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Comprehensive profile of hip, knee and ankle ranges of motion in professional football players

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ABSTRACT

BACKGROUND: Limited ranges of motion (ROM) has been considered as a primary risk factor for some football injuries, but only a few studies have analysed differences in lower extremity joints. The main purposes were (a) to describe the lower extremity ROM profile in professional football players; and (b) to examine differences between goalkeepers and outfield players.

METHODS: 82 professional male football players from 4 teams were measured in the 2013 pre-season. Measures of passive hip (flexion with knee flexed [PHF_{KF}] and extended [PHF_{KE}], extension [PHE], abduction [PHA], external [PHER] and internal [PHIR] rotation), knee (flexion [PKF]) and ankle (dorsiflexion with knee flexed [ADF_{KF}] and extended [ADF_{KE}]) ROMs were taken. Magnitude-based inferences exploring differences between player position and limb were made.

RESULTS: 46% of all participants showed restricted PHF_{KE} and/or around 30% showed restricted ADF_{KF} ROM values. Contrarily, most players reported normal PHF_{KF}, PHE, PHIR and PHER as well as PKF ROM scores with percentage values close to 100%. Bilateral meaningful differences for PHA, PHIR and PHER were found in approximately 30% of outfield players and goalkeepers. Statistical analysis found trivial differences between players for PHF_{KE}, PHE, PHIR, PHER, ADF_{KE} and ADF_{KF}. However, moderate differences between players were found for PHF_{KF}, PHA and PKF, with goalkeepers demonstrating higher values than outfield players.

CONCLUSIONS: The findings of this study reinforce the necessity of prescribing exercises aimed at improving PHF_{KE} and ADF_{KF} ROM within everyday football training routines. In addition, as some bilateral deficits were observed, unilateral training should be considered where appropriate.

Keywords: clinical examination, injury prevention, sport therapy, muscle strain

INTRODUCTION

Football (soccer) is by far the world's most popular sport, with more than 270 millionparticipants.[1] Football requires players to perform a number of repeated high intensity movements such as sudden acceleration and deceleration, rapid changes of direction, jumping and landing tasks; as well as many situations in which players are involved in tackling to keep possession of or to win the ball.[2] The high intensity demands of movements required in football could lead to an overload in the joints, generating sport-specific adaptations that would cause impairments in their normal range of motion (ROM) during football activities and thus may result in a notable risk of injuries.[3-7]

Therefore, it would appear important to analyse the possible football-specific adaptations in the lower extremity joint ROMs at professional level in order to effectively plan and establish successful prevention and rehabilitation programmes. Some studies have analysed the impact of football play in some hip (flexion, extension and abduction) and knee (flexion and extension) ROMs [4-14] reporting normal (compared to the sedentary population) and non-pathologic (based on the previously published cut-off scores to classify athletes at high risk of injury) ROM values. Only Daneshjoo et al.[9] have reported bilateral asymmetries (in favour of the dominant limb) in hip flexion ROM with the knee extended. These results have led some football health care professionals to overlook the assessment of the lower extremity joints ROMs in pre-season screening sessions and to question the use of stretching exercises during both the pre- and in-season training schedules, as a preventative measure to reduce the number and impact of some football-related injuries.

However, when interpreting the extant literature regarding the effects of football play on normal lower extremity joint ROMs, some limitations are noted, which should be clarified before recommendations to football sports science and medicine practitioners can be made. For instance, it should be noted that few studies [7-9, 11, 13, 15] have analysed whether football-specific adaptations would occur in the ankle and hip rotation ROMs despite the fact that restricted scores have been considered as primary risk factors for some of the most common injuries in football, such as ankle sprains [8, 16, 17] and knee osteoarthritis [18], respectively. Furthermore, even less studies [4, 8, 19] have analysed the possible differences in lower extremity joints ROMs between goalkeepers and outfield players in order to make evidence-based training recommendations. Finally, no studies have reported whether professional players present with normal or restricted hip, knee or ankle ROM values. This knowledge would allow sports science and medicine practitioners to better understand the possible football-specific adaptations in the lower extremity joints ROMs that might be caused by technical and tactical training and a lack of bilateral conditioning. Previous studies has suggested that there is a large degree of inter-player variability in ROMs [4, 6-8, 10-14] and thus by reporting group average ROM may distort the true extent of the number of players reporting restricted ROM.

Thus, it remains to be clarified whether the repetitive loading forces generated during football training and match play induce alterations in the lower-extremity joint ROMs profile in professional football players, such as bilateral differences or as an individual deficit in one or more ROM. Furthermore, only two studies have analysed the possible differences in lower extremity ROM profiles between goalkeepers and outfield players reporting conflicting results. [4, 8] Consequently, more studies are needed to address this issue, as this knowledge would allow sports science and medicine practitioners to establish specific ROM goals to be achieved by goalkeepers and outfield players through planned prevention and rehabilitation programmes.

Therefore, the aims of the present study were: (a) to describe the lower extremity ROM profile in professional football players; and (b) to analyse if there are differences between goalkeepers and outfield players in the ROM.

MATERIALS AND METHODS

Participants

Eighty-two professional young adult male football players (68 outfield players and 14 goalkeepers) completed this study. Participants were recruited from 4 different football teams that were engaged in the professional Championships of the Spanish Football Federation. Before data collection, participants completed a questionnaire containing questions about their sport-related background (player position, current level of play, dominant leg [defined as the participant´s kicking leg], sport experience); anthropometric characteristics (age, body mass, stature and body mass index); and training regimen (weekly practice frequency, hours of football practice per week and day, and stretching exercises and load routinely performed in their daily training sessions). Data from questionnaires reported that the sample was homogeneous in potential confounding variables, such as body mass, stature, age, training regime (one game and 4–6 days of training per week), climatic conditions, level of play (professional players), resting periods and sport experience (at least 8 years) (table I). In addition, none of the participants were involved in systematic and specific stretching regimes in the last 6 months, apart from the 1-2 sets of 15-30 s of static stretches designated for the major muscles of the lower extremities (i.e. gluteus, hamstrings, quadriceps, adductors and triceps surae) that were performed daily during their pre-exercise warm-up and post-exercise cool down phases.

The exclusion criterion was history of orthopaedic problems to the knee, thigh, hip, or lower back in the 3 months before the study and whose residual symptoms could have an impact in the habitual players´ movement competency and/or lower extremity ROM profile. The study was conducted at the end of the pre-season phase of the year 2013. The time frame of the study was selected to be sure that the players recruited to each team was definitive and stable within the testing period.

Table 1: Demographic variables for the professional football players

	Mean ± SD
Age (years)	25.5 ± 5.0
Height (cm)	180.1 ± 6.5
Body mass (kg)	75.0 ± 6.5
Years playing football (years)	16.1 ± 4.0
Weekly practice frequency	6.1 ±1.2
Hours of football practice per week	9.8 ±2.1
Hours of football practice per day	1.6 ±0.5

SD: standard deviation

Before any participation, experimental procedures and potential risks were fully explained to the participants in verbal and written form, and written informed consent was obtained. The experimental procedures used in this study were in accordance with the Declaration of Helsinki and were approved by the University Office for Research Ethics.

Procedure

The passive hip flexion with knee flexed (PHF_{KF}) and extended (PHF_{KE}), extension (PHE), abduction (PHA), external (PHER) and internal (PHIR) rotation; knee flexion (PKF); and ankle dorsiflexion with knee flexed (ADF_{KF}) and extended (ADF_{KE}) ROMs of the dominant and non-dominant limb were assessed following the methodology previously described [20] (figure 1). These tests were selected because they have been considered appropriate by American Medical Organizations [21, 22] and included in manuals of Sports Medicine and Science [23, 24] based on reliability and validity studies, anatomical knowledge, and extensive clinical and sport experience. In addition, studies from our laboratory have reported moderate to high reliability for the procedures employed (variability ranging from 4 to 9º).[20, 25]

The dominant limb was defined as the participant´s preferred kicking leg. All tests were carried out by the same two physical therapists under stable environmental conditions.

Figure 1. Lower limb ROMs. Passive hip flexion with knee flexed test [PHF_{KF}] (1A); Passive hip flexion with knee extended test [PHF_{KE}] (1B); Passive hip extension [PHE] (1C); Passive hip extension with knee flexed [PKF]) (1D); Passive hip external rotation test [PHER] (1E); passive hip internal rotation test [PHIR] (1F); Ankle dorsi-flexion with knee flexed test [ADF_{KF}] (1G); Ankle dorsi flexion with knee extended test [ADF_{KE}] (1H).

Prior to the testing session, all participants performed the dynamic warm-up designed by Taylor et at.[26] (table 2). The overall duration of the entire warm-up was approximately 20 min. The assessment of the ROMs was carried out 3-5 min after the dynamic warm-up. A 3-5 min rest interval between the end of the warm-up and beginning of the ROMs assessment was given to the participants because in a pilot study with 10 participants of similar age and training status, practically required some time, to get hydration and to dry their sweat prior to the ROMs assessment. More importantly, it has been shown that the effects elicited by the dynamic warm-up on muscle properties might last more than 5 min[27] and hence, decreases in ROM values within the 3-5 min rest interval were not expected.

Table 2: Pre-assessment dynamic warm up*

Exercise	Duration
1. High knees	3 set over 20 m
2. Butt flicks	3 set over 20 m
3. Carioca	3 set over 20 m each side
4. Dynamic hamstring swings	10 repetitions each leg
5. Dynamic groin swings	10 repetitions each leg
6. Arm swings: forwards and backwards	10 repetitions each direction
7. Faster high knees (shorter stride)	4 sets over 10 m
8. Swerving	2 sets over 30 m at 70% of maximum pace
9. Side stepping	2 sets over 30 m at 80% of maximum pace
10. Spiderman walks	1 set over 20 m
11. Sideways low squat walks	1 set x 10 steps each direction
12. Upper body rotations	10 repetitions each leg
13. Vertical jump	5 repetitions building in intensity
14. Run through	− 2 sets x 20 m at 70% of maximum pace
	− 2 sets x 20 m at 80% of maximum pace
	− 1 set x 20 m at 90% of maximum pace
15. Countermovement jump then 5 m sprint	− 2 sets x 5 m at 90% of maximum pace
	− 1 sets x 5 m at 95% of maximum pace
16. Sprint for 5 m then countermovement jump	2 sets x 5 m

m: meters; *: warm up programme extracted from Taylor et al. [26]

After the warm-up, participants were instructed to perform, in a randomised order, 2 maximal trials of each ROM test for each limb, and the mean score for each test was used in the analyses.

Participants were examined wearing sports clothes and without shoes. A 30 s rest was given between trials, limbs and tests.

One or both of the following criteria determined the endpoint for each test: (a) palpable onset of pelvic rotation, and/or (b) the participant feeling a strong but tolerable stretch, slightly before the occurrence of pain.

Statistical Analysis

Prior to the statistical analysis, the distribution of raw data sets was checked using the Kolomogorov-Smirnov test and demonstrated that all data had a normal distribution ($p > 0.05$). Descriptive statistics including means and standard deviations were calculated for hip, knee and ankle ROM measures separately by player position (outfield players and goalkeepers) and limb (dominant and non-dominant).

Furthermore, in each participant, the hip, knee and ankle ROM scores were categorized as normal or restricted according to the reference values previously reported to consider an athlete as being more prone to suffer an injury [28-32]. In cases where no cut-off scores for detecting athletes at high risk of injury had been previously reported (i.e. PHA and PHIR ROMs), they were compared with data generated on the general population. Thus, ROM values were reported as restricted according to the following cut-off scores: <114º for the PHF_{KE} ROM [28], <80º for the PHF_{KF} ROM [29], <50º for the PHA ROM [33], <25º for the PHIR ROM [31], <25º for the PHER ROM [34], <0º for the PHE ROM [32], <17º for the ADF_{KE} ROM [35], and <34º ADF_{KF}ROM [30].

In order to be able to make comparisons with the results reported in previous similar studies, magnitude-based inferences on differences between player position (outfield players versus goalkeepers) and limb (dominant versus non-dominant) were determined using a spreadsheet designed by Hopkins [36] for change scores between paired comparisons for each ROM variable. This analysis determines the chances that the differences are substantial or trivial when a value for the smallest worthwhile change is entered. The cut off score of >6º proposed by Fousekis, Tsepis[6] determined the smallest substantial/worthwhile change for both the inter- player and limb comparisons for each of the ROM variables. The qualitative descriptors proposed by Hopkins [37] were used to interpret the probabilities that the true affects are harmful, trivial or beneficial: <1%, almost certainly not; 1–4%, very unlikely; 5– 24%, unlikely or probably not; 25–74%, possibly or may be; 75–94%, likely or probably; 95–99%, very likely; >99%, almost certainly. Effect sizes, which are standardised values that permit the determination of the magnitude of differences between groups or experimental conditions were also calculated for each of the variables using the method and descriptors previously described by Cohen [38]. Based on Fousekis et al. [6], the number of players with side-to-side differences (>6º) in each ROM measure were also calculated.

Analysis was completed using SPSS version 20 (SPSS Inc, Chicago, IL, USA) and an online spreadsheet (www.sportsci.org).

RESULTS

Tables III and IV show the descriptive ROM values (mean ± SD) for passive hip (PHF_{KF}, PHF_{KE}, PHE, PHA, PHIR and PHER), knee (PKF) and ankle (ADF_{KE} and ADF_{KF}) for both, outfield players and goalkeepers, respectively.

Statistical analysis reported no meaningful differences (trivial effect with a probability > 99%) between dominant and non-dominant limbs for each ROM variable in both outfield players (table II) and goalkeepers (table III).

Table 3: Field-based players´ descriptive values and inference about side-to-side difference for hip (flexion, extension, abduction, internal and external rotation), knee (flexion) and ankle (dorsal-flexion with knee flexed and extended) ranges of motions (n = 68).

	Dominant limb		**Non-dominant limb**			
	Mean ± SD	**Qualitative Outcome***	**Mean ± SD**	**Qualitative Outcome***		
PHF_{KF}	145.9 ± 8.1	Normal (0)	147.3 ± 7.6	Normal (0)	6	Most likely trivial (0/100/0)
PHF_{KE}	80.3 ± 10.9	Normal (28)	81.1 ± 11.3	Normal (26)	8	Most likely trivial (0/100/0)
PHA	63.3 ± 9.1	Normal (6)	60.6 ± 8.2	Normal (6)	20	Most likely trivial (0/100/0)
PHIR	47.1 ± 8.0	Normal (1)	45.3 ± 7.9	Normal (0)	16	Most likely trivial (0/100/0)
PHER	49.9 ± 9.8	Normal (1)	50.7 ± 9.8	Normal (0)	22	Most likely trivial (0/100/0)
PHE	8.9 ± 8.8	Normal (11)	9.8 ± 8.5	Normal (10)	4	Most likely trivial (0/100/0)
PKF	126.9 ± 13.6	Normal (0)	124.6 ± 13.5	Normal (0)	14	Most likely trivial (0/100/0)
ADF_{KE}	36.1 ± 5.7	Normal (0)	36.3 ± 5.7	Normal (0)	5	Most likely trivial (0/100/0)
ADF_{KF}	37.2 ± 6.6	Normal (21)	37.8 ± 6.1	Normal (18)	5	Most likely trivial (0/100/0)

PHF_{KF}: passive hip flexion with knee flexed test; PHF_{KE}: passive hip flexion with knee extended test; PHA: passive hip abduction test; PHIR:passive hip internal rotation test; PHER: passive hip external rotation test; PHE: passive hip extension test; PKF: passive knee flexion test; ADF_{KE}: ankle dorsi flexion with knee extended test; ADF_{KF}: Ankle dorsi-flexion with knee flexed test.

º: degrees; *: qualitative score of the mean range of motion, in parentheses the number of players with a restricted range of motion score according to previously published cut-off scores (see Statistical analysis section).

[a]Substantial is an absolute change in performance of > 6º for all ROM measures for passing accuracy (see Methods).

[b] If chance of benefit and harm both >5%, true effect was assessed as unclear (could be beneficial or harmful). Otherwise, chances of benefit or harm were assessed as follows: <1%, almost certainly not; 1-5%, very unlikely; > 5-25%, unlikely; >25-75%, possible; >75-95%, likely; >95-99%, very likely; >99%, almost certain

Table 4: Goalkeepers´ descriptive values and inference about side-to-side difference for hip (flexion, extension, abduction, internal and external rotation), knee (flexion) and ankle (dorsal-flexion with knee flexed and extended) ranges of motions (n = 14).

	Dominant limb		Non-dominant limb			
	Mean ± SD	**Qualitative Outcome***	**Mean ± SD**	**Qualitative Outcome***		
PHF_{KF}	150.9 ± 9.4	Normal (0)	151.8 ± 7.2	Normal (0)	0	Most likely trivial (0/100/0)
PHF_{KE}	80.3 ± 10.1	Normal (7)	79.5 ± 10.7	Restricted (8)	2	Most likely trivial (0/100/0)
PHA	67.9 ± 7.6	Normal (0)	66.6 ± 9.8	Normal (1)	4	Most likely trivial (0/100/0)
PHIR	49.4 ± 10.5	Normal (0)	47.9 ± 6.3	Normal (0)	5	Most likely trivial (0/100/0)
PHER	50.8 ± 7.6	Normal (0)	48.5 ± 8.3	Normal (0)	4	Most likely trivial (0/100/0)
PHE	12.2 ± 7.4	Normal (0)	12.7 ± 7.8	Normal (0)	1	Most likely trivial (0/100/0)
PKF	131.7 ± 10.9	Normal (0)	131.4 ± 13.2	Normal (0)	3	Most likely trivial (0/100/0)
ADF_{KE}	36.6 ± 5.1	Normal (0)	37.0 ± 5.1	Normal (0)	3	Most likely trivial (0/100/0)

ADF_{KF}	37.5 ± 7.1	Normal (2)	40.6 ± 4.7	Normal (2)	2	Most likely trivial (0/100/0)

PHF_{KF}: passive hip flexion with knee flexed test; PHF_{KE}: passive hip flexion with knee extended test; PHA: passive hip abduction test; PHIR:passive hip internal rotation test; PHER: passive hip external rotation test; PHE: passive hip extension test; PKF: passive knee flexion test; ADF_{KE}: ankle dorsi flexion with knee extended test; ADF_{KF}: Ankle dorsi-flexion with knee flexed test.

º: degrees; *: qualitative score of the mean range of motion, in parentheses the number of players with a restricted range of motion score according to previously published cut-off scores (see Statistical analysis section).

Statistical analysis also reported trivial differences (trivial effect with a probability of 84-100%; d < 0.2) between players (outfield players and goalkeepers) for PHF_{KE}, PHE, PHIR, PHER, ADF_{KE} and ADF_{KF} ROM measures (table V). However, moderate differences (possibly meaningful effect with a probability of 62-71%; d >0.40) between players were found for PHF_{KF}, PHA and PKF, with goalkeepers showing higher scores than outfield players.

Table 5: Inter-group differences (field players vs goalkeepers) for passive hip (flexion with knee flexed [PHF_{KF}] and extended [PHF_{KE}], extension [PHE], abduction [PHA] and rotation (external [PHER] and internal [PHIR]), knee (flexion [PKF]) and ankle (dorsi flexion with knee flexed [ADF_{KF}] and extended [ADF_{KE}]) ROM values (dominant limb). Chances that the true effects were substantial, and practical assessments of the effects are also shown

PHF_{KF}	-5.0 (-10.4 to 0.4)	-0.49	0	63	37	Possibly meaningful
PHF_{KE}	0.0 (-5.8 to 5.8)	0.00	5	91	4	Likely trivial
PHA	-4.6 (-9.1 to -0.1)	-0.56	0	71	29	Possibly meaningful
PHIR	-2.3 (-8.3 to 3.7)	-0.20	1	84	14	Likely trivial
PHER	-0.9 (-5.4 to 3.6)	-0.11	1	96	3	Very likely trivial
PHE	-3.2 (-7.6 to 1.2)	-0.40	0	86	14	Likely trivial
PKF	-4.8 (-11.2 to 1.7)	-0.40	1	62	37	Possibly meaningful
ADF_{KE}	-0.5 (-3.5 to 2.4)	-0.10	0	100	0	Most likely trivial
ADF_{KF}	-0.4 (-4.4 to 3.7)	-0.05	1	98	1	Very likely trivial

º: degrees; T: mean ± 90% confidence limits.

[a] Substantial is an absolute change in performance of > 6º for all ROM measures for passing accuracy (see Methods).

[b] If chance of benefit and harm both >5%, true effect was assessed as unclear (could be beneficial or harmful). Otherwise, chances of benefit or harm were assessed as follows: <1%, almost certainly not; 1-5%, very unlikely; > 5-25%, unlikely; >25-75%, possible; >75-95%, likely; >95-99%, very likely; >99%, almost certain

DISCUSSION

The main findings of this study reported average values classified as normal (based on the reference values reported in previous studies) for passive hip (flexion, extension, abduction and rotation), knee (flexion) and ankle (dorsiflexion) ROMs for both outfield players and goalkeepers. Similar results have been found in previous studies [4-10, 12, 13] that have described the lower extremity ROM profile of football players. From this standpoint, no specific adaptations in the lower extremity joints ROMs would be expected as a consequence of football training and match play at professional levels and hence, no further injury prevention measures need to be considered, which are aimed at improving ROMs.

However, when a novel and more comprehensive analysis is carried out, the current data indicates that a large number of the football players demonstrate restricted PHF_{KE} (cut-off score < 80º; outfield players ≈ 40%; goalkeepers ≈ 50%) [29] and/or ADF_{KF} (cut-off score < 34º; outfield players ≈ 30%; goalkeepers ≈ 28%) [30] ROM values. These latter results are in conflict with the findings reported by previous studies that have described the lower extremity ROM profile of football players using average ROM scores [4-10, 12, 13]. This discrepancy might be explained by the fact that the average PHF_{KE} and ADF_{KF}ROM values, although categorized as normal, are close to the restricted cut-off score previously published (80º [29] and 34º [30] respectively) and hence, if the inter-player variability is not taken into account the findings might be biased. As a consequence, these biased results might cause an unrealistic diagnostic of non football-specific adaptations in the lower extremity joints ROMs. Comparisons with other previously published findings are not possible as there appears to be no previous study analysing the ROM of hip, knee and ankle using the same comprehensive analysis carried out in the current study.

The large percentage of players reporting restricted PHF_{KE} and ADF_{KF} ROM in the current study might be explained by the demands of football training and match play that requires players to perform a number of repeated high intensity movements such as sudden acceleration and deceleration, rapid changes of directions, jumping and landing tasks. These movements impose strong concentric and eccentric loads on the hip flexor and ankle dorsi-flexion muscles (posterior kinetic chain) at shortened contracted positions [39-41]. When these actions are repeated several times during training sessions and games, they have the potential to generate muscle damage that without the proper recovery and protective measures, they might induce impairments in the mechanical and neural properties of the muscle-tendon units, including a reduction in their normal ROM and strength loss. [42]

In addition, another factor that might have contributed to these restricted ROM values could be the demanding competitive calendar of players at professional levels that can result in athletes focusing on competition and thus compromising training, leading to suboptimal recovery and preparation. These deficits have been suggested as predisposing factors for increasing the likelihood of some of the most prevalent hip and knee pathologies in football players such as hamstring muscles strains [5-8, 43], patellar tendinopathy [7, 44] and ankle sprain [8, 16, 17]. Based on the present results, sports science and medicine practitioners should include during both, the pre- and in-season training schedules, stretching exercises of the hip, enhancing hip flexion ROM with the knee extended; and ankle, enhancing dorsi-flexion ROM with the knee flexed. It seems important to suggest that coaches and strength and conditioning specialists should educate the players in order to be able to distinguishing between the stretching routines used for improving joints ROM (i.e. static and proprioceptive neuromuscular facilitation stretching routines during the training sessions) and the one used as part of the warm-up process (i.e. dynamic stretching exercises), targeting to activate the muscle groups involved in a specific performance task.[45] Therefore, and based on the documented acute negative effect of static stretching on maximal muscle performance [46], routines aimed at improving ROM values that usually include static stretching exercises should be performed at the end of the training sessions or even better as separate training sessions.

The results of the current study also found non-clinically relevant bilateral differences (> 6º) between the dominant and non-dominant lower extremity joints ROM average values in both outfield players and goalkeepers. However, by calculating the number of players with bilateral differences greater than 6º in any hip, knee and ankle ROM measure, approximately 30% of the players (outfield players and goalkeepers) were identified for PHA, PHIR and PHER. In particular, the bilateral differences for PHA and PHIR reported were mostly in favour of the dominant limb for the outfield players (16 up to 20 cases and 13 up to 16 cases for PHA and PHIR ROMs respectively). The asymmetrical and repeated technical gestures of kicking and controlling the ball using mainly the dominant limb might be a plausible explanation for the bilateral differences in favour of the dominant limb, identified in the current study. Thus, the backswing phase of kicking (i.e. volley) and controlling the ball may reflect in some cases a dynamic stretching for the hip external and adductor muscles which may increase the hip internal and abduction ROMs respectively. In addition, and similar to what has been found in tennis players [47], the higher number of repetitive and powerful internal rotational movements generated in the stance limb (non-dominant) during the technical gesture of kicking (forward swing) to transfer power to the final part of the movement could lead to microtrauma and capsular contracture, causing a hip internal rotation ROM deficit in many of the male players. Conversely, there was not a clear pattern for PHER ROM so that almost the same number of outfield players with bilateral differences reported greater values in the dominant and non-dominant limb. An explanation for this discrepancy has not been found. The same circumstance was found in the goalkeepers so there appears not to be clear patterns for any meaningful bilateral difference found for PHA as well as PHIR and PHER ROM measures. Perhaps, the small sample size of goalkeepers (n = 14) might explain why we did not observe any pattern. Although still inconclusive, some studies have suggested that bilateral asymmetries of lower extremity ROMs may alter the kinetic patterns of lower extremity function during the production of excessive and asymmetrical forces in explosive sports activities, such as kicking and cutting in soccer and this might play a role in the mechanisms that predispose a soccer player to suffer an injury (mainly muscle strains). [6, 48] The current study also identified the presence of moderate differences (possibly meaningful effect with a probability of 62-71%; d > 0.40) between players for PHF_{KF}, PHA and PKF ROM measures, with goalkeepers showing higher values than outfield players. Similar PKF ROM differences in favour of goalkeepers were found by Arnason et al.[4]. However, Bradley and Portas[8] did not find differences in PHF_{KF}, PHA and PKF ROM measures between outfield players and goalkeepers. Perhaps, the higher ROM scores shown by goalkeepers may be due to their specific physical demands as they need greater ROM values to cover a large perimeter of the goal and to stretch as much as possible to save or deflect shots. [4]

Some limitations to the study must be acknowledged. The age distribution of participants was relatively narrow and the goalkeepers' sample size was small. Moreover, the use of different testing methodologies (i.e., active ROMs) makes comparisons difficult.

PRACTICAL APPLICATIONS

The findings of this study reinforce the necessity of prescribing exercises aimed at improving PHF_{KE} and ADF_{KF} ROM values in the everyday football training routines of professional male players. Furthermore, the findings of this study also indicate no significant differences (< 5º) in ROM for the hip, knee and ankle between outfield players and goalkeepers and hence, exercises designed and prescribed in applied settings do not have to be adapted for individuals and could be delivered as group exercise. Although we found few ROM deficits in the current sample, some bilateral differences were observed and unilateral training should be considered in sports where training might promote bilateral differences. This is especially so in professional football were repetitive movements are undertaken that involve a kicking and stance leg which develop bilateral deficits.

Conflicts of interest

The authors declare that they have no conflicts of interest in the commercial or proprietary interest in any device, equipment, instrument, authorship or publication of this contribution.

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TITLES OF TABLES

Table I. Demographic variables for the professional football players.

Table II: Pre-assessment dynamic warm up.

Table III. Field-based players´ descriptive values and inference about side-to-side difference for hip (flexion, extension, abduction, internal and external rotation), knee (flexion) and ankle (dorsal-flexion with knee flexed and extended) ranges of motion (n = 68).

Table IV. Goalkeepers´ descriptive values and inference about side-to-side difference for hip (flexion, extension, abduction, internal and external rotation), knee (flexion) and ankle (dorsal-flexion with knee flexed and extended) ranges of motions (n = 14).

Table V. Inter-group differences (field players vs goalkeepers) for passive hip (flexion with knee flexed and extended, extension, abduction and rotation (external and internal), knee (flexion) and ankle (dorsi flexion with knee flexed and extended) ROM values (dominant limb). Chances that the true effects were substantial, and practical assessments of the effects are also shown.

TITLES OF FIGURES

Figure 1. Lower Limb ROMs.

Figure 1a. The passive hip flexion with knee flexed (PHF_{KF}).

Figure 1b. The passive hip flexion with knee extended (PHF_{KE}).

Figure 1c. The passive hip extension (PHE).

Figure 1d. The passive knee flexion (PKF).

Figure 1e. The passive hip external rotation (PHER).

Figure 1f. The passive hip internal rotation (PHIR).

Figure 1g. The passive ankle dorsiflexion with knee flexed (ADF_{KF}).

Figure 1h. The passive ankle dorsiflexion with knee extended (ADF_{KE}).