

Ankle sprain and proprioception in competition-level association football players

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Summary

Objective: To determine the association between ankle sprain and proprioception in competitive level soccer players in Lima, Peru in 2023.

Material and method: An analytical cross-sectional study was conducted involving 42 competitive-level football players from Lima, of both sexes, aged 18 to 29 years. The single-leg stance test was used to assess proprioception, and the presence of ankle sprain was determined through self-reporting of such an injury within the past 12 months. A sociodemographic questionnaire was applied to collect data on covariates, including age, sex, dominant leg, field position, years of experience, training frequency, competitive level, and characteristics of the ankle sprain. For the bivariate analysis, the Chi-square test and Fisher's exact test were employed. To estimate crude and adjusted prevalence ratios, a multivariate analysis was conducted using Poisson regression with robust variance estimators and a 95% confidence interval.

Results: Of the 42 participants, 50% reported having experienced an ankle sprain. The most frequent playing position was defenders. Proprioceptive deficiency was observed in the left lower limb in 28 players and in the right lower limb in 25. A significant association was found between having suffered an ankle sprain and presenting proprioceptive deficiency in the right ankle, both in the crude and adjusted analyses (cPR = 2.1; aPR = 2.1).

Secondarily, it was found that players in the forward position had a threefold higher prevalence of proprioceptive deficiency compared to goalkeepers, in both the right lower limb (aPR = 3.0) and the left lower limb (aPR = 3.1).

Conclusions: A significant association was found between ankle sprains and poor proprioception in the right lower limb; no significant association was found in the left lower limb.

Key words:

Ankle sprain. Proprioception.
Soccer. Sport Medicine.
Physiotherapy.

Esguince de tobillo y propiocepción en futbolistas de nivel competitivo

Resumen

Objetivo: Valorar la asociación entre la presencia de esguince y la propiocepción en futbolistas de nivel competitivo de Lima, Perú.

Material y método: Se realizó un estudio transversal analítico con 42 futbolistas de nivel competitivo de Lima, de ambos sexos y entre 18 a 29 años. Se utilizó la prueba de apoyo unipodal para valorar la propiocepción y para determinar la presencia de esguince de tobillo se usó el autorreporte de padecerla dentro de los últimos 12 meses, para las covariables como edad, sexo, pierna dominante, posición en el campo, años, frecuencia de entrenamiento, nivel futbolístico y caracterización del esguince se usó un cuestionario sociodemográfico. Para el análisis bivariado se emplearon la prueba de Chi² y la prueba exacta de Fisher; para estimar la razón de prevalencia cruda y ajustada se realizó un análisis multivariado se utilizó la regresión de Poisson con varianzas robustas con un intervalo de confianza del 95%.

Resultados: De los 42 participantes, el 50% habían sufrido un esguince. La posición más frecuente fue la de defensa. Se observó una propiocepción deficiente en el miembro izquierdo se observó en 28 futbolistas, mientras que en el derecho en 25. Se encontró una asociación significativa entre haber sufrido un esguince de tobillo y presentar una propiocepción deficiente en el tobillo derecho, tanto en el análisis crudo como en el ajustado (RPC = 2,1; RPa = 2,1). De manera secundaria, se halló que los jugadores en la posición de delantero presentaron una prevalencia tres veces mayor de deficiencia en la propiocepción en comparación con los porteros, tanto en el miembro inferior derecho (RPa = 3,0) como en el izquierdo (RPa = 3,1).

Conclusiones: Se encontró una asociación significativa entre el esguince de tobillo y la propiocepción deficiente en el miembro inferior derecho, pero no en el izquierdo.

Palabras clave:

Esguince de tobillo. Propriocepción.
Fútbol. Medicina del Deporte.
Fisioterapia.

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Introduction

Association football has been and continues to be one of the most popular sports in the world. Its popularity continues to grow; between 2000 and 2006, the International Federation of Association Football (FIFA) estimated that the number of football players increased by 9% (from 242 to 265 million), while the number of women playing the sport increased by 19% (from 21.9 to 26 million)¹. According to data from the South American Football Confederation (CONMEBOL), at present 4% of the world's population (270 million) actively participates in the sport².

In recent decades, the game has become much more dynamic and faster. It is now characterised by shorter ball-contact times, higher passing rates, greater player density and faster transitions. From a physical standpoint, players are required to sprint and accelerate throughout the match, which may or may not involve changes of direction. But, just as the physical component is necessary, perceptual-cognitive components are also important³. Given that football is a contact sport with a high incidence of injuries, different ways to reduce these are being considered. In this regard, proprioception training is recommended for footballers to mitigate injury rates, its having proven to be effective for this purpose⁴.

According to the United States National Sports Injury Registration System, an injury is any accidental event that occurs during a game or training session which may restrict an athlete from activity for a period of time which depends on its severity. In football, ankle sprains and muscle injuries are among the most common injuries⁵.

Ankle sprains are considered one of the most prevalent injuries and are associated with intrinsic factors such as muscle strength asymmetry, decreased flexibility and decreased proprioception⁶. Ankle injuries have also been reported to give rise to changes in muscle strength, neuromuscular control and delayed reaction times, which, in turn, lead to a greater risk of reinjury⁶.

The incidence rate of ankle sprains is 11.5 per 1,000 exposures, with a prevalence of 11.8%. The most frequent type of sprain is the lateral ankle sprain, which is caused by excessive inversion with or without plantar flexion. The anterior talofibular ligament, which has a lower load tolerance, is the most frequently injured. The most severe sprains tend to involve the calcaneofibular ligament, the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament and even the deltoid ligament⁷.

An ankle sprain occurs when the joint is unexpectedly subjected to great tensile forces, causing the ligaments to elongate rapidly beyond their physiological limits⁸. This type of injury is classified into three grades according to its severity: grade 1 is considered mild, grade 2 involves a partial tear and grade 3 involves a complete tear⁹. In addition to damaging the ligament structure, these injuries also affect other structures of the ankle joint, such as muscles, tendons and nerves. They can also lead to impaired joint proprioception, affecting balance, firing of ankle muscles, nerve conduction velocity, cutaneous sensation, muscle power and range of motion of the ankle¹⁰.

Proprioception can be defined as the awareness of the mechanical and spatial state of the body and its parts, which is important for motor actions and provides us with a sense of body ownership¹¹. It is a key element of the somatosensory system and facilitates the integration

of sensory input, central processing and motor output for postural control¹². It plays a fundamental role in movement control, as it provides inputs to internal models that couple sensory signals and motor commands¹³. Along with balance and neuromuscular control, it has been proposed that it is an intrinsic risk factor for non-contact ankle injuries¹⁴.

Ankle sprains can lead to long-term consequences. It is estimated that at least 73% of people who suffer this injury develop symptoms such as pain, instability (a feeling of giving way) and impaired proprioception, which increases the likelihood of recurrence and, consequently, the development of chronic ankle instability¹⁵.

The relevance of this study lies in its addressing one of the most common medical conditions in football¹⁶. Proprioception also plays an important role in the prevention of and recovery from such injuries in footballers¹⁷. This subject is of interest to doctors, physiotherapists, coaches and physical trainers. In this context, the objective of this research was to assess the association between ankle sprains and proprioception in competition-level association football players in Lima, Peru, in 2023.

Materials and methods

Methodological design

An analytical cross-sectional study was conducted to investigate a possible association between proprioception and ankle sprains.

Population and Sample

The study population consisted of athletes who played association football at a competitive level in Lima in 2023. Athletes of both sexes, aged 18 to 29, who trained at least twice a week were included. The participants had to have experienced or have not experienced an ankle sprain within the previous 12 months. Those with contraindications to performing the single-leg stance test, neurological or vestibular problems, recent fractures or who were undergoing physiotherapy for lower limb conditions were excluded.

The program Epidat 4.2 was used to calculate the sample size. The objective of the analysis was to calculate the sample size needed to detect significant differences in the mean balance times with eyes open and eyes closed (proprioception). A 99.9% confidence level and 99% power were established for a hypothesis test comparing independent mean times in seconds. For the calculations, we used standard deviations and mean differences for the single-leg stance test with eyes open and eyes closed from a previous study¹⁵.

For the sample size in the test with eyes closed, calculation used a mean difference to detect of 3.1 seconds, an expected standard deviation for the population with a history of ankle sprain of 1.12 and a standard deviation for the population without a history of ankle sprain of 1.0, using data obtained from a previous study¹⁵. This resulted in a required total of 22 participants. For the test with eyes open, a mean difference to detect of 2.1 seconds was used, along with an expected standard deviation of 1.24 for the population with a history of ankle sprain and 0.95 for the population without a history of ankle sprain, using data obtained from a previous study¹⁵. This resulted in a total of 42 participants. The latter was considered the sample size for the study.

Convenience sampling was used, inviting football players of both sexes who met the selection criteria.

Variables and Instruments

Variables

The outcome variable was proprioception, defined as the ability to sense the relative position of adjacent body parts, regulating the direction and range of motor movement. This was measured using the single-leg stance test, derived from the Balance Error Scoring System¹⁸. Proprioception was considered deficient when the balance time was less than 30 seconds in the test and efficient when the duration was equal to or greater than 30 seconds¹⁹.

The exposure variable was ankle sprain, defined as a self-reported injury occurring within the past 12 months, characterised by the stretching or the partial or complete tear of at least one ligament in this anatomical region²⁰. The variable was investigated using a questionnaire. Sociodemographic and sports-related data, including age, sex, dominant leg, playing position, years and frequency of training, football level, sprain recurrence, sprain severity, affected limb and physiotherapy treatment, were also collected.

Instruments

The proprioception variable was measured using the single-leg stance test. The participants stood barefoot on one leg with their hands on their hips. They then had to flex the other knee without touching or resting on the leg on which they were standing. The test was performed once with eyes open and three times with eyes closed²¹. The examiner measured the time the participant could remain standing without falling and determined their proprioceptive level, divided into times of less than 30 seconds (deficient) and 30 seconds or more (efficient)²². A study validated good test-retest reliability in healthy women aged between 55 and 71: 0.90–0.91, eyes closed: 0.74–0.75. Good inter-rater reliability was also found in the same population with eyes open: 0.99, eyes closed: 0.9923²³.

The ankle sprain variable was investigated using a questionnaire to gather sociodemographic information from the participants.

Procedures and data collection

A pilot test was conducted with 10 football players to verify proper application of the single-leg stance test and completion of the data collection questionnaire. Afterwards, the necessary permission was obtained from both those responsible and coaches to invite the football players to participate in the study after signing informed consent forms. After contacting the participants and coordinating the assessment process, assessment was conducted in a spacious, well-ventilated environment with low noise and interference. First of all, the questionnaire was administered using an electronic device and then the single-leg stance test was performed, beginning with the open-eyes test and ending with the closed-eyes test. Finally, the initial database was created in MS Excel format and these data were analysed.

Statistical method

To analyse the study data, the statistical software STATA 17, to which the database was exported from a spreadsheet, was used. Prior to this, the data was cleansed and we verified that all the selection criteria explained above had been met.

A descriptive analysis of the categorical and quantitative variables was carried out. In the bivariate analysis, the Chi-square test and Fisher's exact test were used to determine if there was a relationship between the exposure variable/ covariates and the outcome variable. For the multivariate analysis, Poisson regression with robust variance was used to calculate the crude and adjusted prevalence ratios. Adjusted prevalence ratio (APR) calculation involved statistical confounders (*p*-value less than 0.2) and the absence of multicollinearity was verified with a subsequent analysis using the variance inflation factor.

Ethical considerations

The research was reviewed by the Research Ethics Subcommittee of Universidad Peruana de Ciencias Aplicadas, which approved it via letter FCS-SCEI/380-06-23. It was registered in the PRISA repository of the National Institute of Health under code EI00000003080 before data collection began.

The subjects took part voluntarily and completed an informed consent form before participating. The study did not involve any significant physical or mental risks which could compromise the participants' wellbeing.

During the consent process, they were informed about the study's objective and procedures, and told that the data from the surveys would be kept strictly confidential. They were free to withdraw from the research at any time without needing to appeal to or consult the researchers.

Results

Participants

A total of 42 association football players were invited to take part in the study, none of whom were excluded, so the analysis was finally carried out with all of them; 21 were female and 21 were male.

Sociodemographic characteristics of competition-level football players from Lima

Of the 42 participants, 41 were between 18 and 25 years old; 21 (50%) were female players; most of them (37 participants) were right-footed and 26 played at university level.

Of all the playing positions, the largest number of players were defenders, with a total of 16. As for years of training, 32 participants had been playing football for 5 years or more, with the most frequent training frequency being 5 or more times per week. 21 participants presented with ankle sprains, of whom 12 presented with a first-grade sprain, 13 had recurrent sprains and only 4 had not received physiotherapy treatment. Poor proprioception was observed more frequently on the left (28 participants) compared to the right (25 participants). The median

maximum balance time was 24 seconds for the left side and 19 seconds for the right, as detailed in Table 1.

Factors associated with ankle proprioception in a closed-eyes test on competition-level football players from Lima

A significant relationship was found between having suffered an ankle sprain and right ankle proprioception ($p = 0.005$). No significant association was found between having suffered an ankle sprain and left ankle proprioception ($p = 0.190$). No statistically significant relationship was found between sociodemographic variables and left and right ankle proprioception (Table 2).

Strength of association for proprioception deficiency

In the analysis, Poisson regression with robust variance was used to calculate the crude and adjusted prevalence ratios; for APR calculation, statistical confounders with a p -value less than 0.2 were used. A statistically significant association was identified between ankle sprain and proprioceptive deficiency in the right lower limb (CPR = 2.1). This association remained significant in the multivariate analysis (APR = 2.1) when accounting for playing position. In contrast, no statistically significant association was observed between ankle sprain and proprioceptive deficiency in the left lower limb in either unadjusted analysis (CPR = 1.3) or analysis adjusted for playing position (APR = 1.13).

The playing position variable was associated with poor proprioception, but no significant association was found; however, it was determined that forwards are three times more likely to have poor proprioception than goalkeepers in both the right (APR = 3) and left (APR = 3.1) lower limbs (Table 3).

Discussion

The main finding of the study was an association between having suffered an ankle sprain in the last 12 months and having poor proprioception in the right lower limb among competition-level football players in Lima ($p = 0.005$). The strength of association was calculated, finding that players with an ankle sprain were twice as likely to have poor proprioception in the right lower limb (APR = 2.1). However, we did not find an association or significant strength of association between having suffered an ankle sprain and having poor proprioception in the left lower limb ($p = 0.190$) albeit with a statistical power of 25.4%.

Regarding our findings, it is known that people who have suffered an ankle sprain show impaired proprioception, which may be linked to: instability in the ankle joint, an altered gait and a greater likelihood of suffering repeat ankle sprains²⁴. This can be explained by the potential for trauma to a tissue to damage mechanoreceptors, leading to a deficit in proprioception. As a result of this deficit, susceptibility to re-injury increases²⁵. Another study supports the aforementioned idea, adding that ankle joint injury causes damage to the capsuloligamentous structure, resulting in impaired proprioception and altered kinesthesia²⁶. Furthermore, recurrent ankle sprains on the same side can lead to chronic ankle instability due to proprioceptive impair-

Table 1. Sociodemographic characteristics of competition-level football players from Lima.

Characteristics		n = 42	
		n	%
Age	18-25 y.o.	41	97.6
	26-29 y.o.	1	2.4
Sex	Men	21	50
	Women	21	50
Dominant leg	Right	37	88.1
	Left	5	11.9
Level of football	University and others	26	61.9
	Competitive leagues	16	38.1
Field position	Goalkeeper	4	9.5
	Defender	16	38.1
	Midfielder	14	33.3
	Forward	8	19.1
Years of training	1-4	10	23.8
	5 or more	32	76.2
Frequency of training	1-4 times per week	15	35.7
	5 or more times per week	27	64.3
Ankle sprain	Yes	21	50
	No	21	50
Sprain severity (n=21)	1st grade	12	57.1
	2nd grade	9	42.9
Limb affected	Right	16	76.2
	Left	5	23.8
Sprain recurrence	Yes	13	61.9
	No	8	38.1
Physiotherapy treatment	Yes	17	80.9
	No	4	19.1
Proprioceptive level	<i>Right</i>		
	Deficient	25	59.5
	Efficient	17	40.5
	<i>Left</i>		
Deficient	28	66.7	
Efficient	14	33.3	
		Median	IQR
Proprioceptive level (seconds)	Maximum right, sec.	19	12 to 30
	Maximum left, sec.	24	15 to 30

ment²⁷ and individuals with chronic ankle instability exhibit ankle proprioceptive deficits²⁸.

Playing position was also associated with impaired proprioception, but no significant association was found; however, it was found that forwards are three times more likely to have impaired proprioception compared to goalkeepers both in the right (APR= 3) and left (APR= 3.1) lower limbs. Although no studies were found that associate these variables, playing positions are indeed associated with injuries²⁹. This could be explained by a balance between the ankle proprioception demands and the risk of ankle sprain for each position. The goalkeeper, for example, is better trained for jumps and short sprints that demand high ankle proprioception but is protected from direct impacts due to the risk of penalties for the attacking team.

Table 2. Factors associated with ankle proprioception in a closed-eyes test on competition-level football players from Lima.

Characteristics		Right lower limb				p	Left lower limb				p
		Deficient		Efficient			Deficient		Efficient		
		n	%	n	%		n	%	n	%	
Age	18-25 y.o.	25	61	16	39	0.405**	28	68.3	13	31.7	0.333**
	26-29 y.o.	0	0	1	100		0	0	1	100	
Sex	Men	12	57.1	9	42.9	1*	15	71.4	6	28.6	0.744*
	Women	13	61.9	8	38.1		13	61.9	8	38.1	
Dominant leg	Right	22	59.5	15	40.5	1**	24	64.9	13	35.1	0.650**
	Left	3	60	2	40		4	80	1	20	
Level of football	University and others	14	53.9	12	46.1	0.518*	18	69.2	8	30.8	0.742*
	Competitive leagues	11	68.8	5	31.2		10	62.5	6	37.5	
Field position	Goalkeeper	1	25	3	75	0.157**	1	25	3	75	0.195**
	Defender	10	62.5	6	37.5		10	62.5	6	37.5	
	Midfielder	7	50	7	50		10	71.4	4	28.6	
	Forward	7	87.5	1	12.5		7	87.5	1	12.5	
Years of training	1-4	7	70	3	30	0.490**	8	80	2	20	0.451**
	5 or more	18	56.3	14	43.7		20	62.5	12	37.5	
Frequency of training	1-4 times per week	8	53.5	7	46.7	0.542*	10	66.7	5	33.3	1*
	5 or more times per week	17	63	10	37		18	66.7	9	33.3	
Ankle sprain	Yes	17	80.9	4	19.1	0.005**	16	76.2	5	23.8	0.190**
	No	8	38.1	13	61.9		12	57.1	9	42.9	
Sprain severity (n=21)	1st grade	9	75	3	25	0.603**	9	75	3	25	1**
	2nd grade	8	88.9	1	11.1		7	77.8	2	22.2	
Limb affected	Right	12	75	4	25	0.532**	11	68.8	5	31.2	0.278**
	Left	5	100	0	0		5	100	0	0	
Sprain recurrence	Yes	10	76.9	3	23.1	1**	9	69.2	4	30.8	0.606**
	No	7	87.5	1	12.5		7	87.5	1	12.5	
Physiotherapy treatment	Yes	14	82.4	3	17.6	1**	13	76.5	4	23.5	1**
	No	3	75	1	25		3	75	1	25	

*Chi-square test **Fisher's exact test

We can also highlight the relevance of proprioception training in injury prevention for football players. A study conducted at a football club in Manizales, Colombia, implemented a four-week proprioception-focused training programme for players who had previously suffered injuries, ankle sprains being one of the most frequent. The results revealed a significant improvement in both proprioception and balance after the exercise programme. The findings also suggest that increased proprioception was associated with a reduced risk of sports injuries³⁰.

It is very important to highlight that proprioception should not only be considered in injury prevention but also in injury treatment. This approach enhances the skills needed for various sports, physical activities and coordination³¹. Furthermore, the need to incorporate proprioception training to prevent ankle sprains should be stressed³². It has been reported that training programmes focused specifically on strength and balance exercises (proprioception) lead to a notable improvement in ankle joint stability in adolescent football players with ankle instability³³.

The relationship between proprioception and athletic performance has been documented, indicating that ankle proprioception is a predictor of the competitive level an athlete could reach. There is also a relationship between ankle proprioception and the risk of ankle injuries, with athletes with poor proprioception at higher risk of suffering them³⁴. Additionally, a comprehensive approach to the treatment of ankle sprains in competitive athletes is now being proposed to prevent the development of chronic instability^{35,36} and this would inevitably include proprioception training³⁷. In consonance with these ideas, our study emphasises the fundamental importance of integrating proprioception training into both the prevention and treatment of injuries, focusing specifically on ankle sprains.

We have identified limitations in the performance of the study, one of which concerns the selection process. Specifically, the use of convenience sampling may have limited the extrapolation of the data; however, specific selection criteria were proposed to lessen its impact.

Table 3. Strength of association for proprioception deficiency.

Characteristics		CPR	CI 95%	p	APR	CI 95%	p
Right lower limb							
Field position	Goalkeeper	1	Reference		1	Reference	
	Defender	2.5	0.4 to 14.5	0.308	2.7	0.6 to 13.2	0.209
	Midfielder	2	0.3 to 12.1	0.450	2	0.4 to 10.1	0.401
	Forward	3.5	0.6 to 19.9	0.159	3	0.6 to 14.4	0.176
Sprain	Yes	2.1	1.2 to 3.8	0.012	2.1	1.2 to 3.7	0.014
	No	1	Reference		1	Reference	
Left lower limb							
Field position	Goalkeeper	1	Reference		1	Reference	
	Defender	2.5	0.4 to 14.5	0.308	2.6	0.5 to 13.9	0.272
	Midfielder	2.9	0.5 to 16.4	0.240	2.9	0.5 to 15.5	0.223
	Forward	3.5	0.6 to 19.9	0.158	3.3	0.6 to 18	0.167
Sprain	Yes	1.3	0.9 to 2.1	0.206	1.13	0.8 to 2	0.318
	No	1	Reference		1	Reference	

The calculation of CPR and APR was performed using Poisson regression with robust variance and was adjusted to the field position for each lower limb.

Regarding the inherent limitations of the study design, its cross-sectional nature precludes establishing causal relationships and potentially opens the door to reverse causality. However, it is important to note that this design is appropriate for identifying associations between variables and that exposure was measured over a 12-month period and outcome at the time of assessment.

Conclusions

In this study, a significant association was found between ankle sprain and poor proprioception in the right lower limb; however, no significant association was found between ankle sprain and poor proprioception in the left lower limb, although this is not conclusive due to a low statistical power.

Conflict of interest

The authors declare no conflict of interest.

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