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Analysis of sports injuries in academy integrated u-16 and u-18 football players
Análisis de las lesiones deportivas en jugadores de fútbol sub-16 y sub-18 integrados en academia

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Abstract. The problematic of analysis and the possible causes of injuries in football continues to be a topic of extreme relevance. In this sense, the aim of this study was to analyze the injuries of U-16 and U-18 soccer players, according to the category and game position. In this ex post facto study (Quasi-experimental methodology) 111 players participated, belonging to the U-16A (n=25), U-16B (n=24), U-18A (n=20), U-18B (n=22), and U-18C (n=20), youth teams of a professional soccer team in the First Division of the Spanish Soccer League. Were considered as independent variables the number of injuries, the body part of the injury, affected tissue, affected side, type of incidence, and occurrence of the injury. To measure the incidence of injuries, official medical reports were considered, by an observer previously trained in recording data. A descriptive analysis of the dependent variables was carried out. To analyze the relationship between variables, Chi-square, Cramer's Phi Coefficient, and Corrected Standardized Residuals were used. The sample distribution was analyzed (Kolmogorov-Smirnov). As the sample presented a non-normal distribution, the Mann-Whitney and Kruskal Wallis test were used (SPSS software). The results show the U-18A ($\bar{X}$=2.55 injuries/player), obtaining significant differences with the rest of the age-categories (exception U-18C). The category does not influence the body part of the injury, the affected side and affected tissue, the type of incidence, and the occurrence of injury. The context influences the body part of injury (p=0.000). On the contrary, there are no significant differences between the affected side, the affected tissue, and the type of incidence.
Keywords: Injury; category; affected tissue; body part; game position

Resumen. La problemática del análisis y las posibles causas de las lesiones en el fútbol continúa siendo un tema de extrema relevancia. En este sentido, el objetivo de este estudio fue analizar las lesiones de jugadores de fútbol sub-16 y sub-18, según la categoría y posición de juego. En este estudio ex post facto (metodología Cuasi-experimental) participaron 111 jugadores pertenecientes a los equipos Sub-16A (n=25), Sub-16B (n=24), Sub-18A (n=20), Sub-18B (n=22), y Sub-18C (n=20), juveniles de un equipo de fútbol profesional de la Primera División de la Liga Española de Fútbol. Se consideraron como variables independientes el número de lesiones, la parte del cuerpo de la lesión, el tejido afectado, el lado afectado, el tipo de incidencia y la ocurrencia de la lesión. Para medir la incidencia de lesiones se consideraron los informes médicos oficiales, realizados por un observador previamente entrenado en el registro de datos. Se realizó un análisis descriptivo de las variables dependientes. Para analizar la relación entre las variables, se utilizaron el Chi-cuadrado, el coeficiente Phi de Cramer y los residuos tipificados corregidos. Se analizó la distribución de la muestra (Kolmogorov-Smirnov). Como la muestra presentaba una distribución no normal, se utilizaron las pruebas U de Mann-Whitney y H de Kruskal Wallis (software SPSS). Los resultados muestran que la sub-18A ($\bar{X}$=2,55 lesiones/jugador), obtiene diferencias significativas con el resto de las categorías de edad (excepción sub-18C). La categoría no influye en la parte del cuerpo de la lesión, el lado y el tejido afectado, tipo de incidencia y ocurrencia de la lesión. El contexto influye en la parte del cuerpo de la lesión (p=0,000). Por el contrario, no hay diferencias significativas entre el lado afectado, el tejido afectado y el tipo de incidencia.
Palabras clave: Lesión, categoría, tejido afectado, parte corporal, posición de juego

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Introduction

Currently, injuries are one of the main causes of concern for soccer clubs (Raya-González et al., 2018). Elite football clubs around the world have training structures for developing talented young players. Therefore, the goal of soccer academies is to prepare selected athletes for training and competitions organized for senior soccer (Jones et al., 2019). In addition, they are players who enter the academies at an early age and complete each sport season for around 9 months per year, with a predetermined number of matches to be fulfilled (Ward et al., 2007). Therefore, high-intensity activities carried out during soccer training and matches expose players to potential injuries (Tierney et al., 2016; Jones et al., 2019). In football, given the popularity of the sport, the large number of players, and the levels of competition, injuries are frequent (Ekstrand et al., 2011). Overall, the incidence of injuries in professional football players is 8.1 injuries/1.000 h of exposure for male players (López-Valenciano et al., 2020). However, the participation in a physically demanding sport such as soccer during youth also entails a high risk of injury compared to other individual and team sports (Robles-Palazón et al., 2022).

Another study indicates that the incidence is 12.5/1.000 h of exposure (Szymski et al., 2022). and previous findings highlight that half of all these injuries are classified as severe, keeping footballers off the pitch for more

than four weeks (Hennig, 2011). Additionally, it was found that the incidence of injuries is higher in matches compared to training sessions, and lower extremity injuries have the highest incidence rates (López-Valenciano et al., 2020). Also, the most time-loss injuries in professional football players led to an absence of up to four weeks (Ekstrand et al., 2020). These are mainly associated with sliding tackles, runs, shots on goal, turning movements, jumps, or subsequent falls (Wong & Hong, 2005), and the lower extremities being the most frequent location, with approximately 70% of all the injuries caused by the practice of football (Butler et al., 2014). With such numbers, football-related injuries may have a major negative impact on physical, mental, and financial burden on the players and their clubs. Therefore, understanding how injuries occur is essential to develop meaningful preventive strategies (O'Brien et al., 2019; Materne et al., 2021). Due to the influence of injuries on individual and overall team performance, individualized training programmes should be carried out to carry out injury prevention work (Gamonales et al., 2024).

Injury severity is commonly calculated as the number of days elapsed from the day of injury until the day the player returns to full training and/or is available for match selection (Bahr et al., 2020), often presented as the proportion of injuries falling within defined bins (e.g., percentage of all injuries lasting 7–28 days). Although cut-offs vary slightly between studies and the choice of injury definition affects distributions, the combined findings suggest that 38% (7–74%) of injuries in boys last less than a week, another 38% (16–67%) last between a week and a month, while every fifth injury (21%, 2–37%) lasts more than a month (Read et al., 2018). Muscle injuries are one of the main problems that footballers face throughout their professional careers (Ekstrand et al., 2011), accounting for approximately 54% of the total injuries suffered by high-level soccer players (Noya Salces et al., 2014), although the corresponding percentage to semi-professionals is lower (Mallo et al., 2011; Raya-González et al., 2018).

Several studies indicate that rates increase with age (Renshaw et al., 2016; Jaber et al., 2022), although, other studies reported fewer clear patterns or bell-shaped relationships peaking around the under 16 (U-16) groups (Cezarino et al., 2020; Raya-Gonzalez et al., 2020). Additionally, elite soccer players in the U-18 categories show a high risk of injuries associated with the lower extremities (Read et al., 2018), and they should be considered an important group for injury prevention (Schmikli et al. 2011). Evaluating risk factors in the training stages are essential to help identify the risk of injury before it occurs to reduce risk (Read et al., 2018), with matches showing the highest data on injury incidence and injury burden (Faude et al., 2013). Therefore, this study aimed to analyze the injuries of U-16 and U-18 soccer players from the youth academy of a professional team in the first division of the Spanish league according to the category and game position.

Methods

Design

The present study uses an ex post facto Quasi-experimental methodology, since the groups are previously established, and have not been randomly selected, as well as no intervention or modification of the variables that intervene in the context. Also, it is a longitudinal study, since it is carried out during the entire 2017/2018 season, through an associative and comparative strategy.

Sample

The study sample consisted of all the players belonging to the U-16 A ($n = 25$), U-16 B ($n = 24$), U-18 A ($n = 20$), U-18 B ($n = 22$), and U-18 C ($n = 20$), youth teams of a professional soccer team in the First Division of the Spanish Soccer League. The study was developed under the premises of the Declaration of Helsinki (2013), being approved by the Bioethics Committee of the University of Extremadura, number 67/2017.

Variables codification

The variables selected for the study were:

a) Dependent variable: Category (U-16A, U-16B, U-18A, U-18B, U-18C), and Game position (goalkeeper, right back, central, left back, midfielder, winger, and forward).

b) Independent variables: Number of injuries, the body part of injury (head, trunk, upper limb, and lower limb), affected tissue (articular, ligamentous, muscular, bone, tendinopathic, tendon, visceral, and others), affected side (right, left and others), type of incidence (acute and non-acute), and occurrence of the injury (training, competition, and others).

Procedures

To understand the injuries incidence during training sessions or official matches, as well as friendly matches, the official medical reports were considered. For this, an observer previously trained in recording data quantified all the injuries in the soccer players. For this, the team coordinators and coaches were informed of the characteristics of the study, as well as the methods and procedures associated with their participation.

Statistical analysis

Firstly, a descriptive and percentage analysis was conducted about the dependent variables and the playing position. To analyze the relationship between these variables, the *Chi-square* ($\chi 2$) (Newell et al., 2014) was used, assessing the level of association between the variables using *Cramer's Phi Coefficient* (φc) (Crewson, 2006). To evaluate the level of association between the studied variables, the Crammer φc indicator was used, through the proposal of Crewson (2006): *Small* (<0.100), *Low* (0.100-0.299), *Moderate* (0.300-0.499), and *High* (>0.500). On the other hand, for the interpretation of the degree of association of the studied variables, the *Adjusted Standardized Residuals* (ASR) was used

(Field, 2013). Subsequently, the distribution of the sample was analyzed through the normality analysis using the *Kolmogorov-Smirnov test*, since the sample consisted of more than 50 cases (Field, 2013). The results obtained showed that the sample presented a non-normal distribution. Therefore, non-parametric tests (Mann-Whitney U test and Kruskal Wallis H test) were used to identify the existence of differences between the selected independent and dependent variables. For the statistical analysis, the software Statistical Package for the Social Sciences (v27, IBM Corp., Armonk, NY, USA) was used.

Results

Table 1 shows the incidence and occurrence of injuries in soccer players depending on the *category* and *game position*. The ASRs regarding the *body part of injury* and the *affected side* concerning the *game position* are shown in Table 2. The results of the associations between the selected variables (*body part of injury* and *affected side*), and the independent variable (*game position*), are shown in Table 3. It can be verified that there is no significant relationship between the variables. In the same way, Table 4 shows the descriptive and comparative results regarding the number of injury occurrences based on the analyzed age-categories. It is observed how the players integrating the U-18A age-category (the older of the sample) present an average of 2.55 injuries per player, obtaining significant differences with the rest of the age-categories, except when considering U-18C.

In Table 5 the results show that the *category* does not influence the *body part of injury*, the *affected side* and *affected tissue*, *type of incidence,* and *occurrence of injury*. On the other hand, the descriptive and comparative results are based on the independent variables and the *context* (Table 6). The results show that the *context* influences the *body part of injury* ($p = .000$). Other situations present differences between Training and Competition. On the contrary, there are no significant differences between the *affected side,* the *affected tissue*, and the *type of incidence*.

Table 1.
Incidence of injuries by category and game position.

Variables	Game position							
Category	Goalkeeper	Right back	Central	Left back	Midfielder	Winger	Forward	Total
U-16 A	2	3	2	2	8	1	2	20
U-16 B	-	2	2	-	9	-	3	16
U-18 C	3	16	5	6	19	4	8	61
U-18 B	3	-	4	-	9	-	5	21
U-18 A	-	2	8	1	8	4	6	29

Table 2.
Descriptive results and ASRs of the body part of injury and affected side as a function of game position.

			Position						
			Central	Forward	Right back	Left back	Winger	Midfielder	Goalkeeper
Body part of injury	Head	n	1	2	1	1	0	0	0
		ASR	0.4	1.5	0.3	1.3	-0.6	-1.7	-0.5
	Upper limbs	n	1	3	0	3	1	3	0
		ASR	-0.5	1.0	-1.5	3.0	0.4	-0.6	-0.8
	Trunk	n	2	1	0	0	0	1	0
		ASR	2.1	0.5	-0.9	-0.5	-0.5	-0.5	-0.5
	Lower limbs	n	17	18	22	5	8	49	8
		ASR	-0.8	-1.8	1.4	-2.8	0.2	1.6	1.2
Affected side	Right	n	5	12	13	5	6	28	6
		ASR	-2.7	-0.1	0.6	0.3	1.0	0.3	1.4
	Left	n	13	10	7	3	3	25	2
		ASR	1.9	-0.1	-1.3	-0.6	-0.6	0.8	-1.0
	Other	n	3	2	3	1	0	0	0
		ASR	1.7	0.5	1.5	0.6	-0.8	-2.3	-0.7

n: Sample; ASR: Adjusted standardized residuals.

Table 3.
Association between injury characteristics and playing position.

Injuries characteristics	Playing position					
	χ^2	df	p	φc	p	Effect size
Body part of injury	24.890	18	0.128	0.411	0.128	Moderate
Affected side	17.341	12	0.137	0.343	0.137	Moderate

χ^2: Chi Square; df: Degree of freedom; $p < 0.05$; φc: Phi de Cramer.

Table 4.
Descriptive results and differences regarding the age-category.

Categories	Number of injuries		H	df	p	Post-hoc
	$\bar{X}$	SD				
U-16A	0.91	0.811				U-18A
U-16B	0.68	1.086				U-18A
U-18C	1.32	1.086	23.13	4	0.000	
U-18B	0.95	1.090				U-18A
U-18A	2.55	1.625				U-16B; U-16A; U-18B

H: Kruskal-Wallis H test; df: Degree of freedom; p: significance difference.

Table 5.
Descriptive results and differences considering the different variables and age-categories.

Variable Age-Categories		Body part						Tissue						Side			Type of incidence	
		Head	Trunk	Upper limbs	Lower limbs	Articular	Ligamentous	Muscular	Bone	Tendinopathic	Tendon	Visceral	Others	Right	Left	Others	Acute	Non-acute
U-16A	n	1		1	18	3		11		2	1	1	2	8	10	2	20	
	%	5		5	90	15		55		10	5	5	10	40	50	10	100	
U-16B	n			2	14	5		8	3					9	7		16	
	%			12.5	87.5	31.3		50	18.8					56.3	43.8		100	
U-18C	n	1	3	2	23	9	6	8	4	1			4	13	12	4	29	
	%	3.4	10.3	6.9	79.3	31	20.7	27.6	13.8	3.4			13.8	44.8	41.4	13.8	100	
U-18B	n			1	20	4	1	13		2			1	10	11		21	
	%			4.8	95.2	19	4.8	61.9		9.5			4.8	47.6	52.4		100	
U-18A	%	3	1	5	52	16	2	35	3	2		2	1	35	23	3	60	1
	n	4.9	1.6	8.2	85.2	26.2	3.3	57.4	4.9	3.3		3.3	1.6	57.4	37.7	4.9	98.4	1.6
H			2.632						5.584						3.508		1,41	
gl			4						4						4		4	
p			0.621						0.224						0.477		0.842	

Table 6.
Descriptive results and differences regarding the variables and context.

Variable Context		Body part						Tissue						Side			Type of incidence	
		Head	Trunk	Upper limbs	Lower limbs	Articular	Ligamentous	Muscular	Bone	Tendinopathic	Tendon	Visceral	Others	Right	Left	Others	Acute	Non-acute
Trainig	n	1	2	3	75	15	4	49	5	5	1		2	42	36	3	80	1
	%	1.2	2.5	3.7	92.6	18.5	4.9	60.5	6.2	6.2	1.2		2.5	51.9	44.4	3.7	98.8	1.2
Competition	n	1	2	5	49	19	5	26	5	2			1	31	24	3	58	
	%	1.7	3.4	10.3	84.5	32.8	8.6	44.8	8.6	3.4			1.7	53.4	41.4	5.2	100	
Others	n	3		2	3	3						3	2	2	3	3	8	
	%	37.5		25.0	37.5	37.5						37.5	25	25	37.5	37.5	100	
H				21.449					5.877						5.073		0.815	
gl				2					2						2		2	
p				0.000					0.053						0.079		0.665	
Post-hoc				Others-Competition / Others-Training														

Discussion

The study aimed to analyze the sports injuries of the soccer players of a professional team of the Spanish league based on the *category* (U-16 and U-18), and the *game position* of the players. The descriptive results show that soccer players in the U-18 C (n=61), U-18 B (n=21), and U-18 A (n=29) categories have a higher number of injuries compared to the athletes in the U-16 A (n=20) and U-16 B (n=16). Depending on the *game position*, the players who have the highest number of injuries are the *midfielders* (n=19), and *right-backs* (n=16), of the U-18 C team. Furthermore, there is a greater probability than expected that injuries will occur in athletes who play as a *left back* and in the upper limbs (ASR=3.0). Likewise, we found differences between the analysed age categories (U-16A-U-18A / U-16B-U-18A / U-18B-U-18A / U-18A-U-16B-U-16A-U-18B), because of the contexts (training, competition, and others). Therefore, there are differences between the contexts analyzed, and injuries usually occur in other contexts (others-competition / others-training). In the scientific literature, there is a diversity of documents related to sports injuries (Ekstrand et al., 2020), which have a significant impact on the socioeconomic systems of the teams (Prieto-González et al., 2021). Consequently, socio-ecological studies are required to analyze and determine the specific contexts of injuries in soccer players (Bolling et al., 2018).

The descriptive results show that the U-18 C team was the group with the highest number of sports injuries (n = 61). These injuries mainly occurred in the right back game position (n = 16) and in midfielders (n = 19). The team with the lowest number of sports injuries during the season was U-16 B (n = 16). The scientific literature shows that elite academy players often participate in national and international tournaments. Therefore, sports calendars are condensed, requiring players to play several matches in a few days (usually between 2 and 4 days). In addition, young athletes may be more resistant to fatigue than senior players (Ratel et al., 2006). Therefore, adequate rest periods are recommended to avoid and recover players from the sporting requirements.

Regarding the results of the associations between injured body parts and playing position, it was found that there is a higher probability of injury to the upper limbs of players playing left-back. In the scientific literature, injury trends differ according to the type of injury, with more related injuries observed in younger players and more muscle injuries and joint and ligament sprains in older players (Read et al., 2018; Materne et al., 2021). Therefore, the results obtained in this study differ from those existing in the scientific literature, and we recommend that the implementation of a comprehensive injury prevention program should be considered in these age categories to avoid any type of injury in football players. In addition, it is important to avoid exposing athletes to long hours of training and competition, to this end, it is recommended that players adequately recover between training sessions and matches.

As for the results of the differences depending on the age category, it was shown that the main differences are between U-16A/U-18A, U-16B/U-18A, U-18B/U-18A, and U-18A/U-16B/U-16A/U-16A and U-18B. The U-18A team was the category with the highest differences.

The training of elite and highly specialized youth football players is a key component in ensuring that athletes receive appropriate training programs and the necessary training exposure to develop their skills. However, it must be recognized that early specialization practices have been shown to predispose these individuals to an increased risk of injury (Price et al., 2004; Hall et al., 2020,). It is important for coaches to regularly monitor the progress of young players and adjust their training to ensure a balance in their development (Bargueiras-Martínez et al., 2023). Therefore, care must be taken with training loads associated with growing players.

The results between context (training, competition, and others), and body part of injury showed the existence of differences ($p = .000$), and these are others-competition and others-training. In the scientific literature, there are few papers related to football athletes' injuries in contexts other than training or competition. Furthermore, the age of the athletes themselves is not a significant risk factor for injuries in football players (Hagglund et al., 2013; Mosler et al., 2018). Therefore, all sports contexts should be monitored. In other words, the extra-sport activities performed by soccer players should be monitored and, it is recommended to conduct further related research, and even to analyze players who are in sports residences or own flats where they have more freedom to manage their free time.

One of the main limitations of the study is the small sample size of the study, as only the number of injuries during one sports season were analysed. On the other hand, the strength of this study is that it is one of the first studies to analyze the injuries of football players in a high-level team according to position and the type of injury and tissue affected. As future lines of research, it is recommended to extend the study sample, increasing the number of analysed seasons. In addition, consideration should be given to analyzing different age categories, and the origin of the injury, as well as the motor actions associated.

Conclusions

The results highlighted that U-18C players (a team with first-year players) suffer more sports injuries than third-year athletes in the same age category or younger players. In addition, the injuries often occurred in other sport contexts than training and competitions. Therefore, it is recommended to increase the number of studies related to other contexts in which elite junior athletes may be involved.

In addition, it is recommended that training loads are adapted to the biological age of the players, and appropriate pauses are considered to avoid sports injuries. The coaching staff should use tools and instruments for the quantification and measurement of training loads to prevent injuries and adapt training sessions to the physical capacity of the players, thereby reducing the possibility of overloading and thus reducing the incidence and production of injuries.

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Conflicto de intereses

The authors declare no conflict of interest.

Institutional Review Board statement

The study was conducted in accordance with the Declaration of Helsinki (2013) and approved by the Ethics Committee, University of Extremadura (registration number 67/2017).

Informed Consent Statement:

Informed consent was obtained from all subjects involved in the study.

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