Journal of Physical Education and Sport ® (JPES), Vol. 23 (issue 5), Art 142, pp. 1142 - 1149, May 2023
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

The impact of injury on match running performance following the return to competitive match-play over two consecutive seasons in elite European soccer players

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Published online: May 31, 2023
(Accepted for publication May 15, 2023)
DOI:10.7752/jpes.2023.05142

Abstract

Based on the assessment and diagnosis, the rest period following a moderate/severe injury may lead to de-conditioning for the injured player and therefore an association with a prolonged rehabilitation, re-conditioning and return to sport is observed post-injury. The aim of the present study was to assess the impact of all injuries on match running performance following the return to competitive match-play over two consecutive seasons in elite European soccer players. A retrospective analysis was conducted utilizing data related to a player's injury and match running performance. A club physiotherapist consistently recorded availability and injury data in a standardized format. Linear mixed modelling analysis revealed no difference between PRE and POST1, POST2, and POST3 for total distance, running distance, high-intensity distance, and sprint distance (all $p > 0.05$). Although, maximum speed was significantly ($p < 0.05$) lower in POST1 and POST2 when compared to PRE, in both cases with a large (ES = 1.88) effect. No significant difference was observed for maximum speed between PRE and POST3 ($p = 0.07$). There were very low correlations between the number of days absent and changes in maximum speed between POST1 and PRE ($r = 0.09$, 95% CI -0.42 to 0.56), and POST2 and PRE ($r = 0.10$, 95% CI -0.42 to 0.57), respectively. In conclusion, no variation in distance variables were found regardless of one, two or three matches post-injury compared to pre-injury status. Moreover, maximum speed was lower during the first three matches post-injury, although the mean value was slightly lower. Finally, a low correlation between absent days and maximum speed loss between pre-injury and following one and two matches were found.

Key Words: soccer; injury analysis; running performance; match data; sprint; maximal speed

Introduction

The literature examining injuries has highlighted a high injury incidence in elite teams (Ekstrand et al., 2011a, 2011b). Injuries are an inevitable drawback in any sport and are debilitating and costly (Hägglund et al., 2013a, 2013b; Knowles et al., 2007). Specifically, muscle injuries in professional soccer are a major concern to teams as a negative impact on performance through lower player availability and club economy as well as the potential for increased risk of subsequent injury can occur (Fanchini et al., 2020). A professional team with a squad of 25 players can expect approximately 16 time-loss muscle injuries per season with most (92%) affecting the hamstring, quadricep, adductor, and calf muscle groups (Ekstrand et al., 2016). Furthermore, the average number of muscle injuries in men's professional soccer can be categorized as six hamstring, three quadricep, three adductor, one/two calf, and one/two 'other' muscle groups (McCall et al., 2015). Thus, the prevention of injuries is an essential aspect in sport management to optimize team performance and resources (Seow and Massey, 2022). Furthermore, based on the assessment and diagnosis, the rest period following a moderate/severe injury may lead to de-conditioning for the injured player and therefore an association with a prolonged

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rehabilitation, re-conditioning and return to sport (RTS) is observed post-injury (Brukner et al., 2018; Pollock et al., 2016; Taberner et al., 2022).

A further practical problem may be that players' RTS may occur prior to fully completing the re-conditioning stage of the rehabilitation process due to internal pressure from the manager/coaching staff and external pressure, namely match outcome and the media. Thus, minor to mild injuries normally involve only a few absent days, and minimal de-conditioning, and may be underestimated. As a result, the player may be required to compete under sub-optimal physical (or even psychological) condition, which may lead to reduced match performance and further injury risk. Therefore, it is necessary to understand if and to what extent match running performance is altered in the first matches following RTS compared to pre-injury performance.

A number of recent studies have assessed the post- vs. pre-injury match performance in soccer players of different age groups and categories, in particular high-intensity running and sprint performance, although the vast majority of this research has only focused on hamstring strains (Hoppen et al., 2022; Jimenez et al., 2020; Whiteley et al., 2021; Whiteley et al., 2022). Only one study (Raya-Gonzalez et al., 2022) examined the impact of all injury types in elite soccer (Spain La Liga, across two seasons), where injuries were identified according to the UEFA guidelines for epidemiological studies as events that caused absence from the next training session or match (Hagglund et al., 2005). Although, Raya-Gonzalez et al. (2022) did not collect and analyse data from official club medical staff, instead publicly available data from the clubs' website was examined. Thus, the validity and reliability of the data may be questionable, as the authors analyzed match performance changes following players sustaining an injury. The main findings of this study showed reductions in playing time following moderate and major injuries. Moreover, reductions post-minor injury were observed during jogging (>6 km/h) and running (6 to 12 km/h). Additionally, greater distances were covered when running at 18-21 km/h and 21-24 km/h by 161 professional Spainish soccer players from La Liga who had sufered major injuries. Lastly, maximum speed also decreased following moderate and major injuries. Overall, these studies highlighted reductions in high-intensity and sprint distance and maximum speed in the matches played immediately following RTS (Hoppen et al., 2022; Jimenez et al., 2020; Raya-Gonzalez et al., 2022; Whiteley et al., 2021; Whiteley et al., 2022). However, the results of these studies are not consistent due to the specific nature of the study and the effects of re-conditioning training. Despite current RTS guidelines in the existing literature regarding timelines following injury in elite soccer (Taberner et al., 2022), limited information is available regarding match running performance post-injury.

Alongside physical performance, injury incidence and subsequent player availability has also been commonly cited as a key factor in the success of teams over the course of a soccer season. Carling et al. (2015) investigated the relationship between injury, player availability and team performance across five consecutive French Ligue 1 seasons. The authors found that during the season with the highest player availability, the team was able to attain the highest points total and conceded the least number of goals across the five examined seasons. While there may be many other contextual factors that contribute towards these achievements, this may suggest that higher player availability may play an important role in the overall success of a soccer team over the course of a season.

Considering the previous literature and the fact that only one study was found to analyze the injury impact on match performance variables (Raya-Gonzalez et al., 2022), the aim of the present study was to assess the impact of any injury, identified according to the UEFA definition (an event involving the absence from subsequent training/match), on match running performance following RTS over two consecutive seasons in elite European soccer players. The study hypothesis was that the first few matches post-injury will result in lower running demands when compared with pre-injury status as suggested by Raya-Gonzaléz et al. (2022).

Material and methods

A retrospective analysis was conducted utilizing player injury and match running performance data collected in an elite European Premier League soccer team. A club physiotherapist consistently recorded availability and injury data on a daily basis in a standardized format for each player. The consensus on definitions and data collection procedures in studies of soccer injuries (Fuller et al., 2006) only administered and recorded time loss injuries. Players that were previously injured at study commencement were included, although were not incorporated into the analysis, while new players recruited during the study period were included. The study was conducted according to the requirements of the Declaration of Helsinki and was approved by the local Ethics Committee of the University of Central Lancashire (N 0104 dated 7/12/20) and the Premiership club from which the subjects volunteered (Winter & Maughan, 2009). To ensure confidentiality, all data were anonymized prior to analysis. All players provided consent for their injury-related and match running performance data to be collected and utilized for research purposes.

Participants

Eleven professional outfield soccer players from a European Premiership club were involved in the study. Data from the complete 2019-20 and 2020-21 seasons included 11 senior players (age 23.6 ± 6.3 years, weight 76.1 ± 7.8 kg, height 1.78 ± 0.08 m). The inclusion criteria for the study were: (i) listed on the first-team roster of the Premiership club at the start of the 2019-20 and/or 2020-21 seasons, (ii) regularly trained with the first-team, (iii) participated in at least 80% of training sessions and matches, (iv) did not use dietary supplements during the study, (v) not injured during the study, and (vi) did not participate in any other training program during the study period. Additionally, the exclusion criteria for the study were: (i) long-term injury, (ii) joining the team late in either of the study seasons, (iii) lack of full, complete data for training and/or match-play, (iv) an in-sufficient number of satellite connection signals, and (v) goalkeepers, due to significant variations in physical demands compared with outfield players. Players were assigned to one of five positions as match demands for these differ considerably. The methodology of differentiating specialized positions was adapted from previous research (Aalbers et al., 2019). Goalkeepers were excluded from the investigation due to the specific nature of their match activity and low running demands (Ingebrigtsen et al., 2015; Bradley et al., 2009).

All injuries (n = 85, including minimal to severe injuries) recorded in rostered outfield players (n = 31) from the study team across the 2019-20 and 2020-21 seasons were initially considered. Subsequently, only players (n = 22) having completed at least 10 matches and for a minimum of 30-minutes were included, thus recording a total of 59 injuries. Finally, only injuries where at least 3 matches were completed and for a minimum of 30-minutes in the month preceding the injury, and 3 matches completed for a minimum of 30-minutes in the month following the last day-off due to injury were examined. Therefore, a total of 16 injuries from 11 players were considered for analysis. Examined injuries included muscle (n = 7), ligament/tendon (n = 4), contusions (n = 3) and concussions/effusions (n = 2). The mean and standard deviation (SD) of number of absent days was 12 ± 15, with a range of 1 to 49.

Data collection

Each season was split into two phases to mirror the official fixture schedule. The first phase was sub-divided into pre-season (mid-June to mid-July) that lasted 5-weeks and the competitive season (mid-July to mid-December) that lasted 25-weeks. The second phase was also sub-divided into pre-season (mid-January to end-February) that lasted 6-weeks and the competitive season (end-February to mid-May) that lasted 11-weeks.

All injuries were assessed, diagnosed and categorized by the club's physiotherapist and head doctor and defined as injury incidence resulting in a modified training program, or missed training sessions or matches (Rogalski et al., 2012). Injuries were further categorized by body-site (injury location and region), injury type (trauma, overuse), sub-type (fracture, other bone injury, dislocation/subluxation, sprain/ligament, meniscus/cartilage, concussion, muscle strain, tendon, hematoma/contusion, nerve injury and synovitis), nature (training, match or undefined), description and days missed. The definition of injury severity differed slightly to previously reported methods (Rogalski et al., 2012), although are consistent with Fuller et al. (2006) where injury severity was defined as the number of days from the date of injury to the date of return to full participation in team training and availability for match selection (Fuller et al., 2006).

A two-camera optical tracking system (InStat, Moscow, Russia) was utilized to record and examine the match running performance across two consecutive seasons. The matches were filmed using two full HD, static cameras positioned on the centre line of the field, not less than 3-metres from the field and 7-metres in height. A consistent 25Hz format was provided. Data were linearly interpolated to 50Hz, smoothed using a 5-point moving average and then down-sampled to 10Hz, which allowed analysis of all player actions with and without the ball (Morgans et al., 2022). The installation process, reliability and validity of InStat have been previously reported (FIFA, 2019; Morgans et al., 2022). Physical performance was analyzed using the InStat Analysis Software System. Match running performance metrics included: time on pitch (mins); total distance covered (m); high-intensity distance (m; total distance covered 5.5-7m/s); sprint distance (m; total distance covered >7m/s); explosive distance (m; distance covered with an acceleration >1.12m.s^{-2}); acceleration distance (m; distance covered during accelerations +3m.s^{-2}); deceleration distance (m; distance covered during decelerations +3m.s^{-2}) and lasted more than 0.5-sec (Algroy et al., 2021). All distance variables were divided by individual playing time (expressed in minutes) to calculate a distance per minute value.

Statistical analysis

All data are presented as mean and 95% confidence interval (CI), or as median and interquartile range (IQR). Physical performance data were averaged across the last three matches completed by a player prior to injury occurrence, to obtain a pre-injury match performance level (PRE). Linear mixed models with random intercepts on individual players's IDs were used to examine, for every match performance variable, the differences between PRE and respectively the first (POST-1), second (POST-2), and third (POST-3) match performed following RTS. Differences were standardized by the estimated between-subject SD to calculate an effect size (ES), that was evaluated as trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0), very large (2.0-4.0) and extremely large (> 4.0) (Hopkins et al., 2009). When a significant difference between PRE and any post-injury match was observed, Pearson's r correlation coefficients calculated between individual changes in that performance variable (POST minus PRE) and the number of absent days due to injury, to determine the relationship between such variables. Furthermore, for each variable, the number of matches played from RTS to achieving or overcoming the pre-injury performance values were calculated (that is 1, 2, 3 or >3), and were expressed as the median and IQR. The analysis were conducted with R software, version 4.2.0. For all analyzes, statistical significance was set at p<0.05.

Results

Table 1 shows the estimated means and 95% CIs for the examined match running performance variables before and following injury, while Table 2 displays the estimated differences with 95% CIs and effect sizes. The linear mixed modelling analysis revealed no difference between PRE and POST1, POST2, and POST3 for total distance, running distance, high-intensity distance, and sprint distance (all p >0.05). Although, maximum speed was significantly (p<0.05) lower in POST1 when compared to PRE, and in POST2 when compared to PRE, in both cases with a large (ES = 1.88) effect. No significant difference was observed for maximum speed between PRE and POST3 (p=0.07).

Table 1. Estimated means and 95% CIs for the examined running performance variables in matches preceding an injury (PRE) and in the first (POST1), second (POST2), and third (POST3) match following RTS.

	PRE	POST1	POST2	POST3
Total distance (m/min)	118 (113 - 122)	118 (114 - 122)	119 (115 - 123)	121 (116 - 125)
Running distance (m/min)	20.5 (18.2 - 22.7)	21.0 (18.8 - 23.3)	21.5 (19.2 - 23.7)	21.7 (19.4 - 23.9)
High-intensity distance (m/min)	8.4 (7.0 - 10.0)	8.6 (7.0 - 10.0)	8.3 (6.8 - 9.8)	9.0 (7.6 - 10.5)
Sprint distance (m/min)	1.6 (1.2 - 2.1)	1.4 (0.9 - 1.8)	1.3 (0.8 - 1.7)	1.3 (0.8 - 1.7)
Maximum speed (m/s)	8.3 (8.1 - 8.5)	8.0 (7.8 - 8.2)	8.1 (7.9 - 8.3)	8.1 (7.9 - 8.3)

Table 2. Estimated differences and effect sizes for POST1, POST2 and POST3 vs. PRE.

	POST1	POST2	POST3
Total distance (m/min)	0.5; ES = 0.11	1.5; ES = 0.33	3.0; ES = 0.67
Running distance (m/min)	0.6; ES = 0.21	1.0; ES = 0.36	1.2; ES = 0.43
High-intensity distance (m/min)	0.1; ES = 0.06	-0.1; ES = -0.06	0.6; ES = 0.33
Sprint distance (m/min)	-0.3; ES = -0.75	-0.3; ES = -0.75	-0.3; ES = -0.75
Maximum speed (m/s)	-0.3*; ES = -1.88	-0.3*; ES = -1.88	-0.2; ES = -1.25

*p<0.05

A very low correlation between number of absent days and changes in maximum speed between POST1 and PRE (r = 0.09, 95% CI -0.42 to 0.56), and POST2 and PRE (r = 0.10, 95% CI -0.42 to 0.57) were observed respectively.

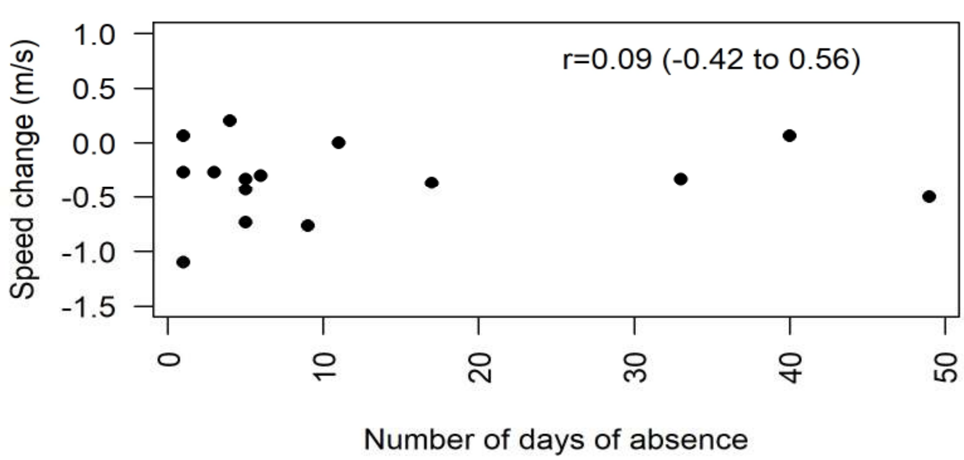

Figure 1. The relationship between the number of days absent and change in maximum speed between PRE and POST1

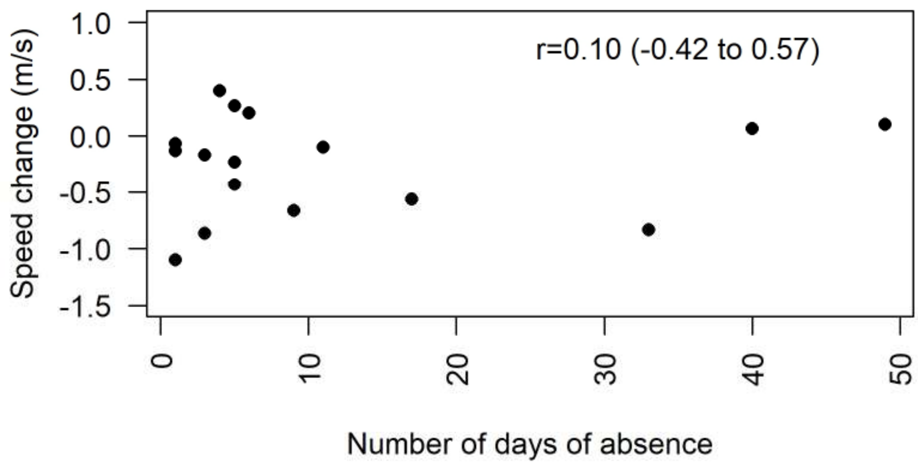

Figure 2. The relationship between the number of days absent and change in maximum speed between PRE and POST2

The median (IQR) for the number of matches to attain pre-injury running performance was 1 (1 to 2) for total distance; 2 (1 to 2.25) for running distance; 1.5 (1 to 3) for high-intensity distance; 2 (1 to 4) for sprint distance; and 3 (1.75 to 4.00) for maximum speed, respectively.

Discussion

The aim of the present study was to assess the impact of all injury types on match running performance following RTS competitive match-play across two consecutive seasons in elite European soccer players. The main findings showed no substantial variations for distance variables regardless of one to three matches post-injury compared to pre-injury status. Only maximum speed was found to be lower in POST1 and POST2, although the mean value was slightly lower. Moreover, no correlations between absent days and maximum speed reductions in POST1 and POST2 were found, which contrasts the Raya-Gonzalez et al. (2022) study, who only highlighted a difference for moderate and severe injuries. Such results did not confirm the hypothesis of the present study.

Regarding the non-variations for running distance variables, specifically for total distance and running distance, the results supported the Raya-Gonzalez et al. (2022) findings. The present study reinforced Raya-Gonzalez et al. (2022) results regardless of injury severity (minor - from 4 to 7 missed days, moderate - from 8 to 28 missed days, and major - more than 28 missed days). However, injury severity was not analyzed in the present study due to the limited number of each injury type. Even so, the present data contrasts Raya-Gonzalez et al. (2022) findings who reported a reduction in playing time experienced by all players who suffered injury, while the present study analyzed mainly starting players.

Previous research has suggested that players suffering injury severity of four to seven days may have participated in official match-play prior to full recovery in terms of health readiness (Wing, 2018). The present study, also reported more injuries of similar severity, noted no differences in high-intensity and sprint distance. Such results may be relevant to clarify each study and thus the need to analyse players specific context. There are other possible justifications for the non-variation results in running distance variables. For instance, a previous study reported that following a major injury, players performed high-intensity running in the fourth match post-injury (Jiménez-Rubio et al., 2020). This may be related to specific high-speed running (Taberner et al., 2019), along with greater control of the training load and fatigue during the re-conditioning program (Jiménez-Rubio et al., 2020). In contrast, it was previously suggested that players that suffered minor injury, may be included as a starting player even prior to full recovery, which may decrease match performance (Raya-Gonzalez et al., 2022). However, minor injuries were most prevalent in the present study, although such results were not confirmed.

Furthermore, maximum speed remained similar pre- and post-injury which opposes the Raya-Gonzalez et al. (2022) study who found increases post-minor injury, and no changes following moderate and major injuries. Again, this does not seem to be confirmed in the present study considering that the higher number of injuries remained in the minor category. On the one hand, Raya-Gonzalez et al. (2022) attributed such findings to maximum speed that decreased following moderate and major injuries. Such a scenario was similar in the present study, since maximum speed showed to be lower in POST1 and POST2, although the mean value was slightly lower. On the other hand, Jiménez-Rubio et al. (2020) study found significant improvements in maximum speed. Nonetheless, there are methodological differences between the studies since in the Jiménez-Rubio et al. (2020) study, all players completed the same re-conditioning program following a grade IIb hamstring strain, while the present study included distinct types of injuries and different types of re-conditioning programs. Therefore, the current findings suggest that more than three official matches are required to fully recover to pre-injury running performance levels. This may also contribute towards an impaired maximum speed performance during match-play, that requires careful consideration for coaches given the importance of this variable (Faude et al., 2012).

Additionally, there was a low correlation between absent days and maximum speed loss. This suggests that players tended to reduce maximum speed following any injury, irrespective of the number of days absent. Even following only one or two absent days, players maximum speed attained were slower in the first two matches completed. Some speculations for this finding may be associated with psychological mechanisms. For instance, fear of worsening the injury if not 100% confident that the injury has fully healed despite being allowed to play, factors that were not controlled in the present study.

Despite the interesting results of this study, there are some limitations to address. Firstly, the limited number of players and injuries was due to only including injuries with at least four matches played pre-injury and at least four matches played post-RTS. Thus, it is suggested that future research should assess longer periods of time with potentially a greater number of participants and injury and running performance data. Secondly, different injury types were examined collectively (i.e., sprains, strains, traumatic, overuse, etc.). This may also be regarded as a study strength, considering that maximum speed was reduced regardless of injury severity classification. Nonetheless, a wider injury sample may be differentiated according to type and varying rehabilitation training for future research. Thirdly, only external load data was analyzed while no different biomechanical or physiological tests were employed to compare pre- and post-injury status as suggested previously (Jiménez-Rubio et al., 2020; Raya-Gonzalez et al., 2022). Fourthly, injured players were not compared with a control group of non-injured players as well as contextual factors such as match result and quality of opposition (Gonçalves et al., 2020; Gonçalves et al., 2019; Rago et al., 2021). These factors may have an impact on running distances and/or maximum speed that may provide greater insights for the present research. Finally, the differences in positional demands were not considered, as players with various tactical roles may perform 7 to 61 sprints (Taylor et al., 2017), as this was not possible due to the small sample size.

In comparison to Raya-Gonzalez et al. (2022) that was the only previous study found relating to this topic in elite soccer players, this was the first analysis conducted on an elite soccer team from a European league utilizing injury data collected from the club medical staff. From a methodological point of view, the number of days absent for each injury was considered rather than classifying injuries into discrete categories (based on absent days). Furthermore, it is also relevant to highlight that four injury types were included in the present study which were not analyzed separately due to the limited number of incidents. This may also be a limitation, although this is the real-world scenario of any professional team and should be considered.

Conclusions

In conclusion, no variation in the examined distance metrics were found regardless of one to three matches post-injury when compared to pre-injury status. Moreover, it was reported that maximum speed was lower during the first three matches post-injury, although the mean value was slightly lower. Finally, a low correlation between absent days and maximum speed loss between pre-injury and following one and two matches, respectively were found. The practical implications of this study for coaches and performance staff are that the number of absent days for each injury is significant in order to individualize the players profile in relation to the positional demands within the unit and team. Such information is relevant to understand when players are ready to RTS competitive match-play based on key performance markers and the comparison to pre-injury levels.

Acknowledgements
The authors would like to express their gratitude to the club that participated in the study.

Conflict of interest
The author(s) declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Funding
This research was funded by the Portuguese Foundation for Science and Technology, I.P., Grant/Award Number UIDP/04748/2020. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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