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Original Article

A six-month unsupervised training program does not improve ankle joint mobility in soccer players

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Abstract
Problem Statement: Soccer practice can induce marked changes in ankle joint mobility (AJM) with dreaded consequences related to the quality of balance, posture and gait. Moreover, a limited ankle range of motion may represent an important risk factor for injuries and negatively affect performance. **Purpose:** The aim of this study was to evaluate the effects of a stretching training protocol (STP) on the AJM of adult male soccer players (SP). **Material and Methods:** 34 amateur male SP (age 29.0±4.6 years) and 24 non-soccer players (control group) matched for age, gender and BMI were included in this study. In both groups AJM and muscle strength were evaluated by inclinometer and Jamar hydraulic hand dynamometer respectively. Moreover, data on sports practiced, years of activity, history of injuries, dominant kicking leg, and presence of athletic trainers were collected. SP group performed six months of a STP that included 4 exercises aimed at improving AJM. Due to the Covid-19 pandemic the STP was suspended for 4 weeks in the middle period of the study. **Results:** At baseline, SP group showed reduced AJM compared to controls (116.1±13.1° *vs*. 137.7±13.6; $p<0.001$) while muscle strength was similar (45.0±7.5 vs 48.0±8.9 kg). STP produced a non-significant effect on AJM (116.1±13.1 vs 116.8±15.1°). No differences were found between the two groups considered as regards the difference in mobility between the two ankles (right vs left; dominant vs non-dominant). Considering the initial values, there was a direct correlation between HS and BMI ($r=0.38$; $p<0.025$), while AJM showed an inverse correlation with years of activity (-0.36; $p<0.037$). No correlation was found between hand grip test and AJM. **Conclusions:** SP showed a significant reduction in AJM which was difficult to recover even following a STP. The interruptions of sport activity due to the Covid-19 pandemic and the absence of athletic trainers in the sports clubs involved, in addition to the long history of soccer practice could justify, at least in part, the results obtained.
Key Words: Sport practice, Footballers, Flexibility, Muscle strength, Hand grip, Injuries.

Introduction

Soccer is often the sport preferred by young males and a large number of adults in many countries (FIFA Big count, 2006; Report, 2022; Taking Part, 2017; National physical activity plan, 2018). It is well known that soccer practice is a significant source of physical activity, and it has many positive effects on health (Merkel, 2013; Milanović et al, 2015; Krustrup&Krustrup, 2018). However, continued soccer practice has also been associated with some negative consequences (Merkel, 2013; De Freitas et al, 2020; Owoeye et al, 2020). Among these, those affecting the joint mobility of the ankles are particularly feared and studied (Armenis et al, 2011; Golanó et al, 2014; Read et al, 2016). The anatomy and physiology of the ankle are very complex because, at the same time, the mobility and stability of the joint must be maintained at the same time. The ankle or talocrural joints is a load-bearing joint and it is one of the most congruous joint in the body. The talocrural joint is formed by the articular surfaces of the tibial (medial malleolus and tibial plafond), fibular distal epiphyses (medial surface of the lateral malleolus) and the superior, lateral, and medial aspects of the talus (Golanó et al, 2014; Brockett&Chapman, 2016). In particular, the medial and lateral malleolus concur to form a mortise to receive the articular surface of the talus (Golanó et al, 2014; Brockett&Chapman, 2016). In addition to the morphology of the articular surfaces of the talocrural joint that forms an angular ginglymus with a single axis of movement (bimalleolar axis), other passive factors (e.g., capsuloligamentous structures surrounding the joint) and dynamic factors (i.e., muscle action) provide both active and passive tension, allowing and limiting the range of motion (ROM) of the ankle joint in dorsiflexion and plantar flexion (Hertel, 2002; Golanó et al, 2014; Brockett&Chapman, 2016). In addition to the ankle joint all periarticular structures can be affected by the practice of this sport and lead to ever greater problems even after the end of sports activity (Ekstrand&Gillquist, 1982; Tol et al, 2002; Golanó et al, 2014; Azuma&Someya, 2020). This condition is much feared for its possible

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consequences on the quality of balance, posture and movement as well as representing, in turn, an important risk factor for injuries in addition to being able to negatively affect performance (Kaufman et al, 1999; Ribeiro et al, 2003; de Noronha et al, 2006; Basnett et al, 2013; Francia 2022-A). It was hypothesized, that several factors contribute to the occurrence and development of limited AJM in SP. In addition to physical contact between the players, during sports practice, different types of high intensity movements such as jumping or running with frequent and rapid changes of speed and direction, twisting and turning, overtaking and landing, can cause joint microtrauma and concur to induce a condition of overuse (Hattori&Oha, 1986; Wong et al, 2005; Read et al, 2016). Other factors such as the soccer field surface or the type of soccer shoes used may affect the risk of injury or ROM of the ankles (Ekstrand et al, 2006; Blanchard et al, 2018). The limited range of motion (ROM) of the ankle in soccer players (SP) can therefore be considered as a sport induced adaptation. It was suggested, that on the one hand this adaptation involves greater joint stability associated with a reduced risk of injury but, on the other hand, it induces a limitation of the ankle range of motion (Hattori&Oha, 1986; Armenis et al, 2011; Francia et al. 2022-B). In this sense, several studies suggested the importance of the prevention or treatment of limited AJM in SP (Ekstrand&Gillquist, 1982; Azuma&Someya, 2020; Francia et al, 2020; Moreno-Perez et al, 2020).
In 1985 Moller et al. studied how stretching exercises performed before or after a training session modified the joint mobility of the lower limbs of the adult male SP. In particular, the authors reported how this type of treatment had positive effects on joint mobility and injury prevention (Möller et al, 1985).

More recently, Zakas and colleagues (2006) evaluated the significant positive effect of a stretching exercise protocol, whether or not associated with a warming-up phase, on the ankle dorsiflexion of a team of adolescent soccer players (Zakas at al, 2006). The improvement in AJM obtained by Zakas et al. is similar to those of our more recent study on a three-month supervised stretching training program with 4 specific exercises involving soccer players (Zakas et al, 2006; Francia et al, 2020). In our study, a control group of non-soccer players was also considered. The results of the study showed that the proposed training protocol significantly increased the ankle ROM even though it was significantly lower than that of the non-SP controls (Francia et al, 2020). Recently, Azuma and colleagues published an article on the evaluation of the effects of a supervised physical therapy intervention on muscle tightness for the injury prevention in adolescent male SP (Azuma&Someya, 2020). In this study, significant increases in ankle dorsiflexion were obtained using a supervised intervention performed for 12 weeks (three times a week, 20-30 minutes of stretching sessions). Moreover, additional exercise instructions were provided during the cool-down period and the voluntary training session. The authors reported also that in the 40 weeks following the training period, the injuries suffered by the SP were lower than those of the controls (Azuma&Someya, 2020). Other studies evaluated the effect of different types and duration of stretching exercises on injuries prevention (Zakas, 2005; Bello et al, 2011; Akbulut et al, 2015), kicking speed and range of motion (ROM) in SP of different ages (Akbulut et al, 2015). Unfortunately, to date there are still no clear indications on the protocols to be used for the recovery of AJM in adult SP. (Hattori&Oha, 1986; Cejudo et al, 2019; De Freitas et al, 2020; Moreno-Perez et al, 2020; Owoeye et al, 2020).

The main aim of this study was to verify the effects of a six months stretching training protocol (STP) on AJM of male soccer players.

Methods

A total of 58 adult male subjects, 34 amateur soccer players (SP) and 24 non-soccer player controls were enrolled in this study. Detailed characteristics of the study participants are shown in Table 1.

Table 1. Detailed characteristics, ankle joint mobility and muscle strength, ankle (AFP) of the study participants.

	SP at baseline vs Controls			**SP at baseline vs SP after STP**		**SP after STP vs Controls**	
	SP at baseline (n=34)	**Controls (n=24)**	**P value**	**SP after STP (n=28)**	**P value**	**Controls (n=24)**	**P value**
Age (yrs)	29.0±4.6	28.2±8.9	0.464*	29.7±4.8	----	28.2±8.9	0.293*
BMI (kg/m^2)	23.2±2.1	23.3±2.3	0.755	23.2±2.2	----	23.3±2.3	0.816
Yrs of Soccer Practice	18.3±5.8	----	----	18.8±5.9	----	----	----
HGS (kg)	45.0±7.5	48.0±8.9	0.198	44.1±7.2	----	48.0±8.9	0.106
APF (°)	25.4±5.1	33.4±6.9	<0.001	28.0±6.3	0.090	33.4±6.9	0.005
ADF (°)	91.4±10.4	104.3±12.8	<0.001	88.2±12.4	0.050	104.3±12.8	<0.001
ATOT (°)	116.8±13.1	137.7±13.6	<0.001	116.1±15.1	0.540	137.7±13.6	<0.001
Dominant AJM (°)	58.2±6.8	68.6±8.1	<0.001	57.9±7.5	0.456	68.6±8.1	<0.001*
Non-dominant AJM (°)	58.6±7.7	68.7±8.4	<0.001	58.3±9.0	0.833	68.7±8.4	<0.001
Right AJM (°)	58.5±6.7	68.2±7.8	<0.001	58.5±7.5	0.560	68.2±7.8	<0.001
Left AJM (°)	58.3±7.8	69.2±8.6	<0.001	57.7±9.0	0.740	69.2±8.6	<0.001
Δ R/L – D/non-D (°)	5.0±3.7	5.4±5.2	0.510*	3.7±4.8	0.877	5.4±5.2	0.270*

Values are mean±SD. Comparisons among groups were performed using *t*-test (paired samples or independent) or non-parametric Mann-Whitney (*) or Wilcoxon rank (^) test. BMI: body mass index; HGS: hand grip strength; ATOT: Total ankle mobility; APF: ankle plantar flexion; ADF: ankle dorsiflexion; R/L: right/left; D/non-D: Dominant/non-Dominant; Δ: difference; STP: stretching training protocol; (°) degrees.

All subjects were recruited in sports clubs from Marche, Tuscany, and Emilia Romagna who had positively replied to the invitation to participate in the study and they were evaluated from September 2021 to June 2022.

The 34 SP were players of 2 teams: Team A (18) and Team B (16). While the players of Team A trained on a dirt soccer field, Team B used an artificial turf soccer field.

The control group was composed of sedentary subjects, people attending a fitness center or people who regularly engage in athletics i.e. conditions that do not have a known effect on AJM (Travers&Evans 1976, Soucie et al; 2011; Francia et al, 2021-A).

Data were collected on age, weight, height, dominant kicking leg, sport practiced, years of activity, number of weekly training sessions and years of practice of different sports. Moreover, the type of shoes used, soccer playing surface, duration of training, injuries suffered and kind of job were considered. Body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared (kg/m^2). The physical examination included foot inspection and the presence of deformity, injuries and traumas such as to affect ankle joint mobility. Exclusion criteria were: age greater than 16 years and less than 50 years old, presence of diabetes, other diseases as well as orthopedic and/or surgical complications at baseline that can affect AJM. Soccer practice for less than 6 months continuously was an additional exclusion criteria per the SP group. All participants and parents were informed of the purpose of the study and its experimental procedures before obtaining their written informed consent and the enrolment in the study. The study protocol and the consent forms were approved by the Paediatrics Ethics Committee of University of Urbino Carlo Bo (cod. CESU20221118VER37 November 2020). The study was performed according to the principles expressed in the Declaration of Helsinki.

Determination of joint mobility

The method used for the assessment of ankle mobility has been described in previous studies (Clarkson, 2000; Francia et al, 2022-A). In brief, the active range of motion (ROM) of the ankle joint in plantar flexion (APF) and dorsiflexion (ADF) was measured by an inclinometer. Players were asked to lie in the supine position on a fixed treatment table with the ankle resting in line with the edge and the feet across the edge of the table, the ipsilateral knee of the assessed ankle was put over a rigid support 5-cm high. The greater angle of the active APF and ADF was measured and the mean of three consecutive readings was reported, while the total ankle mobility (ATOT) was the sum of the two values (APF+ADF). In a previous study, it was reported that the mean standard deviation of three consecutive readings of the ankle ROM, as reported in this study, was very limited: 1.1±0.9 degrees of plantar flexion and 1.4±1.1 degrees of dorsiflexion. The ankle ROM was measured by the same operator who had more than 10 years of experience (Francia et al, 2020). The dominant lower limb was identified by asking the players which was the preferred limb for kicking the soccer ball. The test operator who evaluated AJM did not know the dominant limb of the players (DeLang et al, 2017; Cejudo et al, 2019).

Determination of hand grip strength

The method used for assessing muscle strength has also been described in previous studies (Francia et al, 2021-B). In brief, Hand Grip Strength (HGS) was evaluated by the Jamar hydraulic hand dynamometer (model 5030J1) 0-90 Kg. Before the test, the examiner gave explanations, showed the posture to be maintained, how to hold the dynamometer and how to perform the test. In particular, hand grip was evaluated with subjects in the standing position, arms by the side of the body, shoulder adducted in a neutral position, elbow 90° flexed with the forearm parallel to the ground and pronated in order to maintain the display of the dynamometer on the frontal plane (De S et al, 2011). The players were asked to maintain the same posture and the dynamometer handle during the three tests and to squeeze with the maximum strength for three seconds without moving the rest of the body (Ploegmakers et al, 2013; Sousa-Santos&Amaral, 2017). Only the dominant hand was tested. A trial test was allowed to become familiar with the device. The dominant upper limb was identified by asking the players which hand was used for writing (Ploegmakers et al, 2013). In this study, the Jamar hydraulic hand dynamometer was used since it was a well-validated device for the quantitative measurements of the maximum isometric MS of the hand and it was widely used in clinical practice. Moreover, this dynamometer has a high test-retest and inter-rater reliability in addition to a high reproducibility (De S et al, 2011; Hogrel et al, 2015; Mathiowetz et al, 1984; McQhiddy et al, 2015; Youdas et al, 2009).

Training protocol

Soccer players performed 6 months (twice a week) of stretching training protocol (STP) from 2021 November to 2022 April, including 4 exercises aimed at improving AJM. Due to the Christmas period and Covid-19 pandemic, training was suspended for 7 weeks, from 18 December 2021 to 9 February 2022.

The exercises performed during the initial (warming-up) phase of each soccer training session are described below:

—— exercise 1: players were requested to stand and put one foot forward, keeping the feet pointing straight forward and the heel on the ground, then to lean forward onto the front leg to feel the stretching of the calf muscle (3 repetitions of 20 seconds for each side);

—— exercise 2: standing with feet facing in front, one foot forward while the rear foot rested on the dorsal surface of the foot (toes) keeping the ipsilateral knee extended; weight was gradually shifted to the lower limb in front of the ankle with the lengthening of the extensor muscles of the ankle (3 repetitions of 20 seconds for each side);

—— exercise 3: players sat with extended knees trying to touch their feet in dorsiflexion; they could help themselves to lean forward by using elastic bands placed at the level of the plantar surface of the metatarsal heads (3 repetitions of 20 seconds);

—— exercise 4: players rested with one knee on the ground, the ipsilateral foot pointed backward and maintained in plantar flexion with the contralateral foot positioned anteriorly, trying to achieve the maximum plantar flexion of the corresponding foot maintained in plantar flexion by moving the pelvis backward and the maximum dorsiflexion of the other ankle moving the pelvis forward (3 repetitions of 20 seconds for each side).

The correct execution of each exercise was shown to all the SP together immediately after the initial assessments and before the start of the adapted training period.

Subsequently, the coach was contacted by telephone on a monthly basis to verify compliance with the protocol. The training protocol was performed with one minute of rest between exercises. The training sessions were carried out without the presence of an athletic trainer. The STP was conducted by the coach.

Statistical analysis

Data were reported as mean ± standard deviation (SD). ROM values were expressed in degrees (°). Statistical normality was assessed using Shapiro-Wilk tests. The comparisons between two groups were made using T-test (paired samples or independent) or the nonparametric tests (Wilcoxon rank or Mann-Whitney). The association between the joint mobility and hand strength was evaluated using Pearson or Spearman's correlation coefficients. Multiple linear regression analyses were carried out considering ankle dorsiflexion (ADF), plantar flexion (AFP) and the total AJM (ATOT) as dependent variables and Age, BMI, Years of Activity and Hand Strength as independent variables in SP. The analyses were performed using Stata (StataCorp, v.13) and SPSS Statistics (IBM, v.20) software. The α level of statistical significance was set at 0.05.

Result

The two groups considered (soccer players and controls) were found fully comparable for age, sex and BMI (Table 1).

Among the 34 players evaluated at baseline, 28 participated in the follow-up 6 months later.

At baseline and after the training period, SP group showed a reduced AJM compared to controls ($p<0.001$) in both ADF and APF ($p<0.001$; Table 1). The results related to muscle strength (Hand Grip Strength Test) were similar between the two groups considered (SP vs controls). The STP period did not induce changes in the AJM of SP group (Table 2).

Table 2. Detailed characteristics, ankle joint mobility, muscle strength of Team A and Team B soccer players before and after the stretching training program.

	Baseline			**After STP**			**Baseline vs After STP**	
	Team A (18)	Team B (16)	P value	Team A (16)	Team B (12)	P value	Team A P value	Team B P value
Age (yrs)	29.4±5.6	28.5±3.2	0.782*	-----	-----	-----	-----	-----
BMI (kg/m^2)	23.2±2.4	23.0±1.8	0.788	-----	-----	-----	-----	-----
Yrs of Soccer Practice	19.5±6.5	16.9±4.8	0.279*	-----	-----	-----	-----	-----
HGS (kg)	43.8±7.1	46.3±7.9	0.369*	-----	-----	-----	-----	-----
ATOT (°)	117.4±12.2	116.0±14.3	0.756*	119.5+11.2	111.7+18.8	0.185	0.118	0.197^
APF (°)	26.0±5.2	24.8±5.0	0.506	28.3+4.8	27.6+8.1	0.757	0.659	0.004
ADF (°)	91.4±10.5	91.3±10.7	0.968	91.1+11.7	84.2+12.8	0.146	0.160	0.027
Δ D/non-D (°)	5.6±4.4	4.4±2.8	0.356	4.2+5.3	5.5+4.2	0.236*	0.499	0.344

Values are mean±SD. Comparisons among groups were performed using *t*-test (paired samples or independent) or non-parametric Mann-Whitney (*) or Wilcoxon rank (^) test. BMI: body mass index; HGS: hand grip strength; ATOT: Total ankle mobility; APF: ankle plantar flexion; ADF: ankle dorsiflexion; D/non-D: dominant/non-Dominant; Δ: difference; STP: Stretching training protocol; (°) degrees.

Considering the initial values there was a direct correlation between HS and BMI ($r=038$; $p<0.025$), while ATOT showed an inverse correlation with the years of activity (-0.36; $p<0.037$). No correlation was found between hand grip test and AJM. The results of the present study showed that STP does not significantly affect the ankle range of motion of soccer players.

Similarly, the ankle ROM difference between the two ankles (right vs left; dominant vs non-dominant) is similar between SP and Controls as well as it did not change after the STP.

The two teams considered in this study (Team A and B) performed the same number of weekly training sessions (twice a week) with the same duration (90 minutes). Only the soccer field surface used for training (dirt surface vs artificial turf) and, therefore, the soccer shoes used were different in the two soccer teams considered. The comparison between the two teams (Team A vs Team B; Table 2) showed a very similar ATOT with a difference of 1.4° (1.2%). Even considering the two Teams separately, ATOT values did not change after the training period. Considering the role of the players, the defenders of Team A (n = 6) and Team B (n=5) showed a higher AJM than the other players considered (n=23) (124.4±17.2° vs 113.1±8.8°; p = 0.015). Otherwise, the midfielders (n=13) showed lower muscle strength values (42.9±7.4 kg) even if the differences between the groups considered (n=21; 46.3±7.5 kg) did not reach full significance (data not shown). The multiple linear regression analysis did not show any significant effects of age, BMI, duration of soccer practice or hand grip strength on ankle ROM (Table 3).

Table 3. Multiple linear regression analysis considering dorsiflexion (ADF), plantar flexion (AFP) and total AJM (ATOT) (expressed as degrees) as dependent variables and age, BMI, years of activity and Hand grip strength as independent variables in Adult SP (n=34).

	Soccer Players (34)		
	ß-Reg. coef.	p-Value	p-Model
APF			
			0.687
Intercept	37.72	0.002	
BMI	-0.51	0.279	
Age	-0.03	0.910	
Years of activity	-0.14	0.526	
Hand Grip Strength	0.07	0.628	
ADF			
			0.343
Intercept	107.51	<0.001	
BMI	-1.26	0.178	
Age	0.29	0.594	
Years of activity	-0.54	0.204	
Hand Grip Strength	0.33	0.221	
ATOT			
			0.282
Intercept	145.22	<0.001	
BMI	-1.78	0.129	
Age	0.26	0.701	
Years of activity	-0.68	0.200	
Hand Grip Strength	0.39	0.237	

Note: ß-Reg. Coef.: Unstandardized coefficients

Discussion

The highly interesting topic of the alteration of the ankle joint mobility in soccer players was addressed in this study. This topic is of great interest considering the key role played by ankle mobility for the quality of movement, performance, and injury prevention in SP (Ekstrand&Gillquist, 1982; Armenis et al, 2011; Moreno-Perez et al, 2020; Owoeye et al, 2020).

According to the literature considered (Hattori&Oha, 1986; DeLang et al, 2017; Norkin et al, 2016) , the amateur soccer players included in this study showed an AJM of about 15.2% lower than that of the non-SP controls (Tab. 1). The AJM values found in the control group were similar to those reported in large cohort studies and aimed at defining reference values for this parameter (Boone&Azen, 1979; Grimston et al, 1993; Kumar et al, 2011; Norkin et al, 2016; Soucie et al; 2011). The lower AJM found in SP group was in agreement with what was reported in our previous study on young SP. In particular, in young SP, the reduction in AJM was 9.5% (Francia et al, 2020). Unlike the results obtained with the study conducted on young SP, the results of the present study showed that the proposed STP did not improve the AJM of the amateur SP considered.

As a whole, these results suggest that the effects of soccer practice on AJM are even more evident in adults than in younger SP and difficult to recover. In this sense, in addition to the long history of soccer practice several other factors can contribute to explaining this result, which seems to disagree with what was reported in previous studies. Among these, it is important to consider that the activity proposed in this study was suspended for over a month due to the Christmas period and Covid-19 pandemic. Furthermore, the absence of an athletic trainer in both the teams considered in this study seems to justify the differences in the results achieved compared with those obtained with a similar protocol followed by young SP (Francia et al, 2020). The same absence of an

athletic trainer could also justify the differences between the results obtained from those reported in other previous studies aimed at studying how stretching exercises modified the joint mobility of the lower limbs of SP (Akbulut et al, 2015; Azuma&Someya, 202O; Francia et al, 2020; De Freitas et al, 2020). In fact, in these articles the proposed STP period resulted in an improvement of the ankle ROM. Unfortunately, teams of amateur soccer players, are not always able to cover the costs of collaborating with an exercise science expert.

The difference in mobility between the two ankles of the SP was also considered in this study. In particular, since soccer is a sport that can lead to an asymmetry in the execution of the sporting gesture, such as kicking the ball, a different mobility between the dominant and non-dominant limb can be expected (Ekstrand&Gillquist, 1982; Tol et al, 2002; DeLang et al, 2017). In this sense, the results obtained did not show a significant difference in AJM between the dominant and non-dominant limb as well as between the right and the left in SP. The same comparison of the two soccer teams considered showed an overlap of the results obtained. Although the two teams trained on very different playing surfaces using therefore different soccer shoes, the results of this study seem to indicate that these parameters affected AJM to a lesser degree.

The results obtained showed that only the defenders showed a higher AJM than the players in other roles. The analysis of the factors considered in this study does not provide a possible explanation of the result obtained (Ispyrlidis et al, 2020). Overall, while on the one hand the results obtained indicate the importance of the treatment of AJM in SP, on the other hand they highlight the importance of organizing supervised training programs in order to verify the correct execution of exercises as well as the compliance with the STP proposed. The organization of supervised STP would allow, as reported in previous studies, the modification of the proposed exercises according to the needs of each SP. In this sense, further studies aimed at evaluating the effect of different stretching exercise protocols aimed at improving AJM in SP appear necessary.

Conclusion

The results of the initial assessments carried out with this study allowed verification to verify that soccer practice causes a marked reduction of AJM in amateur male footballers. These reduced AJM values found in the soccer group should be considered worrying for the possible consequences that this deficit can cause over time. The presence of a reduced subtalar joint range of motion can affect the structural integrity of the ankle as well as increasing the risk of injuries in players. It is also important to consider that reduced ankle joint mobility can have negative effects on numerous parameters such as balance, posture, quality of movement and performance. All these possible modifications can, in turn, have negative effects on the mobility of the ankle. All this suggests that the stiffness induced at the ankle level by the practice of soccer is a complex condition with possible medium and long-term consequences. Overall, it is possible to hypothesize how the reduced subtalar joint mobility in footballers is part of a complex vicious circle that should be appropriately known and managed during training.

Therefore, a specific unsupervised exercise training intervention can be considered worthy of attention. Unfortunately, the six-month unsupervised stretching training program proposed in this study does not lead to an improvement in the joint mobility of the ankle of SP. The interruptions of sporting activity due to the Covid-19 pandemic and the absence of Athletic trainers in the sports clubs involved, in addition to the long history of soccer practice could justify, at least in part, the lack of improvement on the ankle ROM. The different playing surfaces considered, as well as age, years of sports practice, muscle strength and BMI did not show an effect on AJM. Further studies are needed to evaluate the usefulness of avoiding the AJM reduction in soccer players

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