Novelty Journals
ISSN 2394-9716
International Journal of Novel Research in Interdisciplinary Studies
Vol. 7, Issue 6, pp: (1-11), Month: November - December 2020, Available at: www.noveltyjournals.com

Differences of physical match performance metrics in professional football players classified as injured and uninjured during a season (2016/2017)

Emmanouil Smpokos[1*],PhD, MSc, Christos Mourikis[2],MSc, Christos Theos[2,3],MD, MSc, Manolis Linardakis[1],PhD, MSc

[1] Department of Social Medicine, Faculty of Medicine, University of Crete, Greece
[2] Laboratory of Football Performance, OF Club, Piraeus, Greece
[3] Piraeus Special Orthopedic Surgery (PirSOS) - Head of the Medical Department of Club, Piraeus, Greece

E-mail: msbokos@edu.med.uoc.gr or manosmpok@yahoo.gr
Phone number: 0030 6945233315, Fax number: 0030 2155308859

Abstract: **Purpose: The purpose of this study was to investigate the differences of physical performance metrics in two footballer groups (injured and uninjured) during one competitive season.**

Methods: In a prospective-observational cohort study for one season (2016/2017) we included thirty-four professional football players. Footballers were classified as injured (n=27) and uninjured (n=7). Using Global-Positioning-System Technology (GPS), High-Speed-Running-(HSR), Very-High-Intensity-Speed-Running-(VHS), Maximal-Sprinting-(MS), High-Metabolic-Load-Distance-(HMLD), Maximum-Velocity-(Vmax) or number of accelerations and sprints were assessed from 635 measurements. MANCOVA was performed.

Results: The mean number of injuries was 2.0 injuries/injured player, 42.6% of them occurred during the matches and high prevalence or 85.1% was estimated in the lower limbs. The clinical incidence was 1.59 injuries/player and the injury incidence 88.8 injuries/1,000 match-playing-exposure hours. Injured players in relation to counterparts had higher mean HSR (483.5 vs. 389.8meters, p<0.001), VHS (376.6 vs. 322.2meters, p=0.001), MS (105.5 vs. 67.7meters, p<0.001), sprints (7.4 vs. 4.9, p<0.001), accelerations (44.7 vs. 40.5n, p=0.008), and Vmax (8.42 vs. 8.03m/s, p<0.001). In injured players, the post injuries measurements had significant (p<0.05) positive change in mean VHS (+17.9%), HSR (+16.4%) or HMLD (+14.1%).

Conclusions: Injured players displayed higher level in physical performance metrics probably due to the effort through the rehabilitation process in order to return faster and more prepared to the official obligations reducing the injury risk.

Keywords: **Global Positioning System (GPS); football; injuries; lower limbs; motor activities.**

1. INTRODUCTION

Modern football is a complex sporting activity, characterized by highly dynamic and acyclical game movements, interspersed with frequent bout of high-speed movements such as accelerating, jumping, changing direction that are performed at high to maximal intensity with physical and technical demands increasing substantially over the past few years (Smpokos-Sbokos et al. 2018).

However, the frequency of competitive matches for the footballers is high and players frequently required playing consecutive matches with few days of poor recovery, sometimes between matches and subsequent training sessions and thus increasing the injury risk (Malone et al. 2017). An appropriate balance between training, competition and recovery is required to attain peak performance and injury avoidance which is not always adequately maintained, as highlighted by the higher injury rate of approximately 50 injuries within an elite squad of 25 players per season (Ekstrand et al. 2011b). Recent research demonstrates that elite soccer players are at increased risk of injury when they experience high-weekly cumulative training loads (≥1500 to ≥2120 AU) (Malone et al. 2017). Additionally it was reported that greater training time spent above 85% maximal heart rate (HR_{max}) resulted in increased injury risk for players in match-play and training sessions (Owen et al. 2015). Most researches have reported that 50 percent of injuries occur more in the players' dominant side rather than in their non-dominant side (37%) and the other injuries are reported in the palyers' trunk (Hawkins et al. 2001).

The introduction of Global Positioning System (GPS) into sports has led to many studies which objectively quantify training loads and monitor motor activities (Gabbett et al. 2012; Piggott et al. 2009). However, despite growing interest, research into the relationship between motor activities and injury is very limited in football (soccer) compared to other sports where more research has been conducted over a longer period of time (Colby et al. 2014). An Australian study, involving a professional team competing in a domestic Australian League reported a moderate effect for an increase in mean speed and body load for 1-week and 4-week blocks prior to the injury week (Ehrmann et al. 2016). However, it should be highlighted that the aforementioned study is limited by the use of predicted match values based on preseason data (Ehrmann et al. 2016). Furthermore a study conducted in elite youth football players was reported that overall contact and non-contact injury risk is significantly increased following >9254 accelerations accumulated over 3 weeks (Bowen et al. 2017). For example, GPS-derived data from elite Rugby League demonstrate that great volumes of High Speed Running (HSR) result in more soft tissue injuries (Gabbett and Ullah 2012). Furthermore, a more soccer specific study reported that small-sided games resulted in higher maximal speeds and greater HSR distances but there was no evidence that these dose-response of these exposures were associated with increased risk of injury (Djaoui et al. 2017).

Thus, lacking of relative data in literature, current study aimed to investigate the impact of physical (match GPS) performance metrics in elite football players which were classified as injured and uninjured during a football season.

2. MATERIAL AND METHODS

Participants

This study is based on data collected from an observational cohort of a Greek team's professional football players during the football season 2016/17. The study covered all domestic national league games, national Cup and internationally in either European Football Associations (UEFA) Champion League (CL) league or the UEFA Europa League (EL) (qualification of Champions League or UEFA Europa league groups) of 49 matches in 2016/2017 season. Data were collected for one entire annual season, from June 27th, 2016 to April 30th, 2017 (307 days or 6.2 days/match). The team used for data collection competed in 3 official competitions across the season (domestic Greek National League matches and National Cup), included European League competition (qualification of Champions League or UEFA League groups).

Thirty-four players who were categorized as injured (n=27) or uninjured (n=7) took part in the present study (details of their descriptive characteristics are described in Table 1). Moreover detailed information of the study is provided in earlier reports (Smpokos et al. 2018; Smpokos-Sbokos et al. 2018). Their weight was measured on calibrated digital scales (Seca 861; Seca, Hamburg, Germany) to the nearest 0.1 kg and height was measured to the nearest 0.5 cm with a wall mounted stadiometer (Seca 225; Seca), without shoes. Body mass index (BMI) was calculated as weight divided by height, squared ($kg \cdot m^{-2}$). The study was approved by the institutional ethics board and written informed consent was obtained for each participant at the begging of the season (Smpokos-Sbokos et al. 2018).

Injuries

All injuries which hinder the player from full participation in training or match participation were recorded by the teams' medical staff (physiotherapist; orthopedic physician). The player was considered injured until the medical practitioners allowed full participation in training and availability for match selection. Injuries were categorized according to severity (Nilsson et al. 2016; Reis et al. 2015; Smpokos-Sbokos et al. 2018) based on the number of days' absence: minimal (1-3 days), minor injury (4-7 days), moderate (8-28 days) and major/severe (above 28 days). All injuries were monitored until the final day of rehabilitation. The location of the injury was defined according to the following general categories: head/neck, upper limbs, trunk, and lower limbs while the type of injury was classified as fracture/bone stress, joint (non-bone)/ligament, muscle/tendon, contusions, laceration/skin injury, central/peripheral nervous system and some others (Reis et al. 2015). All injuries in the present study were confirmed by the team's medical doctor using diagnostic imaging. The mechanism of injury was classified as traumatic i.e. resulting from a specific and identifiable event and characterized by acute onset, or as overuse injury defined as a pain syndrome of the musculoskeletal system with insidious onset and without any known trauma that might have given previous symptoms (Reis et al. 2015; Smpokos-Sbokos et al. 2018; Walden et al. 2005).

Match analysis data & Physical/motor activity measurements

Each match was monitored using a computerized semi-automatic video match analysis image recognition system (data were supplied by Viper pod 2, STATSport, Belfast, UK). The data systematically analyzed using proprietary software to provide an interactive coaching and analysis tool that provided a comprehensive data on each individual (Impellizzeri et al. 2006). Match data collection for this study was carried out at the football club's official stadium and both home and away stadiums, respectively (Smpokos et al. 2018).

Each player's physical activity, during each match, was monitored using portable global positioning system (GPS) units (Viper pod 2, STATSports, Viper Belfast, UK). This device provides position velocity and distance data at 10Hz. Each player wore a special adjustable neoprene harness which enables this device to be fitted to the upper part of his back (i.e. between the left and right scapula). All devices were activated 30 minutes before data collection to allow acquisition of satellite signals, and synchronize the GPS clock with the satellite's atomic clock (Maddison and Ni Mhurchu 2009). GPS data were downloaded after every match and analyzed using the respective software package (Viper PSA software, STATSport, Belfast, UK). In order to avoid inter-unit error, players wore the same GPS device for each game (Buchheit et al. 2014; Jennings et al. 2010). The players' external load that were selected for analysis included total distance covered (TD; km), relative total distance: distance/time (meters/minutes) (D/T), maximum sprint velocity reached (Vmax) (m/s) and high speed categories were used: Very High Speed running (VHS; from 19.8 to 25.2Km/h) and Maximal Speed-Sprint (MS;>25.2Km/h) or High Speed Running (zone 5 + zone 6) (HSR;>19.8Km/h, in meters) (Di Salvo et al. 2007; Jennings et al. 2010). A sprint was defined as a running exercise lasting at least 1 sec at the speed of at least 25.2Km/h (>7 m/s). Acceleration activity was measured on the basis of the change in GPS speed data and was defined as a change in speed for a minimum period of 0.5 s with a maximum acceleration in the period at least 0.5 $m \cdot s^{-2}$. The acceleration was considered finished when the player stopped accelerating. The classification of accelerations by zone is based on the maximum acceleration reached in the acceleration period. The same approach was used with regard to deceleration. The load and intensity measures were identified as total number of accelerations or decelerations (>2 $m \cdot s^{-2}$) and accelerations/min or decelerations/min, respectively. In addition, the "dynamic stress load" (DSL = measure of accumulated load) was calculated as the total of the weighted impacts during a match (sum of the G-forces experienced by the athlete throughout the match). Impacts were weighted using convex-shaped function (approximately a cubic function), an approach similar to the one used in the speed intensity calculation, with the key concept being that an impact of 4g is more than twice as hard on the body as an impact of 2g. The weighted impacts were totaled and finally scaled to give more workable values expressed in arbitrary units (AU). The load and intensity measures were identified as Dynamic Stress Load (DSL) (Bangsbo and Krustrup 2009). Both speed intensity and dynamic stress load were calculated automatically using a custom algorithm included in the proprietary software provided by the manufacturers (Viper Version 1.2, STATSports, Belfast, UK). High Metabolic Load Distance (HML; distance covered >25.5 $W \cdot Kg^{-1}$) was used as measure of movement intensity (Gaudino et al. 2015). The HML distance measure combines the energy cost of all constant velocity running above 5.5$m \cdot s^{-1}$ and acceleration and deceleration activity over 2 $m \cdot s^{-2}$ during intermittent running (Coutts et al. 2015; Osgnach et al. 2010). Players who didn't get into HSR zones because of covering short, sharp distances were given credit in their HML score because the intensity of the work could be just great (total distance covered at a speed of 5.5m/sec or accelerating or decelerating at a magnitude or 2m/s^2 or above) (Smpokos et al. 2018).

The total measurements of the footballers in the present study (through GPS) were 635 and retrieved from 49 matches, 505 of injured and 130 of uninjured players. Moreover, a secondary division of 505 measurements of injured players was performed according to pre-to-post occurrence of injuries. As 'pre' were all the measurements before the injuries occurrence (n=413) and 'post' after of them (n=92). In 'pre' measurements included those of the matches that players had been injured.

Analysis

Data were analyzed using the SPSS software (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Distributions of descriptive characteristics of the 34 professional football players were estimated according to injuries' presence (uninjured and injured groups). Characteristics were compared between the two groups with non-parametric Mann-Whitney test or chi-square and binomial tests. The prevalence of injuries and the relevant 95% confidence intervals (95%CIs) were estimated based on bootstrap techniques. In addition, the rates of clinical incidence were estimated as the ratio of the summing of injuries per total number of the players. They are expressed the risk of injury for each player at the beginning of the season. Their 95%CIs were based on proposals of Knowles and colleagues (Knowles et al. 2006). The injury incidence (and corresponding 95%CIs), was also assessed as the injuries per 1,000 match playing exposure hours (Stubbe et al. 2015). In rehabilitation, the mean days per injured player and mean days per injury were estimated. Multivariate analysis of covariance (mancova) was also performed to assess the differences of motor activity measurements between the two groups. Effect size (η^2) and heterogeneity of comparisons were also estimated (based on Levene's test). Age, body mass index, players' position, kicking leg, nationality and minutes playing per match were used as covariates. With similar analysis, pre-and-post injuries measurements of injured players were compared in order to assess the percentage changes.

3. RESULTS

The 34 players of the current study had mean age of 25.3 years (±4.7) (**table 1**) and were classified as 'Uninjured' (n=7; 20.6%) and 'Injured' with at least one injury during the whole season of 2016/17 (n=27; 79.4%). Between the two groups there was no significant difference in their descriptive characteristics such as age, body measurements, nationality, position, kicking leg, matches and minutes playing during the season or per match (p>0.05).

Table 1. Characteristics of 34 Greek team's football players of the present study (2016/17).

		Players			
		Total	Uninjured	Injured	
		mean±stand.dev.			p-value
Players, *number (%)*		34	7 (20.6) [a]	27 (79.4)	<0.001
Age, *years*		25.3±4.7	25.4±5.6	25.3±4.4	0.967
Weight, *kg*		73.9±6.3	73.7±5.4	74.0±6.5	0.901
Height, *cm*		180.9±6.3	179.6±6.5	181.2±6.4	0.771
Body Mass Index, *kg·m*$^{-2}$		22.6±1.4	22.8±1.1	22.5±1.4	0.403
Nationality/Region	*Greece*	11 (32.4)	3 (42.9)	8 (29.6)	
	Europe	10 (29.4)	2 (28.6)	8 (29.6)	
	Latin America	8 (23.5)	1 (14.3)	7 (25.9)	0.238
	Africa	4 (11.8)	-	4 (14.8)	
	Asia	1 (2.9)	1 (14.3)	-	
Position	*defender*	7 (20.6)	1 (14.3)	6 (22.2)	
	wingback	7 (20.6)	1 (14.3)	6 (22.2)	0.901
	midfielder	16 (47.1)	4 (57.1)	12 (44.4)	
	forward	4 (11.8)	1 (14.3)	3 (11.1)	
Kicking leg	*both*	4 (11.8)	1 (14.3)	3 (11.1)	
	right	19 (55.9)	3 (42.9)	16 (59.3)	0.735
	left	11 (32.3)	3 (42.9)	8 (29.6)	
Matches playing during the season		18.7 [20.0] [b]	18.6 [20.0]	18.7 [20.0]	0.934
Minutes playing during the season		1320 [1365]	1201 [1361]	1351 [1581]	0.868
Minutes per match		65.6 [69.0]	68.6 [69.0]	64.8 [69.0]	0.901

Players include all players at the begging of the season or/and the transfers during the season.
As "Injured" players were defined those with at least one injury in the whole season.
Values are: [a] n (%), [b] mean [median].
Binomial, χ^2 and Mann-Whitney methods were performed.

Analytical injuries' profile of the 27 injured football players is presenting in **table 2**. 33.3% of the players were found to have one injury while 52.9% were recorded to have sustained two or more injuries. The total number of all injuries was '54' and the mean number was calculated to be 2.0 injuries/injured player (95%CI 1.6, 2.4) and the frequency of injuries occurrence was not significantly different between matches (42.6%; 95%CI 30.1, 55.9) and training (57.4%; 95%CI 44.1, 69.9). The clinical incidence was 1.59 injuries per player (95%CI 1.45, 1.72) and the injury incidence was also estimated to 88.8 injuries per 1,000 match playing exposure hours. The sum of days for rehabilitation, by all injured players and during the whole duration of the study season, was 524. The mean number of days per injured player was 19.4 (95%CI 12.3, 28.4) and the mean days per injury was 9.7 (95%CI 3.6, 15.8). According to severity classification, high percentage or 66.6% of the injured players seem to have moderate-to-major/severe injuries. Nevertheless, the distribution of injuries in current classification seem to be similar across the four categories (p=0.125).

Table 2. Injuries profile on 34 football players.

			In season 2016/17	
Injured players		*n*	27/34	
		% (95%CI)	79.4 (63.8, 90.3)	
Injuries		*with one*	9 (33.3%)	
		two	13 (48.2%)	18 (52.9%)
		three	2 (7.4%)	
		four	2 (7.4%)	
		five	1 (3.7%)	
		sum of injuries	54	
		mean injuries (95%CI)	2.0 (1.6, 2.4)	
		median	2.0	
Occurrence	in matches	*n (%; 95%CI)*	23 (42.6%; 30.1, 55.9)	
	in training	*n (%; 95%CI)*	31 (57.4%; 44.1, 69.9)	
Clinical incidence		*rate [a] (95%CI)*	1.59 (1.45, 1.72)	
Injury incidence		*rate [b] (95%CI)*	88.8 (65.1, 112.5)	
Rehabilitation		*sum of days*	524	
		mean days per injured player (95%CI)	19.4 (12.3, 28.4)	
		mean days per injuries (95%CI)	9.7 (3.6, 15.8)	
Severity of injuries		*Minimal (1-3 days)*	4 (14.8%)	
		Minor (4-7 days)	5 (18.6%)	
		Moderate (8-28 days)	12 (44.4%)	18 (66.6%)
		Major, Severe (28+ days)	6 (22.2%)	
		p-value [c]	0.125	

95%CI, 95% confidence intervals.
[a] Injuries per total number of the players (sum of injuries:n).
[b] Injuries per 1,000 match playing exposure hours.
[c] Chi-square (χ^2) tests of homogeneity.

Table 3 presents the distribution of 54 injuries in location, type, mechanism and recurrence. A higher prevalence of 85.1% was estimated in the lower limbs while findings regarding the type of injuries showed 70.7% of the injuries were recorded in muscles/tendon, 74.1% were traumatic injuries or vice versa 25.9% as overuse injuries and finally 27.8% were as non-recurrence injuries.

Table 3. Distribution of 54 injuries of 27 football players.

		Players		Injuries	
	injuries	n	%	n	%
Location	*neck, head*	1	3.7	1	1.9
	upper limbs	1	3.7	1	1.9
	trunk	5	18.5	6	11.1
	lower limbs	25	92.6	46	85.1
Type	*fracture/bone stress*	3	11.1	3	5.6
	joint (non-bone)/ligament	11	40.7	14	25.9
	muscle/tendon	23	85.2	38	70.7
Mechanism	*traumatic*	22	81.5	40	74.1
	overuse	10	37.0	14	25.9
Recurrence	*non-recurrence*	12	44.4	15	27.8
	early	8	29.6	8	14.8
	late	6	22.2	6	11.1

In most of the motor activities measurements, presented in **table 4**, injured players seem to have significantly higher mean levels or greater differences in relation to their counterparts. Especially, injured players in relation to uninjured had higher mean HSR (483.5 vs. 389.8meters respectively or difference +19.4%, p<0.001), VHS (376.6 vs. 322.2meters respectively or difference +14.5%, p=0.001), MS (105.5 vs. 67.7meters respectively or difference +35.8%, p<0.001), sprints (7.4 vs. 4.9 respectively or difference +34.5%, p<0.001), accelerations (44.7 vs. 40.5n, respectively or difference +9.4%, p=0.008), decelerations (57.5 vs. 48.1n, respectively or difference +16.3%, p<0.001) and Vmax (8.42 vs. 8.03m/s, respectively or difference +4.6%, p<0.001). Moreover, in injured players most of the motor activities were higher after (post) their injury in relation to pre injury time (**Figure 1**). Among others, in post injuries measurements was noticed significant positive change in mean VHS (+17.9%, p<0.05), HSR (+16.4%, p<0.05) or HMLD (+14.1%, p<0.05).

Table 4. Differences in motor activities between uninjured and injured football players in the season of 2016/17.

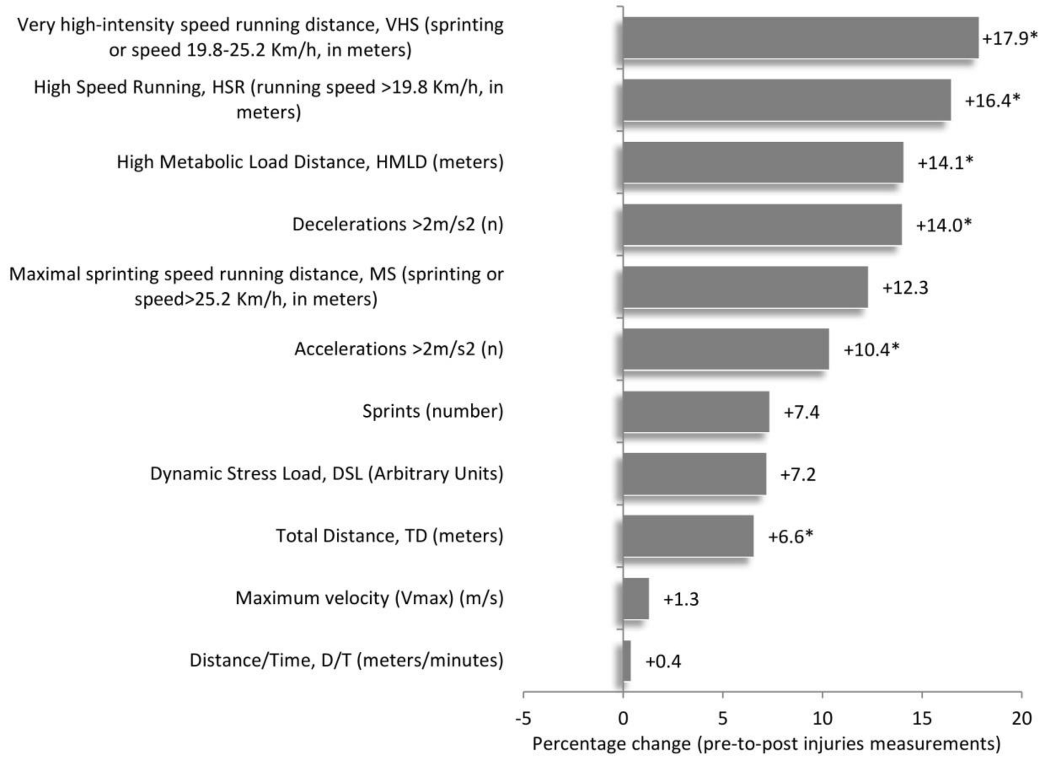
	Players					
measurements during the season [a]	Uninjured (n=7) $i_{uninjured}$=130	Injured (n=27) $i_{injured}$=505				
	mean (stand. error)		*Difference*	%	*p*-value	η^2
Total Distance, TD *(meters)*	7615 (120)	7593 (58)	-23	-0.3	0.869	0.001
High Speed Running, HSR *(running speed > 19.8 Km/h, in meters)*	389.8 (18.3)	483.5 (8.8)	93.7	19.4	<0.001	0.031
Very high-intensity speed running distance, VHS *(sprinting or speed 19.8-25.2 Km/h, in meters)*	322.2 (14.0)	376.6 (6.7)	54.5	14.5	0.001	0.018
Maximal sprinting speed running distance, MS *(sprinting or speed>25.2 Km/h, in meters)*	67.7 (6.2)	105.5 (3.0)	37.8	35.8	<0.001	0.043
Distance/Time, D/T *(meters/minutes)*	101.1 (1.2)	100.1 (0.6)	-1.0	-1.0	0.463	0.001
Dynamic Stress Load, DSL *(Arbitrary Units)*	232.6 (8.4)	240.0 (4.0)	7.4	3.1	0.439	0.001
Sprints *(number)*	4.9 (0.4)	7.4 (0.2)	2.6	34.5	<0.001	0.051
High Metabolic Load Distance, HMLD *(meters)*	1279 (35)	1362 (17)	83	6.1	0.037	0.007
Accelerations >2m/s2 *(n)*	40.5 (1.4)	44.7 (0.7)	4.2	9.4	0.008	0.011
Decelerations >2m/s2 *(n)*	48.1 (1.7)	57.5 (0.8)	9.4	16.3	<0.001	0.036
Maximum velocity (Vmax) *(m/s)*	8.03 (0.05)	8.42 (0.03)	0.39	4.6	<0.001	0.060

Multivariate analysis of variance (Levene's test was used for testing the equality of error variances). Age, body mass index, players' position, kicking leg, nationality and minutes playing per match were used as covariates.

[a] The total measurements were 635 and retrieved from 49 matches during the season of 2016/2017 (27th June 2016 to 30th April 2017).

International Journal of Novel Research in Interdisciplinary Studies
Vol. 7, Issue 6, pp: (1-11), Month: November - December 2020, Available at: www.noveltyjournals.com

Figure 1. Percentage changes in motor activities of injured players between the pre-to-post injuries measurements.



Footnote of Figure 1:

Pre injuries measurements were n=413 and post n=92. In 'pre' measurements included those of the matches that players had been injured.

Multivariate analysis of variance (*p-value<0.05). Levene's test was used for testing the equality of error variances. Age, body mass index, players' position, kicking leg, nationality and minutes playing per match were used as covariates.

4. DISCUSSION

In current study was investigating the difference of physical performance metrics into two classification categories of footballer players (injured-uninjured) during a season. The principal findings were: i) high prevalence of injuries in lower limbs that were recorded as traumatic injuries, ii) the low mean days of rehabilitation per injuries (approximately 10 days) and the low number of injuries per player, iii) the highest percentage of the injured players seems to have moderate-to-major/sever injuries and approximately five-to-ten footballers (approximately 53%) had sustained between two and five injuries during an annual season, iv) the significant difference that injured players displayed in HSR, VHS, MS, Sprints, decelerations and maximum velocity (Vmax) in relation to their counterparts (uninjured) v) in injured players most of the physical performance metrics were higher after (post) their injury in relation to pre injury time.

There is still a gap in the literature to be able to draw conclusions about the association and the impact of physical performance metrics in injured and uninjured football players. This is the first study to examine this association. Our data highlight that the injured players probably train harder in order to develop a greater resilience and tolerance for the intensity and fatigue of competition by increasing their physical/motor activities. Practically, the current study suggest that injured players should be exposed to large and rapid increases in HSR, VHS distances and MS during training that best prepare them to attain higher intensity speed movements in order to return faster to the official obligations of the team and offer a protective effect against injury. Additionally, this notion can be verified by the fact that the percentage change of the motor activities of the injured players was higher after post injury than pre injury time. The results of the present study propose the training injury prevention paradox that physically hard training of the injured players probably is high enough to adapt to match demands and to protect them against injuries. A major finding of the current study was that injured players exposed to large and rapid increases in rehabilitation training load, were more likely to sustain better motor activities than uninjured players. Our results have shown that increased aerobic fitness through rehabilitation process allows injured players to better tolerate increased distances at HSR, VHS or MS across weekly rehabilitation program. Previously TD and low-speed running are reported to be protective against injury in rugby league, Australian rules football and soccer (Bowen et al. 2017; Piggott et al. 2009). In a study contacted to Australian football League players was found that sprinting distance correlated with increased injury risk with inclusion of predicted match running loads (Colby et al. 2014).

In current study, the mean days per injury that caused absence of more than a week was found to be 9.7 days. The average number of days lost due to injury in the study was in agreement with the study conducted in Hong Kong in seven teams in professional Football League and was 7.6 days (Lee et al. 2014). Nineteen studies have reported that the injury incidence in football is high; between 65% and 82% of the players will sustain at least one injury during a season and these findings are consistent with the findings in the present study that reports the rate of clinical incidence of each player in every season to be approximately 2.0 per year (Arnason et al. 2004; Ekstrand et al. 2011a; Nielsen and Yde 1989). In agreement with the results of the present study more than 85% of all injuries affect the lower extremities (Hagglund et al. 2005; Walden et al. 2005). In other studies, the proportion of overuse injuries varied between 31% and 35% (Arnason et al. 2004; Ekstrand et al. 2011a; Ekstrand et al. 2011b) similarly to findings present here. Most of the injuries found in this study were non-recurrent. When investigating the injury mechanism, the present data of the study indicate that 74.1% of the injuries were traumatic. Most of the studies in this sense coincide that the majority of injuries that take place in football are caused by traumatic mechanism (Noya Salces et al. 2014). This study was conducted in a professional football team in Greece, which has dominated the domestic Greek League for the last 20-25 years, competed in the most successful tournament in Europe (European Champions League). To date this study is the first that studied and reported on this issue the impact of injuries in physical/motor activities inside the team and in Greece and Globally in general.

When interpreting the current findings, a number of limitations should be considered. One of the limitations of the study was the absence of recordings of training session load Regular recording of match load data would have provided more information about each player and therefore established particular load-fatigue relationships for each one, in the search for the adequate dose for each player. As current study recorded the match exposure official minutes playing during the season, due to lack of data on the exact hours of training per player, it was not possible to determine the injury incidence per training exposure time. In order to investigate the specific risk factor for certain injuries, individual exposure data would be required in future studies (Fuller et al. 2006). Factors in addition to weekly load, such a previous injury, perceived muscle soreness, fatigue, mood, sleep ratings and psychological stressors, are likely to impact upon an individual’s injury risk and should be also evaluated (Malone et al. 2018). Current results also do not necessarily have impact to all elite professional footballers as there are many factors that can affect the injury burden and should be taken into consideration, like coaching staff, training methodology, medical services, environmental conditions, level of football required for National/European league etc. (Mallo et al. 2011).

5. CONCLUSIONS

In summary, current study recorded and analyzed the difference of physical performance metrics in elite professional Greek team’s football players which were classified as injured and uninjured and competing in National Greek League and UEFA European matches, during a single season. The significant difference that injured players displayed in HSR, VHS, MS, Sprints, decelerations and maximum velocity (Vmax) in relation to uninjured players and in post injuries measurements the positive changes in VHS, HSR and HMLD, showed that players were tried to increase physical fitness due to an effort (through the rehabilitation process) to best prepare and return faster to the official obligations reducing also the injury risk.

ACKNOWLEDGMENTS

The authors would like to thank all of the team’s coaches, players and technical staff for their cooperation during all data collection procedures.

DISCLOSURE STATEMENT

No conflict of interest in reported by authors

Ethical approval

The study was approved by the institutional ethics board and written informed consent was obtained for each participant at the beginning of the season.

REFERENCES

[1] Arnason A, Sigurdsson S, Gudmundsson A, Holme I, Engebretsen L, Bahr R (2004) Risk factors for injuries in football. The American Journal of Sports Medicine 32 (1 Suppl):5S-16S. doi:10.1177/0363546503258912

[2] Bangsbo J, Krustrup P (2009) Physical demands and training of top-class soccer players. In: Reilly T, Korkusuz F (eds) Science and football VI. Routledge, New York, pp 318-330

[3] Bowen L, Gross AS, Gimpel M, Li FX (2017) Accumulated workloads and the acute:chronic workload ratio relate to injury risk in elite youth football players. Br J Sports Med 51 (5):452-459. doi:10.1136/bjsports-2015-095820

[4] Buchheit M, Al Haddad H, Simpson BM, Palazzi D, Bourdon PC, Di Salvo V, Mendez-Villanueva A (2014) Monitoring accelerations with GPS in football: time to slow down? Int J Sports Physiol Perform 9 (3):442-445. doi: Doi: 10.1123/ijspp.2013-0187

[5] Colby MJ, Dawson B, Heasman J, Rogalski B, Gabbett TJ (2014) Accelerometer and GPS-derived running loads and injury risk in elite Australian footballers. J Strength Cond Res 28 (8):2244-2252. doi:10.1519/JSC.0000000000000362

[6] Coutts AJ, Kempton T, Sullivan C, Bilsborough J, Cordy J, Rampinini E (2015) Metabolic power and energetic costs of professional Australian Football match-play. J Sci Med Sport 18 (2):219-224. doi: Doi: 10.1016/j.jsams.2014.02.003

[7] Di Salvo V, Baron R, Tschan H, Calderon Montero FJ, Bachl N, Pigozzi F (2007) Performance characteristics according to playing position in elite soccer. Int J Sports Med 28 (3):222-227. doi: Doi: 10.1055/s-2006-924294

[8] Djaoui L, Chamari K, Owen AL, Dellal A (2017) Maximal Sprinting Speed of Elite Soccer Players During Training and Matches. J Strength Cond Res 31 (6):1509-1517. doi:10.1519/JSC.0000000000001642

[9] Ehrmann FE, Duncan CS, Sindhusake D, Franzsen WN, Greene DA (2016) GPS and Injury Prevention in Professional Soccer. J Strength Cond Res 30 (2):360-367. doi:10.1519/JSC.0000000000001093

[10] Ekstrand J, Hagglund M, Walden M (2011a) Epidemiology of muscle injuries in professional football (soccer). The American Journal of Sports Medicine 39 (6):1226-1232. doi:10.1177/0363546510395879

[11] Ekstrand J, Hägglund M, Waldén M (2011b) Injury incidence and injury patterns in professional football: the UEFA injury study. British Journal of Sports Medicine 45 (7):553-558. doi:10.1136/bjsm.2009.060582

[12] Fuller CW, Ekstrand J, Junge A, Andersen TE, Bahr R, Dvorak J, Hagglund M, McCrory P, Meeuwisse WH (2006) Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. Clin J Sport Med 16 (2):97-106. doi:00042752-200603000-00003

[13] Gabbett TJ, Ullah S (2012) Relationship Between Running Loads and Soft-Tissue Injury in Elite Team Sport Athletes. The Journal of Strength & Conditioning Research 26 (4):953-960. doi:10.1519/JSC.0b013e3182302023

[14] Gabbett TJ, Ullah S, Finch CF (2012) Identifying risk factors for contact injury in professional rugby league players – Application of a frailty model for recurrent injury. Journal of Science and Medicine in Sport 15 (6):496-504. doi:https://doi.org/10.1016/j.jsams.2012.03.017

[15] Gaudino P, Iaia FM, Strudwick AJ, Hawkins RD, Alberti G, Atkinson G, Gregson W (2015) Factors influencing perception of effort (session rating of perceived exertion) during elite soccer training. Int J Sports Physiol Perform 10 (7):860-864. doi: Doi: 10.1123/ijspp.2014-0518

[16] Hagglund M, Walden M, Ekstrand J (2005) Injury incidence and distribution in elite football--a prospective study of the Danish and the Swedish top divisions. Scandinavian Journal of Medicine & Science in Sports 15 (1):21-28. doi:10.1111/j.1600-0838.2004.00395.x

[17] Hawkins R, Hulse M, Wilkinson C, Hodson A, Gibson M (2001) The association football medical research programme: an audit of injuries in professional football. British Journal of Sports Medicine 35 (1):43-47. doi:10.1136/bjsm.35.1.43

[18] Impellizzeri F, Sassi A, Rampinin E (2006) Accuracy and reliability of a commercial video-computerized, semi-automatic, soccer match analysis system: preliminary results. In: Hoppeler H, Reilly T, Tsolakidis E, Gfeller L, Cologne K (eds) 11th Annual Conference of the European College of Sport Science. Sportverlag Strauss, Lausanne, Switcher land, pp 319-320

[19] Jennings D, Cormack S, Coutts AJ, Boyd LJ, Aughey RJ (2010) Variability of GPS units for measuring distance in team sport movements. Int J Sports Physiol Perform 5 (4):565-569

[20] Knowles S, Marshall S, Guskiewicz K (2006) Issues in estimating risks and rates in sports injury research. Journal of Athletic Training 41 (2):207-215

[21] Lee JW-Y, Mok K-M, Chan HC-K, Yung PS-H, Chan K-M (2014) A prospective epidemiological study of injury incidence and injury patterns in a Hong Kong male professional football league during the competitive season. Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology 1 (4):119-125. doi:10.1016/j.asmart.2014.08.002

[22] Maddison R, Ni Mhurchu C (2009) Global positioning system: a new opportunity in physical activity measurement. Int J Behav Nutr Phys Act 6:73. doi: Doi: 10.1186/1479-5868-6-73

[23] Mallo J, Gonzalez P, Veiga S, Navarro E (2011) Injury incidence in a spanish sub-elite professional football team: a prospective study during four consecutive seasons. Journal of Sports Science and Medicine 10 (4):731-736

[24] Malone S, Owen A, Mendes B, Hughes B, Collins K, Gabbett TJ (2018) High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk? Journal of Science and Medicine in Sport 21 (3):257-262. doi:https://doi.org/10.1016/j.jsams.2017.05.016

[25] Malone S, Owen A, Newton M, Mendes B, Collins KD, Gabbett TJ (2017) The acute:chonic workload ratio in relation to injury risk in professional soccer. Journal of Science and Medicine in Sport 20 (6):561-565. doi:https://doi.org/10.1016/j.jsams.2016.10.014

[26] Nielsen A, Yde J (1989) Epidemiology and traumatology of injuries in soccer. The American Journal of Sports Medicine 17 (6):803-807. doi:10.1177/036354658901700614

[27] Nilsson T, Östenberg AH, Alricsson M (2016) Injury profile among elite male youth soccer players in a Swedish first league. Journal of Exercise Rehabilitation 12 (2):83-89. doi:10.12965/jer.1632548.274

[28] Noya Salces J, Gomez-Carmona P, Gracia-Marco L, Moliner-Urdiales D, Sillero-Quintana M (2014) Epidemiology of injuries in First Division Spanish football. Journal of Sports Sciences 32 (13):1263-1270. doi:10.1080/02640414.2014.884720

[29] Osgnach C, Poser S, Bernardini R, Rinaldo R, di Prampero PE (2010) Energy cost and metabolic power in elite soccer: a new match analysis approach. Med Sci Sports Exerc 42 (1):170-178. doi: Doi: 10.1249/MSS.0b013e3181ae5cfd

[30] Owen AL, Forsyth JJ, Wong DP, Dellal A, Connelly SP, Chamari K (2015) Heart Rate–Based Training Intensity and Its Impact on Injury Incidence Among Elite-Level Professional Soccer Players. The Journal of Strength & Conditioning Research 29 (6):1705-1712. doi:10.1519/jsc.0000000000000810

[31] Piggott B, Newton M, McGuigan M (2009) The relationship between training load and incidence of injury and illness over a pre-season at an Australian Football League Club. ECU Publications 17 (3):4-17

[32] Reis GF, Santos TRT, Lasmar RCP, Oliveira Júnior O, Lopes RFF, Fonseca ST (2015) Sports injuries profile of a first division Brazilian soccer team: a descriptive cohort study. Brazilian Journal of Physical Therapy 19:390-397

[33] Smpokos-Sbokos E, Mourikis C, Theos C, Linardakis M (2018) Injury prevalence and risk factors in a Greek team's professional football (soccer) players: a three consecutive seasons survey. Research in Sports Medicine:1-13. doi:10.1080/15438627.2018.1553779

[34] Smpokos E, Mourikis C, Linardakis M (2018) Differences in motor activities of Greek professional football players who play most of the season (2016/17). Journal of Physical Education and Sport art70 (18 (suppl 1)):490-496. doi:10.7752/jpes.201

[35] Stubbe J, van Beijsterveldt A, van der Knaap S, Stege J, Verhagen E, van Mechelen W, Backx F (2015) Injuries in professional male soccer players in the Netherlands: a prospective cohort study. Journal of Athletic Training 50 (2):211-216. doi:10.4085/1062-6050-49.3.64

[36] Walden M, Hagglund M, Ekstrand J (2005) UEFA Champions League study: a prospective study of injuries in professional football during the 2001-2002 season. British Journal of Sports Medicine 39 (8):542-546. doi:10.1136/bjsm.2004.014571