

# Evaluation of Weight-bearing Ankle Dorsiflexion Range in Professional Soccer Players

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## ABSTRACT

**Introduction:** The ankle dorsiflexion range of motion (ROM) in closed kinetic chain (CCF) is an important variable that contributes to changes in lower limb mechanics in soccer, and its limitation increases the risk of injuries. Thus, the aim of this study was to evaluate the range of ankle dorsiflexion with weight bearing in professional soccer players in Brazil, as well as to associate it with sports injuries.

**Methods:** An observational and cross-sectional study was carried out with professional football teams in the pre-season of a Brazilian Football Championship in 2017. Initially, data were collected regarding professional career time, injury history and presence of post-game pain or post-workout. Subsequently, the evaluation of ankle dorsiflexion ROM in CCF, on both sides, was performed using the Leg Motion system.

**Results:** there was no significant difference in ankle dorsiflexion ROM between the sides, in addition, the correlation between ankle dorsiflexion ROM and professional career time was weak, as well as between dorsiflexion ROM and age. There were also no associations between asymmetry and mobility restriction with post-game/training pain. However, asymmetry and limitation of dorsiflexion ROM showed association with injury history.

**Conclusion:** we can conclude that the reference value of ankle dorsiflexion ROM with load in professional soccer players is like that already established in healthy players. However, asymmetry between the limbs and limited mobility of the ankle can influence the presence of injuries.

**Keywords:** Soccer; Injury; Articular Range of Motion; Ankle

## Introduction

Soccer is considered the most popular sport in the world, because there are approximately 265 million people practicing regularly in a professional, semiprofessional or amateur fashion. According to the International Federation of Football Association (FIFA) [1] in 2007 there were more than 1.7 million teams and approximately 301 thousand clubs around the world, representing 4% of the world population and currently included both in social and cultural aspects. Molded in a millionaire product/service, which is part of the world economy. However, this sport brings high injury rates, regardless of the level [2]. When aimed at professional level, the physical demands are even higher, for its athletes work at high intensity, along with practices and consecutive matches in a short period of time. During each match, athletes run total distances of 9 to 12 kilometers, associated to high speeds, changes of direction, jumps, headers, kicks and sprints [3]. These premises, specific of this sport, increase the propensity of osteomyoarticular lesions, and the lower end is responsible for 75 to 85% of every injury. Ankle and knee sprain and muscle strain, especially of harmstrings, and low back pain are the most prevalent lesions, besides the dominant side being the most affected (Zabka, et al. [4]).

Limitation of range of motion (ROM) of ankle dorsiflexion results from various clinical events such as history of injuries, calcaneus pain and nerve entrapment, that leads to abnormal biomechanics of the lower ends during closed chain strengthening exercises. For example, the reduction of ankle flexion during squats results in increased knee valgus, decreased quadriceps activation and increased activation of solear [5]. For this reason, it is necessary to have a thorough evaluation with the objective of minimizing lesions risk. Measuring articular ROM is fundamental for diagnosing, planning and monitoring the evolution in the training or treatment program (from discharging to returning to normal activities). For such, the choice of evaluation instrument, the vision and the clinical practice are key pieces in good data collection. In view of this, countless evaluation instruments are being developed. Among them, the leg motion system stands out, portable device, easy to apply, trustworthy, able to evaluate weight-bearing ROM of ankle. An important variable, because directly simulates the sporting gesture [6]. Given the professional soccer is a sport that involves several sectors, from financial to emotional, a thorough investigation on functional deficiencies is necessary, especially those that most interfere in the process of contactless injury. The present study aims to evaluate ankle dorsiflexion ROM with weight bearing, using Leg Motion, as well as to associate it with the sports injuries that most affect professional soccer players.

## Material and Methods

### Casistry and Sample Characterization

A cross-sectional observational study was performed with the professional soccer teams from 2017 Sergipe's Soccer Championship in pre-season. Of the 10 teams involved in the championship, 3 teams

did not make themselves available for the study, totaling a sample of 7 teams, containing 121 players. Were excluded from the study 23 athletes that presented lesion or physical complaint at evaluation day and 31 that presented any injury in the 6 months prior to collection.

### Research Steps

Initially the athletes received information about the research objectives, instruments used, verbal commands to be answered and other data collection procedures, as well as signed the Written Informed Consent Form (WICF) (Attachment A). The research project was approved by Human Beings Research Ethics Committee (Attachment B) (CAAE protocol number: 78661317.1.0000.5546). Next, answered an evaluation sheet, with personal data (name, age, address and phone for contact) and were subjected to anthropometric evaluation, with a Welmy® brand scale, previously calibrated, the volunteers were using light clothes and barefoot. Body Mass Index (BMI) was calculated through high and weight measurement, according to ABESOs (2016) [7] guidelines. They were still questioned about the time of performance as professional athletes, history of injury, as well as presence and level of post-match or post-practice pain (Appendix A). Later, an assessment of ankle mobility was performed.

### Evaluation of Ankle Mobility

To evaluate weight-bearing ROM of ankle dorsiflexion was used the Leg Motion device, that was positioned in a large room, with flat and non-stick surface, in a private physiotherapy clinic. Players were instructed not to do any kind of physical exercise prior to the evaluation, wear light and comfortable clothes e barefoot. To perform the test, two evaluators were used, evaluator one, positioned to the side, realizing the entire procedure and evaluator two, positioned in front of the subject, writing results and supporting evaluator one. To run the test, the player was instructed by evaluator one to position one foot on a platform, with pododactyles behind a horizontal line, hallux as distal reference and second finger positioned above a median line dividing the device. The counter-lateral foot was more posterior, free to position more comfortably and balanced and hands on the hips. Requested the athlete to perform a squat movement with the objective of touching the knee in a metal stick, high adjusted to patellar base, located in front of him. Three tries were performed to habituate the participant and, next, three more, of which the highest obtained value in numerical graduation was registered. According to Calatayud, et al. [8] the reference value of mobility using Leg Motion in healthy individuals is 11cm. in a recent study, the symmetry of mobility of right and left ankle was investigated and considered an asymmetrical relation when the value of one side was 10% different of its counter lateral [9]. Thus, in this study, the athletes with value over 1.5 were considered asymmetrical. The measures of mobility averages between right and left side were compared, as well as performed correlations between mobility and age and mobility and time of performance as professional athlete. Were still performed associations of mobility changes with history of injury and presence of post-practice

or post-match pain, presence of asymmetry with history of injury and presence of post-practice or post-match pain.

### Statistical Analysis

Statistical analysis was performed by Bio Estat 5.3 software establishing trust interval of 95% ( $p < 0.05$ ), continuous variables were expressed as average, standard deviation and percentage. To compare between averages initially was performed the Kolmogorov-Smirnov test of normality and, after investigating the normality, were performed the comparisons between samples paired through T Test or Wilcoxon. Correlations were measured by simple linear regression using Pearsons ( $r$ ) correlation coefficient or Spearmans ( $r_s$ ) and for the chi-square association tests.

### Results

The sample was made of 121 professional field soccer players, all males (aged  $24.22 \pm 5.11$ , weight  $74.93 \pm 8.18$ , high  $1.76 \pm 0.10$  and BMI  $23.67 \pm 1.67$ ). Results of history of injury evaluation showed that 66.1% of the athletes had some kind of injury last year. From these lesions, ankles (30.5%), knees (19.8%) and posterior thigh muscles (16.5%) were the most incidental. When investigating the presence of post-practice or post-match, was observed that 50.5% of players presented pain, being that 16.2% in posterior thigh area, 16.2% in lower back area, 14.2% in ankles and 13.2% in knees. The results of evaluation of weight-bearing ROM of ankle dorsiflexion, used by Leg Motion, were  $11.01 \pm 3.59$  on the right side (RS) and  $10.94 \pm 3.29$  on the left side (LS), there was no significant difference between sides ( $p = 0.90$ ). Was found a percentage of 78.8% of athletes with mobility changes on the right side and 80.9% on the left side, being considered 11cm the normality value of such variable. Regarding the symmetry of limbs, was found that 38.8% of athletes presented asymmetry. A correlation between weight-bearing ROM of ankle dorsiflexion and time of performance as professional was made and found a weak correlation between RS ( $r_s = -0.1731$ ) and LS ( $r_s = 0.1969$ ). A weak correlation was also found between weight-bearing ROM of ankle dorsiflexion and age (RS:  $r_s = -0.1720$  and LS:  $r_s = -0.0924$ ). When analyzing associations between changes in mobility and history of injury and presence of post-match or post-practice pain was observed associations only between the first variables ( $p = 0.0403$  - RS and  $p = 0.0002$  - LS) (Table 1). Besides that, was verified association of asymmetry of limbs with history of injury ( $p = 0.0104$ ), there is no association of asymmetry with post-practice or post-match pain ( $p = 0.4135$ ) (Table 2).

**Table 1:** Association between changes in mobility and history of injury and presence of post-practice or post-match pain.

| Association   | LRL            | LLL            |
|---|----------------|----------------|
| Change in Mobility and History of injury                | $p = 0,0403^*$ | $p = 0,0002^*$ |
| Change in Mobility and post-practice or post-match pain | $p = 0,1418$   | $p = 0,6799$   |

Note: Chi-square test with value of  $p < 0.05^*$  when there is association. LRL: Lower Right Limb; LLL: Lower Left Limb.

**Table 2:** Association between Asymmetry and History of Injury/Asymmetry and presence of post-practice or post-match pain.

| Association                                    | Value of p     |
|--|----------------|
| Asymmetry and history of injury                | $p = 0,0104^*$ |
| Asymmetry and post-practice or post-match pain | $p = 0,4135$   |

Note: Chi-square test with a value of  $p < 0.05^*$  when there is association.

### Discussion

The results of this research point that the area's most affected by injuries are knees, ankles and posterior thigh muscles. These data corroborate to the results found by several epidemiological studies related to soccer lesions [10-12]. During Hong Kong's, China, professional soccer championship, Lee, et al. [13] identified 296 soccer players affected by injuries over season 2010/2011, with ankle sprain as the most common and recurrent lesion, followed by posterior thigh muscles injury. The study of Salces, et al. [14] found similar incidence, registering 286 injuries during Dutch Championship, muscle lesions being the most prevalent and ankle and knee the most affected joints. Added to this, Zabka et al. [4] in their study, had already described that 68% to 88% of osteomyoarticular injuries in soccer happen in the lower limbs, supporting the results found in the present study, because the most incident areas are located there.

The higher incidence rate of muscle injuries in soccer players was proven in a prospective cohort study by Ekstrand, et al. [15]. They accompanied 36 teams of 12 european countries, for 13 years and found a total of 1,614 athletes affected by lesions in posterior thigh area. However, in these years, rates of articular injuries lowered due to preventive programs and more specific assessment of risk factors. Jain, et al. [16] said that a thorough physical evaluation of athletes significantly lowers the frequency of injuries, especially when performed in pre-seasons. Kudas, et al. [17] also emphasized that functional diagnosis has an essential role in preventing and lowering injuries. The main finding in this study was the reference value of ROM of ankle dorsiflexion, in professional field soccer players, applying Lunge test, using Leg Motion. Was verified an average value of 11cm for each joint, similar to the parameter found in the paper of validation and reliability of Adillón et al. (2022). when evaluating healthy individuals. Moreover, Docherty (2017) [18] found in his study a normal value of approximately 10,3cm for ROM of dorsiflexion in healthy individuals, simultaneously compared with the inclinometer at 15cm distal to tibial tuberosity ( $^\circ$ ), angle of dorsiflexion with inclinometer at the tibial tuberosity ( $^\circ$ ) and angle of dorsiflexion using 2D motion capture system ( $^\circ$ ). Research shows that to verify ROM of dorsiflexion in a reliable manner, measures must be obtained from a careful and thorough evaluation.

Konor, et al. [19] compared, in their study, three methods of evaluation, inclinometer, measuring tape against the wall (Lunge test) and goniometer. The first two were the most reliable, while the goni-

ometer showed more error prone. The visual reference of foot, ankle and knee is fundamental to a more reliable measure of ROM, since the alignment of these joints during the test brings more precision e more accuracy in values. This is one of the most important advantages of Leg Motion in relation to the other instruments, because during test execution the foot stands still and necessarily the knee has to touch the line set by the device, making unwanted movements difficult, which could generate biases in the analysis. Ratified by Morales, et al. [6] as valid, accessible and reliable to perform weight-bearing Lunge test to measure ROM of ankle dorsiflexion in elders above 65 years old. Other study data was the weak correlations found between mobility and age and between mobility and time performing professionally. Possibly, such weak correlation occurred because of the low age average of players in the current study. Faude, et al. [20] described that injuries in younger players are mainly associated to lower limbs fracture and incidence of lesions with no contact increase in older players. Waldén, et al. [21] related that in a cohort of 11 years of ankle injuries that ankle injuries rate significantly reduced over the years. Therefore, with the advent of preventive functional trainings incidence of ankle lesions over time has been reducing, what bases the result for the weak correlations found in this study (Hammami, et al. [22]).

Ankle mobility is an important variable, because predicts injuries in soccer, since physical demands in this sport are strenuous and use rotational movements, changes of direction, acceleration/ deceleration [3]. So, when evaluating ROM of dorsiflexion, it is better performed it with load, because simulates activities of daily living, in other words, are more functional (Hoch, et al. [23]). Results also showed that changes in mobility are associated to history of injury. Probably due to the mechanical relationship between joints of lower limbs, because changes in ankle ROM directly influences the dynamic and static balance of individuals. Proven by Basnett, et al. [24], who found a significant positive relation when associating ankle mobility changes to functional test of dynamic balance, mainly in the anterior area. According to Youdas, et al. [25] the decrease in ROM of dorsiflexion entails a dynamic knee valgus, which is a classic injury mechanism for rupture of anterior cruciate ligament in soccer players. Ratified by Lima, et al. [26], who found, in their meta-analysis, evidence of correlation of changes in ROM of dorsiflexion with dynamic valgus, even when ROM of ankle was evaluated without load. Highlights the significance of this evaluation, since the change in mobility relates to abnormal movements patterns in lower limbs, increasing risk of injuries. Begalle et al. [27], who verified that individuals with higher changes in ROM of dorsiflexion presented higher changes during tasks of unipodal and bipodal squats, pointed out other significant finding. Besides that, Rein, et al. [28] verified that limitation of ROM reflects in increased risk on functional instability of ankle joint, due to intensification of feet related work, increasing, thus, injuries risk.

Worth noting that no association of changes in mobility with presence of pain was found in this sample. Strong femoral quadriceps musculature and hips muscles directly interfere in pain modulation and functional capacity, especially when dealing with soccer players (Nascimento, et al. [29]). Probably because it's a group of young athletes with good muscular strength, the probable changes in ankle mobility found in the study weren't enough to trigger significant biomechanical repercussions in other joints, which could lead to pain in the sample. Rabin, et al. [30] and Bell-Jenje, et al. [31] described examples that restriction in ankle joints may cause pain in other areas of the lower limb. They proved that increased hip adduction, by consequence of dorsiflexion mobility restriction lower than 45 degrees caused patellofemoral and iliotibial tract pain. The results referring to asymmetry and history of injury showed that players that presented a difference of 1.5cm in mobility values between right and left sides had association to history of injury. On the other hand, such asymmetry didn't present association with post-practice or post-match pain. Henry, Evans, Snodgrass, Miller e Callister [32] concluded that functional asymmetries are one of the main causes of injuries in soccer, because they change the correct gait development. Over the literature, there are some functional tests to evaluate other symmetries, which are associated to criteria of post-injury return to the sport, as predictors of a new lesion. The Jumping Tests, which evaluate muscle power of lower limbs and describe a difference of 10% between sides, is significant for a recurrence of anterior cruciate ligament injury [33]. Another example of asymmetry and impediment of the athlete's return to the sport, because subject to another lesion, is the one described by Kyritsis in 2016. They concluded that a difference higher than 20% in maximum isometric strength between femoral quadriceps are predictors of injury. Because of this, the value found in the study can be considered as a significant asymmetry, because it is according to the values of other functional tests mentioned in the literature.

This study was the first to perform the parameterization of the value of ROM of ankle dorsiflexion in professional field soccer players. The value found of such variable offers great benefits to the scientific community and the sporting modality, because it was found that its changes are related with history of injury. Thus, must be highlighted the need to perform a thorough evaluation during pre-season, including mobility validation (changes/asymmetries), so that there is smaller number of athlete departures in official matches and practicing sessions. Besides, a lesioned player entails significant costs to the team's finances, increasing medical costs, with supplies for physiotherapeutic treatment and labor taxes. Junge, et al. [34] described that the annual costs for the absence of athletes in Switzerland in 2011 were estimated in 1.3 billion euros. Because of this, concrete data on ROM of ankle dorsiflexion are fundamental for the technical crew to add, in the daily training sessions, proprioceptive exercises for the ankle, aiming to minimize the risk of injuries and increase mechanical stability of lower limbs [35].

## Conclusion

It's concluded that the value of parameterizing of ROM of ankle dorsiflexion in professional field soccer players is similar to the one already established for non-athletes' individuals. We highlight that changes in mobility and asymmetries in ROM of ankle dorsiflexion have influence in the presence of injuries and that they should be used as evaluative parameters for monitoring practices and rehabilitation processes. Evidenced that Leg Motion system is a tool of easy applicability and effective to perform Lunge test in professional field soccer players, because enables a wider view of the test execution, avoiding the risk of errors.

## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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