evaluated this relationship at the team level in elite soccer.

Purpose/Hypothesis: The aim of this study was to investigate whether the number of preseason training sessions completed by elite soccer teams was associated with team injury rates and player availability during the competitive season. It was hypothesized that elite soccer teams who participate in more preseason training will sustain fewer injuries during the competitive season.

Study Design: Descriptive epidemiology study.

Methods: We used the Union of European Football Associations (UEFA) injury dataset to analyze 44 teams for up to 15 seasons (total, 244 team-seasons). Separate linear regression models examined the association between the number of team preseason training sessions and 5 in-season injury measures. Injury-related problems per team were quantified by totals of the following: (1) injury burden, (2) severe injury incidence, (3) training attendance, (4) match availability, and (5) injury incidence.

Results: Teams averaged 30 preseason training sessions (range, 10-51). A greater number of preseason training sessions was associated with less injury load during the competitive season in 4 out of 5 injury-related measures. Our linear regression models revealed that for every 10 additional preseason training sessions that the team performed, the in-season injury burden was 22 layoff days lower per 1000 hours (P = .002), the severe injury incidence was 0.18 severe injuries lower per 1000 hours (P = .015), the training attendance was 1.4 percentage points greater (P = .014), and the match availability was 1.0 percentage points greater (P = .042). As model fits were relatively low (adjusted R^2 = 1.3%-3.2%), several factors that contribute to in-season injury outcomes were unaccounted for.

Conclusion: Teams that performed a greater number of preseason training sessions had ''healthier'' in-season periods. Many other factors also contribute to in-season injury rates. Understanding the benefit of preseason training on in-season injury patterns may inform sport teams' planning and preparation.

Keywords: soccer; professional; injury; preseason training; UEFA Elite Club Injury Study (ECIS); injury burden

Preseason training is designed to develop players' physical capacities and prepare them for the various demands of the competitive season. For example, professional soccer players who increased their aerobic capacity across a 6-week preseason period were less likely to be injured during the subsequent in-season period.[12]

In rugby, it was identified that maximizing participation in preseason training may protect elite players against in-season injury.[25] Such findings have also been documented in Australian football[5,22] and in American football.[21] Each of these previous studies included data from a single team, so the collective conclusion may be that players who participate in a greater proportion of a team's planned preseason may be less prone to injuries during the regular season. This may be attributable to the potential "protective effect" of chronic loads[14,17] or due to a "survival of the fittest" phenomenon, where more resilient players are likely to complete more preseason and in-season sessions.

Elite soccer clubs playing in European countries with an autumn-spring (August-May) season experience a short

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preseason period. Many top European elite teams also devote part of the preseason to "promotional travels," which reduces the number of days available for training.

Only 1 study has directly evaluated the relationship between preseason training and in-season injury risk in elite soccer.[6] There was no association between a single team's (35 total players) preseason training workloads and in-season injury rates across 2 seasons. To our knowledge, no study has yet compared the preseason training workloads of multiple teams and their association with in-season injury rates. Therefore, we investigated whether the number of preseason training sessions among elite soccer teams was related to injury rates and player availability during their competitive seasons. We hypothesized that teams who participate in more training sessions during the preseason period would experience fewer injuries during the in-season period.

METHODS

The Union of European Football Associations (UEFA) Elite Club Injury Study (ECIS) is an ongoing prospective injury surveillance study of male professional soccer that started in 2001.[10] The total study cohort includes 64 teams (with an average of 32 players per team) invited by the UEFA that met the criteria that they had participated at the highest level in Europe since 2001.[9]

Ethics

Individual written informed consent was obtained from all participating players. The study protocol was approved by the UEFA Football Development Division and the UEFA Medical Committee.

Inclusion and Exclusion Criteria

In this substudy of the ECIS covering 15 consecutive seasons (March 2002 to July 2016), only teams participating in the UEFA Champions League (UCL) or UEFA Europa League (UEL) were included in the analyses. Most countries follow the traditional western European season, with a preseason training period starting in July followed by a competitive league's season starting in August and ending in May. However, a few countries in Europe have a spring-autumn season with a longer preseason period followed by league play during April to November. Therefore, teams from national leagues with a spring-autumn season were excluded from this study (14 team-seasons). Teams that failed to provide data for the months of June-August were also excluded. This resulted in 44 teams from 13 European countries with a total of 244 team-seasons (Table 1).

Data Collection

Data collection procedures and data definitions followed the UEFA guidelines[15] and were harmonized with the 2006 consensus statement for soccer injury surveillance.[13] Individual player participation in training and matches was registered by a member of the team medical staff (usually a doctor or a physiotherapist, but in rare cases a sports scientist) on an exposure form and sent monthly to the study group. All team training and match exposures were included. The first team medical staff recorded injuries on an injury form that was sent to the study group each month. The injury form had information about the diagnosis, nature, and circumstances of injury occurrence. A recordable injury was defined as any physical complaint sustained by a player that resulted from a soccer match or training and led to the player being unable to take a full part in future soccer training or match play (ie, time-loss injury). The player was considered injured until the medical staff allowed full participation in training and availability for match selection. Absence because of injury was measured as the number of days from injury occurrence to full participation.

Evaluating Preseason Team Training Sessions and In-Season Injury Rates

Preseason team training sessions were counted for each team, covering the period from the first training session of the season until the first competitive match (in the national league or in the European Cups, for instance, qualification for the group stage of UCL or EL). Preseason team training sessions include a large variety of training types, for instance, match play, running, and fitness training.

The preseason session number was analyzed for its association with 5 different injury outcomes during the in-season period. These dependent variables were injury burden, incidence of severe injuries, team training attendance, team match availability, and injury incidence. Injury burden was expressed as the sum of layoff days/

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TABLE 1
Inclusion of the 44 Teams and 244 Team-Seasons From 13 Countries Over the 15-Year Study Period

Country	Team	Number of Team-Seasons Included Between March 2002 and July 2016
England	League total	59
	Arsenal FC	15
	Manchester United FC	11
	Chelsea FC	7
	Liverpool FC	7
	Tottenham Hotspur FC	7
	Manchester City FC	6
	Newcastle United FC	4
	Leicester City FC	1
	Southampton FC	1
Spain	League total	34
	Real Madrid CF	15
	FC Barcelona	13
	Club Atlético de Madrid	3
	Athletic Club Bilbao	2
	Valencia CF	1
Italy	League total	30
	Juventus FC	11
	FC Internazionale	8
	AC Milan	6
	AS Roma	2
	SSC Napoli	2
	ACF Fiorentina	1
Portugal	League total	28
	FC Porto	12
	SL Benfica	12
	Sporting Clube de Portugal	3
	SC Braga	1
The Netherlands	League total	25
	PSV Eindhoven	14
	AFC Ajax	11
Germany	League total	22
	BVB Dortmund	7
	FC Bayern München	5
	Bayer 04 Leverkusen	4
	Hamburger SV	4
	FC Schalke 04	2
Belgium	League total	18
	Club Brügge KV	13
	RSC Anderlecht	5
France	League total	17
	Paris Saint-Germain FC	7
	Olympique Lyonnais	5
	RC Lens	2
	Olympique de Marseille	2
	LOSC Lille	1
Scotland	League total	3
	Celtic FC	3
Greece	League total	2
	Panathinaikos FC	1
	Olympiakos FC	1
Slovenia	League total	2
	NK Maribor	2
Switzerland	League total	2
	FC Basel 1893	2
Turkey	League total	2
	Galatasaray AS	2
Total		44 teams, 244 team-seasons

sum of exposure hours per 1000 hours of soccer training and match play, thus accounting for the incidence and severity of injuries in a season.[2] Severe injury incidence was calculated as the sum of severe injuries (injuries causing absence of more than 28 days)/sum of exposure hours per 1000 hours of soccer training and match play. Team training attendance was expressed as the average proportion of players available for training sessions across the season. Team match availability was expressed as the average proportion of players available for match play across a season. Both training and match attendance were quantified as percentages. Finally, injury incidence was calculated as the sum of the number of injuries/sum of exposure hours per 1000 hours of soccer training and match play.

Our primary analysis evaluated these 5 variables during the whole season. However, the seasons were also divided into 2 parts: the period between the beginning of the season and New Year's Eve (August 1–December 31), and the period from New Year's Day to the end of the season (January 1–May 31). This was done to investigate whether preseason training was associated with just the first half and not the second half of the soccer season.

Statistical Analyses

Linear regression was used to analyze the association between preseason sessions and in-season injury rates with each team-season as an observation. Separate linear regression models were fit for each of the 5 injury outcomes (injury burden, incidence of severe injuries, team training attendance, team match availability, and injury incidence). The analyses were performed for all 3 time periods studied: the whole season, August to December only, and January to May only (5 linear regressions for primary analyses and 10 linear models for secondary analyses, for a total of 15 linear regression models). Model assumptions were evaluated for each regression model. The significance level was set at $P < .05$ in all analyses. IBM SPSS Statistics (version 25.0) for Windows was used for all analyses.

RESULTS

In total, 11,564 preseason and in-season injuries (4963 training, 6601 match play) during 1,701,992 hours of soccer training and match play were included. The mean number of preseason team training sessions was 29.4 (median, 29.0) (Table 2). For the whole dataset, the average injury burden was 144.6 days (median, 138.2 days) missed per 1000 hours of exposure, the severe injury incidence was 1.2 injuries (median, 1.2 injuries) per 1000 hours of exposure, the team training attendance was 82.1% (median, 82.3%), the team match availability was 86.9% (median, 86.9%), and the injury incidence was 7.1 injuries (median, 6.8 injuries) per 1000 hours of exposure.

Preseason Training Sessions and Injury Burden

More preseason team training sessions were associated with lower injury burden for the whole season ($P = .002$) (Table 3, Figure 1-1). For every 10 additional preseason

TABLE 2
Descriptive Statistics on Number of Preseason Training Sessions and Injury-Related Outcomes Over the 15-Year Study Period

	Mean (SD)	Median	Range
Preseason training sessions, n	29.4 (6.0)	29.0	10.0-51.0
Injury burden, d			
Whole season	144.6 (68.3)	138.2	25.7-348.0
August-December	163.5 (92.1)	146.0	23.1-501.2
January-May	138.3 (79.9)	119.6	13.5-411.5
Severe injury incidence, n			
Whole season	1.2 (0.7)	1.2	0.0-3.6
August-December	1.4 (0.9)	1.3	0.0-4.6
January-May	1.2 (0.9)	1.1	0.0-4.3
Team training attendance, %			
Whole season	82.1 (5.5)	82.3	64.4-93.7
August-December	79.1 (6.3)	79.2	62.6-92.4
January-May	84.0 (5.9)	84.4	64.2-96.9
Team match availability, %			
Whole season	86.9 (4.8)	86.9	74.2-96.5
August-December	86.4 (5.4)	86.5	73.4-97.5
January-May	87.1 (5.4)	87.3	73.4-98.3
Injury incidence, n			
Whole season	7.1 (3.2)	6.8	0.7-20.5
August-December	7.4 (3.6)	6.6	0.9-21.9
January-May	7.3 (3.6)	6.9	0.5-21.0

training sessions, the injury burden decreased on average by 21.8 layoff days per 1000 hours of exposure. This association was present for the second part of the season (January-May, $P = .005$), in which the injury burden on average decreased by 24.0 days missed per 1000 hours of exposure for every 10 additional training sessions. For the first part of the season, this association was not significant ($P = .076$).

Preseason Training Sessions and Severe Injury Incidence

Undertaking a greater number of preseason team training sessions was associated with fewer severe injuries (injury incidence) for the whole season ($P = .015$) (Table 3, Figure 1-2). For every 10 team training sessions, the severe injury incidence decreased on average by 0.20 injuries per 1000 hours of exposure. The corresponding association was also present for the second part of the season ($P = .035$), in which the severe injury incidence on average decreased by 0.20 injuries per 1000 hours of exposure for every 10 additional training sessions. For the first part of the season, this effect estimate was similar (–0.20 severe injuries per 1000 hours of exposure for every 10 additional training sessions) but not significant ($P = .083$).

Preseason Training Sessions and Team Training Attendance

Completing more preseason team training sessions was associated with higher team training attendance for the whole season ($P = .014$) and for the second part of the season ($P = .017$) (Table 3, Figure 1-3). In the first case, the team training attendance increased on average by 1.4 percentage points for every 10 additional preseason sessions. During the second part of the season, the corresponding association was 1.5 percentage points for every 10 additional preseason sessions. For the first part of the season, the estimated association was similar (1.1 percentage points for every 10 additional preseason sessions), but this was not significant ($P = .085$).

Preseason Training Sessions and Team Match Availability

More preseason team training sessions were associated with higher team match availability for the whole season ($P = .042$) (Table 3, Figure 1-4). For every 10 additional preseason training sessions, the team match availability increased on average by 1.0 percentage point. When analyzed separately, similar associations were estimated for both the first half (1.0 percentage point for every 10 additional preseason training sessions) and the second half (1.1 percentage points for every 10 additional preseason training sessions) of the season, but neither of these was significant ($P = .090$, and $P = .068$, respectively).

Preseason Training Sessions and Injury Incidence

Preseason training volume was not associated with team in-season injury incidence for the whole season ($P = .174$). This was also the case for both the first ($P = .257$) and second ($P = .217$) half of the season. However, the point estimates in all 3 of these models were negative, in line with the findings for the other 4 injury-related outcomes.

DISCUSSION

In this 15-year cohort study of the UCL clubs, we measured injury-related problems through 5 outcomes: injury burden, severe injury incidence, training attendance, match availability, and injury incidence. Teams that undertook a greater number of preseason training sessions experienced fewer injury-related problems during their competitive seasons.

To our knowledge, this is the first study that has associated multiple professional teams' preseason training volumes with subsequent in-season injury risk. The lower in-season injury problems experienced by teams that held more preseason sessions suggests that the preseason period helps prepare players for the demands of the upcoming season. The findings were consistent and statistically significant for 4 of the 5 injury-related outcomes.

Our findings run counter to those in a single French professional soccer team where there was no association between preseason training and in-season injury rates,[6] but they extend previous studies in rugby,[25] American football,[21] and Australian football[5,22] where athletes who completed more preseason training were less likely to be

TABLE 3
Associations Between Team-Season Injury Burden Rates
and Number of Preseason Training Sessions in Professional Soccer Over the 15-Year Study Period

Dependent Variable	B (95% CI)	*P* Value	Adjusted R^2 (%)	Estimated 10-Session Effect
Injury burden				
Whole season	−2.18 (–3.59 to –0.78)	**.002**	3.2	−21.8 layoff days/1000 h
August-December	−1.74 (–3.66 to 0.18)	.076	0.9	−17.4 layoff days/1000 h
January-May	−2.40 (–4.07 to –0.72)	**.005**	2.8	−24.0 layoff days/1000 h
Severe injury incidence				
Whole season	−0.02 (–0.03 to <–0.01)	**.015**	2.0	−0.20 severe injuries/1000 h
August-December	−0.02 (–0.04 to <0.01)	.083	0.8	−0.20 severe injuries/1000 h
January-May	−0.02 (–0.04 to <–0.01)	**.035**	1.4	−0.20 severe injuries/1000 h
Team training attendance				
Whole season	0.14 (0.03 to 0.26)	**.014**	2.0	+1.4%-points training attendance
August-December	0.11 (–0.02 to 0.25)	.085	0.8	+1.1%-points training attendance
January-May	0.15 (0.03 to 0.28)	**.017**	1.9	+1.5%-points training attendance
Team match availability				
Whole season	0.10 (<0.01 to 0.20)	**.042**	1.3	+1.0%-points match availability
August-December	0.10 (–0.02 to 0.21)	.090	0.8	+1.0%-points match availability
January-May	0.11 (–0.01 to 0.22)	.068	1.0	+1.1%-points match availability
Injury incidence				
Whole season	−0.05 (–0.11 to 0.02)	.174	0.3	−0.50 injuries/1000 h
August-December	−0.04 (–0.12 to 0.03)	.257	0.1	−0.40 injuries/1000 h
January-May	−0.05 (–0.12 to 0.03)	.217	0.2	−0.50 injuries/1000 h

[a]Boldface indicates statistical significance.

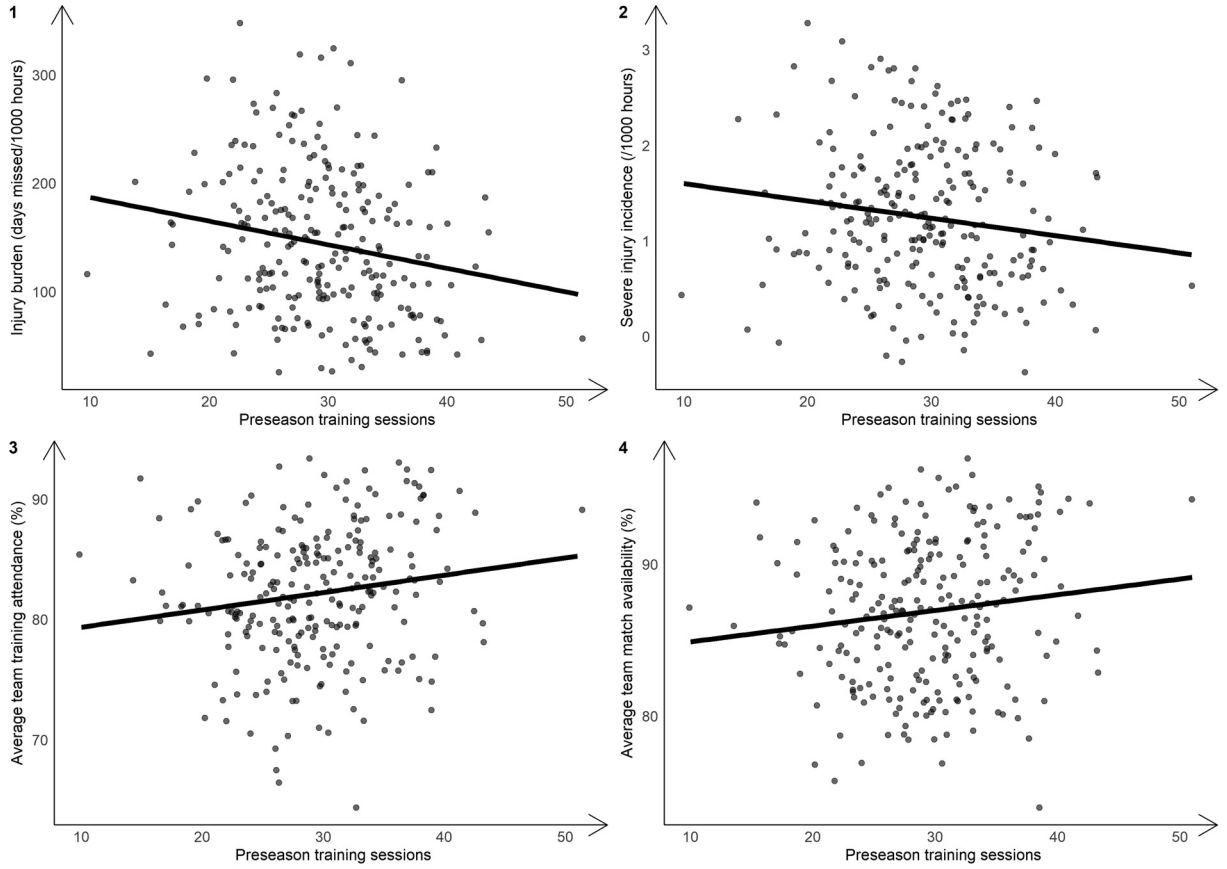

Figure 1. Scatterplots between preseason training volume and in-season (1) injury burden, (2) injury incidence, (3) training attendance, and (4) match attendance.

hurt during the in-season period. Improved physical fitness and well-developed physical qualities protect players from the demands of the competitive soccer season.[12,18]

Is it plausible that preseason training would influence severe injury incidence? It depends on the nature of these severe injuries (eg, reducing noncontact injuries is plausible, whereas traumatic injuries may be questionable). However, severe injuries play an important role in injury burden and player availability, and our data suggest that preseason training volume may have contributed to a slightly decreased severe injury incidence. Although overall injury incidence was not significantly associated with preseason training volume, injury burden is a more important measure within elite soccer,[2] as injury burden/player availability is more closely associated with team success than injury incidence.[16]

Team performance is inversely associated with higher in-season injury burden, higher severe injury incidence, and concomitant lower match availability.[8,16] Our data raise the question of whether increasing the number of preseason sessions may also improve the team performance.

We note the relatively small effect sizes and take the overall model fits into account when interpreting these findings. The relatively poor fit of our univariable linear regression models (R^2 = 1.3%-3.2%) indicates that preseason training explains a small proportion of in-season injury outcomes; the number of injuries prevented is small when compared with interventions like neuromuscular prevention programs, which have been cited as reducing injuries by 30% to 50%.[2,17] However, that is a comparison between apples (the number of preseason sessions, not an intervention) and oranges (randomized trials of interventions to prevent injuries).

Several other factors may contribute to in-season injury outcomes, such as workload management,[20] warm-up and injury prevention program implementation,[4,23] congested calendars,[3] communication between the coaching and medical staff,[11] high-speed running exposure, and players' physical qualities.[7,19] Therefore, while preseason training volume was associated with in-season injury, the association was relatively small.

Methodological Considerations, Strengths, and Limitations

The strength of this study lies in its substantial dataset—a homogeneous group of male professional soccer players. The UEFA ECIS is an appropriate, reliable, and useful tool for evaluating injury risk and injury patterns in elite male soccer players. To test whether the observed preseason association held over time, we performed the same analyses on the most recent 10-year and 5-year cohort and observed similar results (the only exception was in the 10-year cohort, where training attendance and match availability were not statistically significant but had similar effect estimates).

The large team-level dataset also presented some limitations. We were unable to identify whether the players who completed the increased numbers of preseason sessions were those who were more robust against in-season injury. We were also unable to report the composition of preseasons beyond session number (eg, total training time, training intensity), as this information was not collected by teams during this time. Furthermore, previous investigations of preseason composition and in-season injury data[5,25] have included in-season load measures for players, which we were not able to do.

Because different teams were included in this enduring pan-European dataset, data collection could vary between teams and affect the validity of the dataset. To ensure the data were consistent and of high quality, we took 3 steps. First, a study manual was provided to the contact person for each included team. The manual defined all the variables that were important for the study. The manual also contained detailed information about how the study forms should be completed, giving examples of different situations that might cause confusion for the contact person. Second, members of the study group remained in close communication with all teams during their participation in the ECIS. Contact persons were encouraged to contact the study group to receive further guidance if they had any questions concerning any aspect of the data collection. In addition, members of the study group reviewed all data that were collected to make sure they were complete, accurate, and coherent with the study methodology. If any questions arose or any information was missing during this review, quick feedback was sent to the contact person to complete the data. Finally, participating clubs received continuous overviews and reports about the medical situation in their team, based on the data that they had collected for ECIS, to keep them motivated in collecting complete and accurate data. ECIS is also strengthened by the prospective design of the data collection.

More research in elite football is warranted to help practitioners understand how to optimize preseason training plans and how this prepares athletes for in-season demands. While our results and those of others suggest that more preseason training may allow athletes to enter their competitive seasons better prepared, preseason training is also where the highest rates of training injuries may occur.[24] We were also not able to evaluate the details of teams' preseason training, although we understand that structuring preseason programs to include known injury prevention approaches is important.[1] Future research may examine training regimens that minimize preseason injury rates while also preparing athletes for competition demands. While this large dataset in elite soccer is a strength of this study and adds to the field, the external validity of this study is limited, and therefore researchers are encouraged to examine preseason training in other levels of play and in other sporting contexts.

CONCLUSION

Preseason training prepares players for the demands of the upcoming competitive season. Completing more preseason training sessions may help elite soccer teams to remain healthier during the competitive season.

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