



ORIGINAL ARTICLE

Muscle injuries in the academy of a Spanish professional football club: A one-year prospective study



Javier Raya-González^{a,*}, Luis Suarez-Arrones^b, Jon Larruskain^c,
Eduardo Sáez de Villarreal^b

^a *Facultad de Ciencias de la Salud, Universidad Isabel I, Burgos, Spain*

^b *Facultad del Deporte, Universidad Pablo de Olavide, Sevilla, Spain*

^c *Departamento de Genética, Antropología Física y Fisiología Animal, Facultad de Ciencia y Tecnología, Universidad del País Vasco (UPV/EHU), Leioa, Spain*

Received 22 November 2017; accepted 27 December 2017

Available online 3 February 2018

KEYWORDS

Epidemiology;
Hamstring;
Adductors

Abstract

Introduction: Due to its high incidence, muscle injury is one of the major problems for football players. The aim was to analyse the rate and characteristics of muscle injuries in the academy of a Spanish professional football team (Spanish First Division) during a complete competitive season (2015–2016) using a prospective cohort design.

Material and methods: Time-loss injuries and exposure time were recorded following the UEFA consensus in 139 elite young football players from 4 levels (Senior, U19, U16 and U14) over one season.

Results: A total of 118 injuries were recorded. Overall injury incidence was 1.47 muscle injuries/1000 h, with a lower incidence in younger players. Nevertheless, injury burden (days lost/1000 h) was similar between levels. The injuries with the highest incidence and burden were hamstring and adductor injuries in Senior (50 and 58 days respectively), hamstring injuries in U19 and U16 (109 vs 89), and adductor injuries in U14 (175 days). Regarding the severity of injuries, it was observed that moderate injuries were the most common injuries and muscle injuries during competition had a higher incidence towards the end of the matches (75–90').

Conclusions: Muscle injury prevention strategies are necessary in players from all levels and should be adapted to their specific needs, with hamstring and adductor injuries being the main problem in the present study.

© 2018 FC Barcelona. Published by Elsevier España, S.L.U. All rights reserved.

* Corresponding author.

E-mail address: rayagonzalezjavier@gmail.com (J. Raya-González).

PALABRAS CLAVE

Epidemiología;
Isquiosurales;
Aductores

Lesiones musculares en las distintas categorías de un club profesional de fútbol Español: estudio prospectivo de una temporada

Resumen

Introducción: Debido a su elevada incidencia, las lesiones musculares son uno de los principales problemas para los futbolistas a lo largo de su carrera profesional. El objetivo de este estudio fue analizar la incidencia lesional y las características de las lesiones musculares de la cantera de un equipo de fútbol profesional (primera división española) durante una temporada completa (2015–2016).

Material y métodos: Se registraron las lesiones y el tiempo de exposición de 139 jugadores de fútbol de 4 categorías (sénior, U19, U16 y U14) durante una temporada siguiendo los criterios UEFA.

Resultados: Un total de 57 lesiones musculares fueron registradas. La incidencia lesional fue de 1,47 lesiones musculares/1.000h, siendo esta incidencia menor cuanto menor era la categoría. No obstante, las consecuencias en forma de días de baja/1.000h fueron similares entre categorías. Las lesiones más comunes y las que produjeron el mayor número de días de baja fueron las de isquiosurales y aductores en los sénior (50 y 58 días, respectivamente), las de isquiosurales en U19 y U16 (109 vs. 89 días), y las de aductores en U14 (175 días). Además, las lesiones moderadas fueron las más comunes y las lesiones musculares producidas en competición tuvieron una mayor incidencia hacia la fase final de los partidos (75-90 min).

Conclusiones: Las estrategias preventivas de lesiones musculares son necesarias en futbolistas de todas las categorías y deben ser adaptadas a sus necesidades específicas, siendo las lesiones de isquiosurales y aductores el mayor problema para los jugadores del presente estudio.

© 2018 FC Barcelona. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

Introduction

Injuries are now a major cause of concern for football clubs. This is because they have been shown to reduce team performance, have a high economic cost and may lead to long-term health problems.¹ Muscle injuries are one of the main problems faced by footballers throughout their professional career.² They now amount to approximately 54% of the total number of injuries suffered by high level football players,³ although the corresponding percentage for semi-professional players is lower.⁴ This is shown in the results of a recent study, in which it was found that about 15 muscle injuries per season could be expected in a club with 25 players.² It also has to be taken into account that these injuries are not uniformly distributed among the 4 main muscle groups² (ischio-crural, quadriceps, adductor and calf muscles), as most injuries occur to the ischio-crural and adductor muscles, so that this notably hinders the task of preventing muscle injuries.

Due to the significant differences between the incidence of injuries in players at different levels,⁵ it is advisable to commence the process of preventing injuries on the basis of an epidemiological analysis of the category in question.⁶ This is why many previous studies have been conducted in recent years, the majority of which cover high level international players.^{1,2,5} Nevertheless, there are few studies of Spanish team epidemiology.^{3,4} Noya et al.³ studied the incidence of injuries in 16 Spanish first division clubs, showing that muscle injuries account for 53.8% of all the injuries suffered by these players in a year. On the other hand, Mallo et al.⁴ studied the specific epidemiology of Spanish semi-professional

players. The results showed that the most common muscle injuries are to the ischio-crural muscles (1.0 injury/1000h exposure). In spite of the valuable information supplied by these previous studies, there is very little information on the incidence of injuries among young players.⁷⁻⁹ The work by Price et al.⁹ stands out, in which the injury rate in the young players of 38 professional English clubs was studied over two complete years. During this time muscle injuries were the most common (39%), and as was the case with the results of previous studies with senior footballers,³⁻⁵ the ischio-crural muscles suffered the highest percentage of injuries.

Although the epidemiology of injuries has been studied in depth in footballers at different levels, the authors believe that to date the incidence of muscle injuries in the young players of a professional club in Spain has not been studied. As there are a great many young players in Spain, it would be important to learn the epidemiological characteristics of the young players in a Spanish football team to optimise preventive strategies and reduce the incidence of injuries in this population. This study therefore analyses the rate of muscle injuries and their characteristics in a professional football team during a whole season.

Methods

Participants

139 young players in a professional football club took part in this study. More specifically, they belonged to 7 different teams which were grouped into categories (senior, U19,

U16 and U14). There were 14 goalkeepers in the sample, together with 28 centre backs, 27 left and right backs, 28 centre midfield players, 27 wide midfield players and 15 forwards.

Before starting the study the participants were informed about the protocol that would be followed, and their informed consent forms were filled in by their parents in the case of minors. The older participants signed their own informed consent documents. Procedures were followed according to the ethical standards recommended by the Helsinki Declaration (2013). All of the participants were free to abandon the study at any time and without any penalty.

Procedures and definitions

A prospective study was undertaken of cohorts of the young players in a professional football team (in the first division, Spain) throughout the 2015–2016 season. During the study the coach of each team was in charge of recording the data on injuries in their team during training as well as matches. All data were supervised by the club coaches coordinator. Muscle injuries were recorded using a standardised and computerised questionnaire based on the UEFA criteria for epidemiological studies.¹⁰ This recorded information on the date an injury occurred and when the player recovered, together with the type, location and severity of the injury and the number of days the player was on sick leave, the injury mechanism and diagnosis, and whether it occurred during training or while competing. Injury was defined as follows: "an injury that occurs during a training session or match and which causes the player to be out of the next training session or match".¹⁰ Footballers were considered to be fully recovered from an injury after a session when the medical staff stated that they were ready to fully take part in the next training session or match. A relapse was defined as an injury that occurred after an initial one of the same type and location.¹⁰ Injuries were classified according to severity as light (1–3 absence days), slight (4–7 days), moderate (8–28 days) and severe (>28 days). Types of muscle injury were divided according to the damaged muscle group, based on the 4 groups that suffer the highest rate of football injuries (ischiocrural, quadriceps, adductors and calf).² Exposure time during training and matches (friendly and competitive) was recorded every day in minutes.

Statistical analysis

Injury incidence is shown as the number of injuries/1000 h, with a confidence interval (CI) of 95%, and the number of absence days/1000 h was calculated with a 95% CI.¹¹ The incidence of injuries and the number of absence days/1000 h were compared for the different categories by calculating the incidence ratio (IR) with a 95% CI, and using the Z-test.¹² The differences between the categories respecting player characteristics and exposure time were calculated using Student's *t*-test. The level of significance was set at $P < .05$, and statistical analysis was performed using Microsoft Excel 2011 software (Microsoft, Redmond, WA, USA) and GraphPad Prism v.6.0c (GraphPad Software, La Jolla, CA, USA).

Results

Exposure time and injury incidence

Participants' anthropometric data and exposure time are shown in Table 1. There were no significant differences between the categories in terms of exposure time. Table 2 shows the number of muscle injuries and the incidence of injuries in the different muscle groups. A total of 57 muscle injuries were recorded in this study, with a total incidence of muscle injuries of 1.47 muscle injuries/1000 h (0.89/1000 h training vs 6.47/1000 h competition). The incidence and number of muscle injuries varied depending on category, with a lower incidence in the younger categories. Ischiocrural injuries were the most common in the senior, U19 and U16 categories, while adductor injuries were the most common in the U14 category, and they were as common as ischiocrural injuries in the senior category. Only 2 relapses were recorded during the whole study, amounting to 3.5% (2/57) of the total number of muscle injuries. Additionally, injuries caused by overuse were more common (52/57) than those in which the cause of injury was traumatic (5/57).

Severity and absence days

The number of absence days during the season and the severity of injuries in the different player categories are shown in Table 3. The muscle injuries recorded in this study led to a total of 759 absence days, and on average each injury resulted in players taking 13 ± 11 absence days (median = 11, range = 1–53 days). More specifically, the injuries that led to the most absence days in the senior players were those to the ischiocrural and adductor muscles, the ischiocrural muscles in the U19 and U16 and the adductors in the U14 group. In terms of severity moderate injuries were the most common (32/57) and severe ones were the least common (5/57). Table 3 shows how absence days/1000 h varies significantly depending on player category and muscle group.

Injury distribution

The 57 injuries recorded throughout the season were distributed in the following way: 13 in the pre-season, 21 in the first half of the season and 23 during the second half of the season. Fig. 1 shows the muscle injury distribution data according to player position and category. On the other hand, Fig. 2 shows the moment in matches when injuries occurred, and the highest number of injuries selected for this study (11/26) occurred during the final part of matches (75–90'). In fact, the incidence of injuries during the last 15 minutes of matches (16.43/1000 h) was more than 3 times higher than the incidence in the rest of the match (4.48/1000 h, IR = 3.67, 95% CI 1.68–7.98).

Discussion

The main novelty of this study is that it analyses the incidence of muscle injuries and their characteristics in the young players of a professional football team during a complete season, comparing them with the injuries suffered

Table 1 Participant data, average \pm SD.

	Senior	U19	U16	U14
<i>Number of players</i>	22	40	39	39
<i>Age (years)</i>	21.7 \pm 1.8	17.5 \pm 1.1	14.4 \pm 1.9	12.77 \pm 1.5
<i>Height (cm)</i>	181.7 \pm 0.1	177.2 \pm 6.1	172.5 \pm 3.9	165.9 \pm 4.1
<i>Weight (kg)</i>	78.2 \pm 6.3	70.1 \pm 5.8	61.2 \pm 5.5	49.3 \pm 3.7
<i>Body mass index (kg/m²)</i>	22.1 \pm 1.8	22.3 \pm 2.1	20.6 \pm 1.7	17.9 \pm 1.5
<i>Exposure time</i>				
Total hours	8033	12 738	9372	8766
Training hours	7290	11 620	8250	7809
Match hours	743	1118	1122	957
Total hours per player	382 \pm 42	318 \pm 35	240 \pm 26	225 \pm 25
Training hours per player	347 \pm 31	289 \pm 26	211 \pm 19	200 \pm 18
Match hours per player	35 \pm 13	28 \pm 10	29 \pm 10	25 \pm 9

Table 2 The incidence of muscle injuries in the different categories of a professional football club.

Injuries	Total			Training			Competition		
	Number	Incidence/ 1000 h	95% CI	Number	Incidence/ 1000 h	95% CI	Number	Incidence/ 1000 h	95% CI
<i>Muscle injuries</i>									
Senior	19	2.36 ^b	1.51–3.71	11	1.51 ^a	0.84–2.72	8	10.77	5.39–21.54
U19	18	1.41	0.89–2.24	12	1.04	0.59–1.83	6	5.05	2.27–11.24
U16	12	1.28	0.73–2.25	4	0.48	0.18–1.29	8	7.13	3.57–14.26
U14	8	0.91	0.46–1.82	4	0.51	0.19–1.37	4	4.14	1.55–11.04
<i>Ischiocrural</i>									
Senior	6 (32)	0.75	0.34–1.66	2 (18)	0.27	0.07–1.10	4 (50)	5.39	2.02–14.35
U19	8 (44)	0.63	0.31–1.26	4 (33)	0.35	0.13–0.92	4 (67)	3.37	1.26–8.97
U16	5 (42)	0.53	0.22–1.28	3 (75)	0.36	0.12–1.13	2 (25)	1.78	0.45–7.13
U14	–	–	–	–	–	–	–	–	–
<i>Quadriceps</i>									
Senior	1 (5)	0.13	0.02–0.88	1 (9)	0.14	0.02–0.97	–	–	–
U19	2 (11)	0.09	0.12–5.98	1 (8)	0.09	0.01–0.61	1 (17)	0.84	0.12–5.98
U16	2 (17)	0.21	0.05–0.85	–	–	–	2 (25)	1.78	0.45–7.13
U14	1 (13)	0.12	0.02–0.81	1 (25)	0.13	0.02–0.91	–	–	–
<i>Adductor</i>									
Senior	6 (32)	0.75	0.34–1.66	3 (27)	0.41	0.13–1.28	3 (38)	4.04	1.30–12.53
U19	2 (11)	0.16	0.04–0.63	2 (17)	0.17	0.04–0.69	–	–	–
U16	1 (8)	0.11	0.02–0.76	–	–	–	1 (13)	0.89	0.13–6.33
U14	5 (63)	0.57	0.24–1.37	2 (50)	0.26	0.06–1.03	3 (75)	3.11	1.00–9.63
<i>Calf</i>									
Senior	4 (21)	0.50	0.19–1.33	3 (27)	0.41	0.13–1.28	1 (13)	1.35	0.19–9.56
U19	3 (17)	0.24	0.08–0.73	3 (25)	0.26	0.08–0.81	–	–	–
U16	1 (8)	0.11	0.02–0.76	1 (25)	0.12	0.02–0.86	–	–	–
U14	–	–	–	–	–	–	–	–	–

CI: confidence interval; $P < .05$.^a Ratio significantly higher than it is for U16.^b Ratio significantly higher than it is for U14.

by the corresponding senior team. The results obtained show that the younger footballers suffered a lower rate of injuries, although their consequences (absence days/1000 h) were similar in all of the categories. These results also show that the most common injuries and the ones which led to

the largest number of absence days were to the ischiocrural muscles and adductors in the senior players, the ischiocrural muscles in the U19 and U16 categories, and the adductors in the U14 category. The majority of injuries occurred in the final 15 min of matches.

Table 3 Absence days due to injuries according to location and type, in the different categories of a professional football club.

Injuries	Total absence days	Absence days/1000 h	Median absence days per injury (range)	Severity (number of injuries)			
				Light (1–3 days)	Slight (4–7 days)	Moderate (8–28 days)	Severe (>28 days)
<i>Muscle injuries</i>							
Senior	170	21	8 (1–19)	5	3	11	–
U19	236	19	14 (3–40)	3	4	10	1
U16	162	17 ^d	9 (2–31)	2	3	5	2
U14	191	22	16 (12–53)	–	–	6	2
<i>Ischiocrural</i>							
Senior	50	6	8 (3–17)	1	2	3	–
U19	109	9	12 (3–40)	2	1	4	1
U16	89	10 ^a	10 (2–39)	1	1	1	2
U14	0	0	0	–	–	–	–
<i>Quadriceps</i>							
Senior	8	1	8	–	–	1	–
U19	20	2	10 (5–15)	–	1	1	–
U16	18	2	9 (7–11)	–	1	1	–
U14	16	2	16	–	–	1	–
<i>Adductor</i>							
Senior	58	7 ^b	11 (1–18)	2	–	4	–
U19	34	3 ^{c,d}	17 (13–21)	–	–	2	–
U16	2	0.2 ^a	2	1	–	–	–
U14	175	11 ^{a,b}	14 (12–47)	–	–	4	1
<i>Calf</i>							
Senior	36	4 ^c	7 (2–19)	1	1	2	–
U19	49	4 ^c	19 (17–20)	–	–	3	–
U16	8	1	8	–	–	1	–
U14	0	0	0	–	–	–	–

^a Ratio significantly higher/lower than it is for senior ($P < .05$).

^b Ratio significantly higher/lower than it is for U19 ($P < .05$).

^c Ratio significantly higher/lower than it is for U16 ($P < .05$).

^d Ratio significantly higher/lower than it is for U14 ($P < .05$).

The total injury rate in young elite players in our study (1.47 muscle injuries/1000h) was lower than the rate detected in national and international professional footballers.² The results for injuries during training were lower (0.89 muscle injuries/1000h vs 1.38 muscle injuries/1000h²), than they were for competition (6.47 injuries/1000h vs 9.58 injuries/1000h).² These differences may be influenced by the large number of games which professional players at UEFA level have to play in a short period of time.¹³ When the results of our study are analysed according to category, the number of muscle injuries and the total incidence of injuries were found to be lower in the younger categories. These findings may be due to the influence of age as an intrinsic risk factor that mainly affects muscle injuries.¹⁴ This was shown previously in the study by Price et al.,⁹ which also covered elite young players.

Although the injury rate is higher in older players, the number of absence days/1000h was similar in the different categories. It therefore seems that the younger players suffer more severe injuries, or ones that require more time to recover. This may be due to the possibility that,

even though they are young players in a professional club, the human and material resources used in preventing and recovering from injuries are insufficient. It is interesting to examine the fact that the highest number of absence days/1000h occurred in the U14 category. This may be explained by their lack of strength, as they have yet to adapt to the demands of competition.¹⁵ This leads to more severe injuries, as strength-increasing preventive programmes have been shown to not only reduce the injury rate, but also have the secondary aim of reducing the severity of muscle injuries.¹⁶ Strategies to prevent muscle injuries are therefore necessary in all categories, and it is recommendable to spend more time and resources on injury prevention and recovery for younger footballers.

Regarding the distribution of muscle injuries in the different categories, as was the case in previous studies^{2–4,9} the ischiocrural muscles suffered the highest number of injuries. Nevertheless, the U14 footballers suffered no injury of this type. In this study the absence of ischiocrural muscle injuries seems to be justified by the fact that at these ages footballers do not run at high speeds in training or when

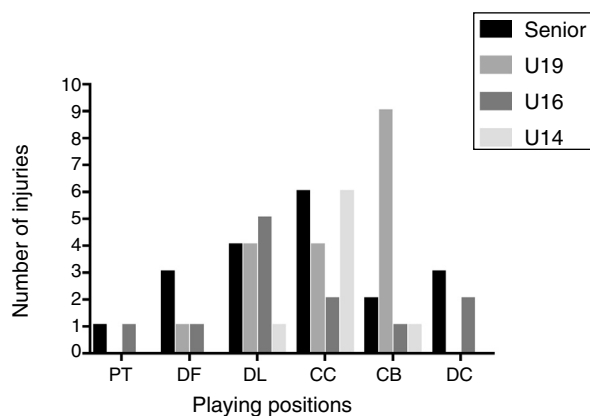


Figure 1 Distribution of muscle injuries according to player position and category (PT: goalkeeper, DF: centre back, DL: right or left back, CC: midfielder, CB: midfielder, DC: forward).

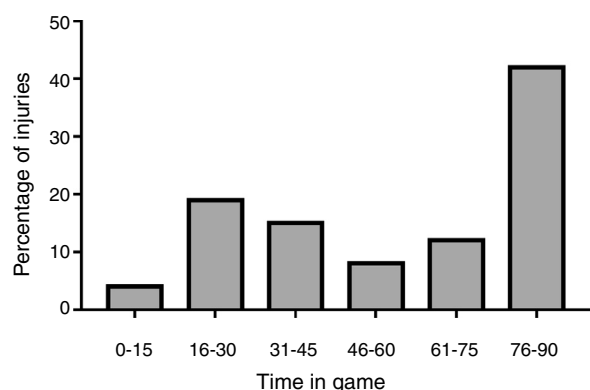


Figure 2 Distribution of muscle injuries in match playing time.

competing.^{17,18} On the other hand, 63% of the muscle injuries in this category involved the adductors. This may be due to the fact that these footballers had not yet adapted to the intrinsic demands of football, as they had been training and competing in 7 a-side Football until the year before.¹⁵

Nevertheless, to select suitable preventive strategies for footballers in different categories it is not enough to analyse the incidence and distribution of injuries. The consequences must also be considered, in terms of absence days/1000 h, as this variable combines the frequency and severity of injuries.¹¹ Injuries to the ischiocrural and adductor muscles caused the highest number of absence days in the senior category, while in the U19 and U16 categories the majority of absence days were due to ischiocrural injuries. However, in the U14 category adductor injuries caused the highest number of absence days. It can be seen from this analysis that quadriceps and calf muscle injuries seem to be a lesser problem for the footballers who took part in this study. Moreover, it is interesting to learn that analysis of muscle injury severity revealed a similar pattern to those obtained in other studies of the young players in professional teams,⁹ where moderate injuries were the most common.

There is broad evidence that having had a previous injury is the most important risk factor in football.⁵ For example, this multiplies by 11 times the risk of suffering an

ischiocrural injury,^{19,20} and multiplies by 7 times the possibility of suffering an adductor muscle injury,^{19,21} these two groups of muscles being the ones that suffer the highest number of relapses in football.^{5,22-24} There were only two relapses in our study, affecting the ischiocrural and calf muscles. The percentage of relapses in young elite players was lower (3.5%) than it was in national⁵ and international⁵ level professional footballers, at 24.4% and 16.4%, respectively. These results may be influenced by the pressure in elite clubs on medical departments to achieve the rapid return of injured players to routine team training, leading to insufficient physical and sports adaptation.

Although no significant differences were found between the muscle injuries suffered by players in different positions, it is important to underline that these muscle injuries were not distributed uniformly among the different specific positions and categories. This information may be a great help for trainers and sports directors when forming teams. As was found in previous epidemiological studies,^{9,18} the majority of injuries occur during the final part of matches (75–90') due to the fatigue suffered by footballers at this time.

The chief limitation of this study is that it analyses teams belonging to a single football club, so that it is possible that the results cannot be extrapolated to other clubs. Given the high injury rate and the large number of absence days in young footballers, studies are needed that include multiple professional club academies and last for several seasons. This evidence would make it possible to optimise injury prevention programmes, promoting the healthy practice of football among young players and increasing their possibilities of becoming professional footballers.

Conclusions

The main findings of this study were that although younger footballers suffer fewer injuries, the number of absence days/1000 h was similar in the different categories. The most common injuries and the ones that led to the highest number of absence days in the senior category were to the ischiocrural and adductor muscles. This was so for ischiocrural injuries in the U19 and U16 categories, and the adductor muscles in the U14 category, while the majority of injuries occurred in the final 15 min of matches. This information may be very useful for trainers and medical staff for the development of effective prevention strategies to reduce the incidence and severity of muscle injuries in young Spanish elite footballers.

Conflict of interests

The authors have no conflict of interests to declare.

References

- Ekstrand J. Keeping your top players on the pitch: the key to football medicine at a professional level. *Br J Sports Med.* 2013;47:723–4. <http://dx.doi.org/10.1136/bjsports-2013-092771>.
- Ekstrand J, Häggglund M, Waldén M. Epidemiology of muscle injuries in professional football (Soccer). *Am J*

- Sports Med. 2011;39:1226–32, <http://dx.doi.org/10.1177/0363546510395879>.
3. Noya J, Gómez-Carmona PM, Gracia-Marco L, Moliner-Urdiales D, Sillero-Quintana M. Epidemiology of injuries in First Division Spanish football. *J Sports Sci.* 2014;32:1263–70, <http://dx.doi.org/10.1080/02640414.2014.884720>.
 4. Mallo J, González P, Veiga S, Navarro E. Injury incidence in a Spanish sub-elite professional football team: a prospective study during four consecutive seasons. *J Sports Sci Med.* 2011;10:731–6.
 5. Hägglund M, Waldén M, Ekstrand J. Injury recurrence is lower at the highest professional football level than at national and amateur levels: does sports medicine and sports physiotherapy deliver? *Br J Sports Med.* 2016;50:751–8, <http://dx.doi.org/10.1136/bjsports-2015-095951>.
 6. van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Med.* 1992;14:82–99. <http://www.ncbi.nlm.nih.gov/pubmed/1509229> [accessed 27.09.17].
 7. McCarroll JR, Meaney C, Sieber JM. Profile of youth Soccer injuries. *Phys Sportsmed.* 1984;12:113–7, <http://dx.doi.org/10.1080/00913847.1984.11701775>.
 8. Nilsson S, Roaas A. Soccer injuries in adolescents. *Am J Sports Med.* 1978;6:358–61, <http://dx.doi.org/10.1177/036354657800600608>.
 9. Price RJ, Hawkins RD, Hulse MA, Hodson A. The Football Association medical research programme: an audit of injuries in academy youth football. *Br J Sports Med.* 2004;38:466–71, <http://dx.doi.org/10.1136/bjism.2003.005165>.
 10. Hägglund M, Waldén M, Bahr R, Ekstrand J. Methods for epidemiological study of injuries to professional football players: developing the UEFA model. *Br J Sports Med.* 2005;39:340–6, <http://dx.doi.org/10.1136/bjism.2005.018267>.
 11. Bahr R, Clarsen B, Ekstrand J. Why we should focus on the burden of injuries and illnesses, not just their incidence. *Br J Sports Med.* 2017, <http://dx.doi.org/10.1136/bjsports-2017-098160>.
 12. Kirkwood B, Sterne J. In: Malmgren M, editor. *Essential medical statistics*, 2nd ed. Blackwell Science; 2003. http://www.blackwellpublishing.com/essentialmedstats/further_reading.htm [accessed 07.10.17].
 13. Bengtsson H, Ekstrand J, Hägglund M. Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med.* 2013;47:743–7, <http://dx.doi.org/10.1136/bjsports-2013-830923>.
 14. Yeung SS, Suen AMY, Yeung EW. A prospective cohort study of hamstring injuries in competitive sprinters: preseason muscle imbalance as a possible risk factor. *Br J Sports Med.* 2009;43:589–94, <http://dx.doi.org/10.1136/bjism.2008.056283>.
 15. Sanchez-Sanchez J, Sanchez M, Hernandez D, Ramirez-Campillo R, Martinez C, Nakamura FY. Fatigue in U12 Soccer-7 players during repeated one-day tournament games – a pilot study. *J Strength Cond Res.* 2017;1, <http://dx.doi.org/10.1519/JSC.0000000000002141>.
 16. Owen AL, Wong DP, Dellal A, Paul DJ, Orhant E, Collie S. Effect of an injury prevention program on muscle injuries in elite professional Soccer. *J Strength Cond Res.* 2013;27:3275–85, <http://dx.doi.org/10.1519/JSC.0b013e318290cb3a>.
 17. Abade EA, Gonçalves BV, Leite NM, Sampaio JE. Time-motion and physiological profile of football training sessions performed by Under-15 Under-17, and Under-19 Elite Portuguese players. *Int J Sports Physiol Perform.* 2014;9:463–70, <http://dx.doi.org/10.1123/ijspp.2013-0120>.
 18. Woods C, Hawkins RD, Maltby S, Hulse M, Thomas A, Hodson A, et al. The Football Association Medical Research Programme: an audit of injuries in professional football – analysis of hamstring injuries. *Br J Sports Med.* 2004;38:36–41.
 19. Hägglund M, Waldén M, Ekstrand J. Risk factors for lower extremity muscle injury in professional Soccer. *Am J Sports Med.* 2013;41:327–35, <http://dx.doi.org/10.1177/0363546512470634>.
 20. Opar DA, Williams MD, Shield AJ. Hamstring strain injuries. *Sport Med.* 2012;42:209–26, <http://dx.doi.org/10.2165/11594800-000000000-00000>.
 21. Hölmich P, Thorborg K, Dehlendorff C, Krogsgaard K, Gluud C. Incidence and clinical presentation of groin injuries in sub-elite male soccer. *Br J Sports Med.* 2014;48:1245–50, <http://dx.doi.org/10.1136/bjsports-2013-092627>.
 22. Cross KM, Gurka KK, Saliba S, Conaway M, Hertel J. Comparison of hamstring strain injury rates between male and female intercollegiate Soccer athletes. *Am J Sports Med.* 2013;41:742–8, <http://dx.doi.org/10.1177/0363546513475342>.
 23. Petersen J, Thorborg K, Nielsen MB, Hölmich P. Acute hamstring injuries in Danish elite football: a 12-month prospective registration study among 374 players. *Scand J Med Sci Sports.* 2010;20:588–92, <http://dx.doi.org/10.1111/j.1600-0838.2009.00995.x>.
 24. Hägglund M, Waldén M, Ekstrand J. Lower reinjury rate with a coach-controlled rehabilitation program in amateur male soccer: a randomized controlled trial. *Am J Sports Med.* 2007;35:1433–42, <http://dx.doi.org/10.1177/0363546507300063>.