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Prevalence of Restricted Dorsiflexion in Professional Runners- An Observational Study

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Abstract

Background: The ankle joint complex is comprised of the lower leg and the foot and forms the kinetic linkage allowing the lower limb to interact with the ground, a key requirement for gait and other activities of daily living. It is seen that reduced ankle dorsiflexion may alter lower-extremity landing mechanics in a manner, which predisposes athletes to injury. A better understanding of how to interpret ankle dorsiflexion test results and their implications for sport performance would help to identify those athletes who may benefit most from injury prevention and a targeted conditioning programme. Reduced ankle dorsiflexion may alter lower limb biomechanics during gait placing the lower limb in an increased predisposition to injury and may limit subtalar joint movement, preventing the ankle joint reaching a stable closed pack position needed during walking and running. Aim was to study prevalence of restricted dorsiflexion motion in professional runners

Methodology & Materials: This was a cross sectional observational study with 87 sample size of 1 year or more professionally trained runners of age group between 18 to 25 years. Runners with no soft tissue and bony abnormalities were taken. Patients were sampled conveniently from the professional athlete population. This study was conducted for 4 months in Jalgaon City, Maharashtra. Measurement of restricted dorsiflexion motion in professional runners using Goniometer and interpretation of the score of foot ankle ability measure [FAAM] to check restriction of dorsiflexion motion in functional abilities. Normality of the data was evaluated using Shapiro-Wilk normality test. Data was analysed and plotted using statistical computing software version 4.0.2 (20) in INSTAT. Level of significance for all inferential statistics was set at $p \leq 0.05$ which is statistically significant. Microsoft Excel was used for performing graphic illustrations.

Result: A total of eighty seven (87) professional runners were assessed. Seventy (70) which represent 80% of the participants were males and Seventeen (17) which represent 20% were females The dorsiflexion ankle range of motion of professional runners values had mean of 14.172 with the standard deviation of 1.549 and p value of <0.0001 which is extremely significant. The foot ankle ability measure [FAAM] of professional runners values had mean of 30.183 with the standard deviation of 1.596 and p value of <0.0001 which is extremely significant.

Conclusion: It was concluded that restricted ankle dorsiflexion mobility and reduced fuctional abilities in sports were observed in this study. There was positive prevalence of restricted dorsiflexion in professional runners.

Keywords: Ankle Dorsiflexion 1, Professional Runner 2, Foot Ankle Ability Measure[FAAM] 3

INTRODUCTION

The ankle joint complex is comprised of the lower leg and the foot and forms the kinetic linkage allowing the lower limb to interact with the ground, a key requirement for gait and other activities of daily living. The key movement of the ankle joint complex are Plantarflexion and Dorsiflexion = Sagittal plane. Abduction and Adduction = Transverse plane and Inversion and Eversion = Frontal plane. Several studies have indicated an overall ROM in the sagittal plane is between 65 and 75°, moving from 10 to 20° of dorsiflexion through to 40–55° of plantarflexion. [4,5] The calf muscle situated at the posterior side of the lower limb is composed of soleus muscle, the medial and lateral heads of the gastrocnemius (composing the triceps surae muscle), and the tibialis posterior. [6] These muscles insert onto the largest and strongest human tendon, known as the Achilles tendon. [6]

It is seen that reduced ankle dorsiflexion may alter lower-extremity landing mechanics in a manner, which predisposes athletes to injury. [11] A smaller amount of ankle dorsiflexion during landing is associated with less knee flexion displacement and greater ground reaction forces which may lead to ACL injury during landing.[22] Muscle flexibility is the ability of a muscle to lengthen, allowing one joint (or more than one joint in a series) to move through a range of motion. Loss of flexibility is defined as a decrease in the ability of a muscle to deform. Benefits of enhanced flexibility are reduced risk of injury, pain relief and improved athletic performances. Ankle dorsiflexion range of motion from tight calf muscle have been linked to injuries such as ACL injury, Achilles tendinitis, gastrocnemius strains and plantar fasciitis. [7]

A better understanding of how to interpret ankle dorsiflexion test results and their implications for sport performance would help to identify those athletes who may benefit most from injury prevention and a targeted conditioning programme. A new and useful subclassification of ankle dorsiflexion test results, beyond dichotomisation, would help to achieve this goal.Ankle dorsiflexion range of motion limitation has been associated with physical training in previous study. In a cross-sectional study, Malliaras et al, analyzing several strength and flexibility variables in volleyball athletes, found that only ankle dorsiflexion restriction was associated with physical training. Similarly, Scattone Silva et al showed that basketball, volleyball, and handball athletes with physical training had lower dorsiflexion range of motion than healthy athletes.[7] Finally, Backman and Danielson in a 1-year prospective study reported that lower dorsiflexion range of motion was the main risk factor for physical training. However, a recent systematic review concluded there is no strong evidence that ankle dorsiflexion limitation is a risk factor for physic al training development.[6] Although the association between dorsiflexion ROM limitation and physical training has been observed, the mechanism of how dorsiflexion restriction could contribute to physical training remains unknown. It is believed that the ankle dorsiflexion movement and eccentric calf muscles contraction are important aspects to absorb the forces acting on the lower limbs during jump landing, and impairment in this mechanism may result in higher patellar tendon load. Scattone Silva et al found that athletes with physical training have smaller peak ankle dorsiflexion during a drop landing task when compared with healthy athletes.[15] Considering that dorsiflexion restriction has been shown to cause a stiff jump landing pattern, with less hip and knee flexion,it is possible that ankle dorsiflexion excursion restriction may lead to further injuries to the athelete.

NEED OF STUDY

Running has many health benefits, although it also posess a significant risk of injury. The average runner has a 37 to 56% risk of injury during the course of a single year's training (McDaniel et al., 2010). Despite efforts from biomechanics researchers, 30 to 70% of all runners will have a running related injury each year and this number has not declined over the past forty years(Herzog, 2012).An adequate ankle range of motion is considered to be a necessary component for functional activities such as running, ascending/descending stairs and normal gait. A disturbance of ankle range of motion, may affect not only the ankle-foot complex but also the remaining joints of the lower extremities. Intrinsic factors such as anatomical and biomechanical abnormalities, lack of flexibility, poor strength and muscle imbalances are the most frequently associated risk factors related to foot and ankle running-related injuries.With the increase in leisure activity participation there exists a parallel increase in the number of related injuries reported, with increased intrinsic and extrinsic risk factors becoming more apparent.Adequate range of ankle dorsiflexion (>10) is required in mid stance of gait to allow for the tibia to advance over the foot when propelling the body forwards during normal gait. Reduced ankle dorsiflexion may alter lower limb biomechanics during gait placing the lower limb in an increased predisposition to injury and may limit subtalar joint movement, preventing the ankle joint reaching a stable closed pack position needed during walking and running. It is thought that increasing ankle dorsiflexion will benefit runners by reducing the degree of subtalar joint pronation, keeping the subtalar joint closest to its optimal position and limiting unwanted movement which could predispose to injury (Donatelli, 1996). Hence assessment of dorsiflexion is necessary for professional runners.

AIM AND OBJECTIVES

- **Aim:** To study prevalence of restricted dorsiflexion motion in professional runners
- **Objectives:**
    1. To observe restriction of dorsiflexion motion in professional runners using Goniometer.
    2. To observe and interpret the score of foot ankle ability measure [FAAM] to check restriction of dorsiflexion motion.

METHODOLOGY AND MATERIALS

- STUDY TYPE: Observational study
- STUDY DESIGN: Cross sectional study
- STUDY SETTING: Field based study, Jalgaon
- SAMPLING TYPE :Convenience sampling
- SAMPLE SIZE: 87
- DURATION OF STUDY: 4 months

All data was analysed using descriptive statistics of mean, standard error, percentages, pie-charts, and bar charts. Normality of the data was evaluated using Shapiro-Wilk normality test. Independent student's t-test and Wilcoxon rank-sum test were performed for parametric and non-para metric data to establish statistically significant variables using INSTAT Software. Data was analysed and plotted using statistical computing software version 4.0.2 (20) in INSTAT. Level of significance for all inferential

statistics was set at $p \leq 0.05$ which is statistically significant. Microsoft Excel was used for performing graphic illustrations.

- **Materials**

Consent form, Pen, Paper, Chair/table, Adhesive skin marker, Disposable glove, Disinfected liquid/sanitizer
Goniometer,Measuring tape

- **Inclusion criteria-**

Subjects with informed consent, Both male and female age between 18-25yrs, Professionally trained runners for more than 1 year.

- **Exclusion criteria**

Congenital deformities, Previous fracture and traumatic injuries around lower limb and lumbar spine, Any recent surgery, Malignant condition, Soft tissue injury, Flat foot, Ankle instability,Limb length discrepancy, Any deformities related to neurological condition.

PROCEDURE

Ethical clearance will be obtained from the institutional ethical committee.The purpose & procedure of the study will be explained to participant.A written consent will be obtained.Selected participant will be evaluated for the presence of restricted ankle joint dorsiflexion by following assessment and procedure.Subjects will be screened according to inclusion & exclusion criteria.Subjects were evaluated for restricted dorsiflexion motion in professional runners by using goniometer.The scores of foot ankle ability measure [FAAM] were taken and interpreted in bar graphs accordingly for statistical analysis.

- **Measurement of ankle dorsiflexion using Goniometer-**

1. Starting position**:-** Place the subject high sitting, with the knee flexed 90^0 and foot in 0° of inversion and eversion.
2. Stabilization**:-** Stabilize tibia and fibula to prevent knee motion and hip rotation.
3. Goniometer alignment**:-**
    - Center fulcrum of goniometer over the lateral aspect of the lateral malleolus.
    - Align proximal arm with the lateral midline of the fibula, using the head of the fibula for reference.
    - Align distal arm parallel to the lateral aspect of the fifth metatarsal.

- **Assessment of Foot & Ankle Ability Measure (FAAM)-**

1. The Foot and Ankle Ability Measure is a 29-item questionnaire divided into two subscales: the Foot and Ankle Ability Measure, 21-item Activities of Daily Living Subscale and the Foot and Ankle Ability Measure, 8-item sports subscale.

2. The Sports subscale assesses more difficult tasks that areessential to sport, it is a population-specific subscale designed for athletes.
3. A pre post scoring was conducted

RESULT

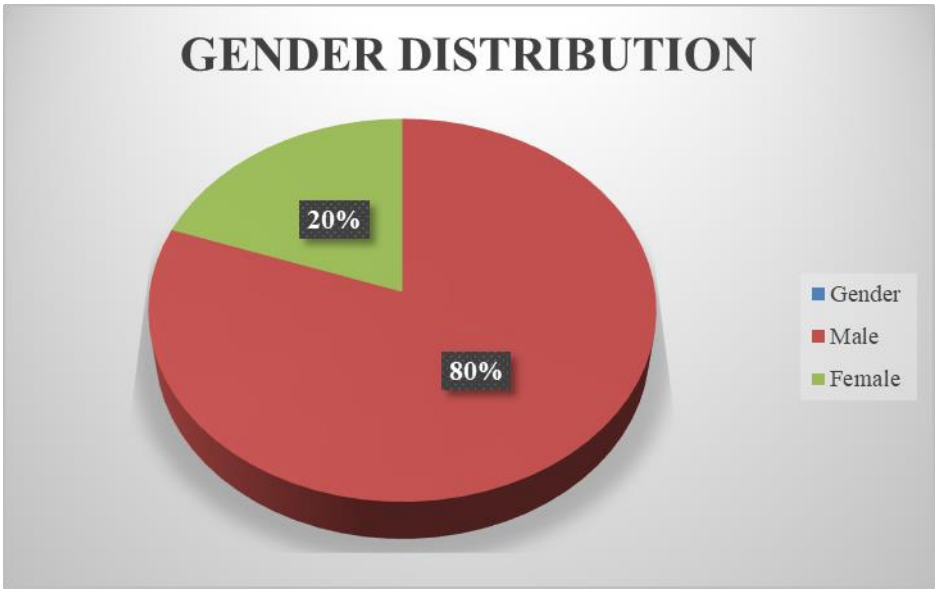
A total of eighty seven (87) professional runners were assessed. Seventy (70) which represent 80% of the participants were males and Seventeen (17) which represent 20% were females as shown in graph 1. As the age criteria were between 18 to 25 years the maximum number of runners was between age group of 22 to 25. There were 63% runners in age group 23 to 25 and 37% runners in age group of 18 to 22 as shown in graph 2. The dorsiflexion ankle range of motion of professional runners values had mean of 14.172 with the standard deviation of 1.549 and p value of <0.0001 which is extremely significant shown in Table 1.The percentile value for each measurement of dorsiflexion is illustrated in graph 3. The foot ankle ability measure [FAAM] of professional runners values had mean of 30.183 with the standard deviation of 1.596 and p value of <0.0001 which is extremely significant shown in Table 2.The total attained score of FAAM along with no patients attained that score is illustrated in graph 4

N [sample size]	Mean	SD	p value	Level of significance
87	14.172	1.549	<0.0001	Extremely significant

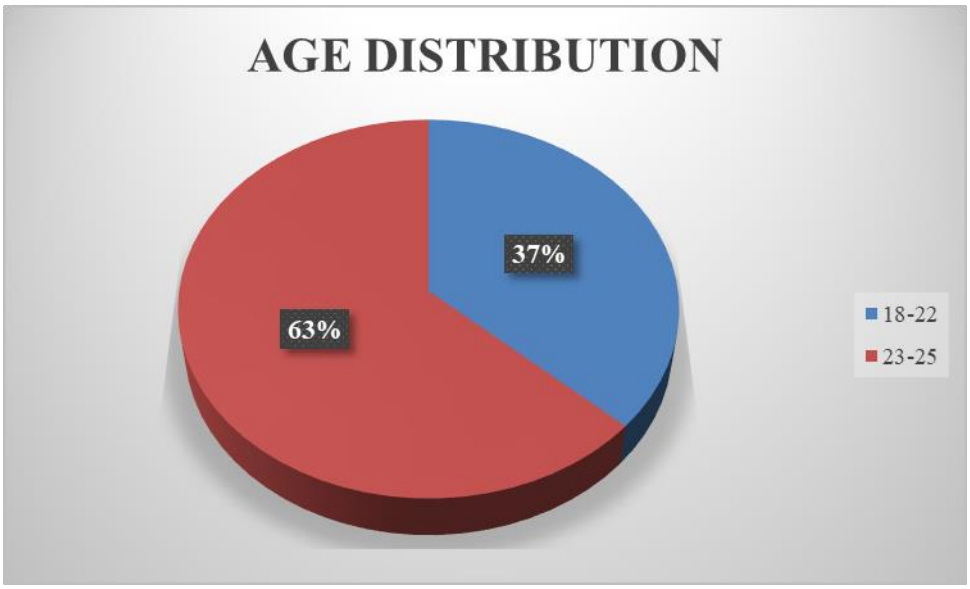
Table 1[Observation table for goniometry outcome with mean, standard deviation and p value]

N[sample size]	Mean	SD	p value	Level of significance
87	30.183	1.596	<0.0001	Extremely significant

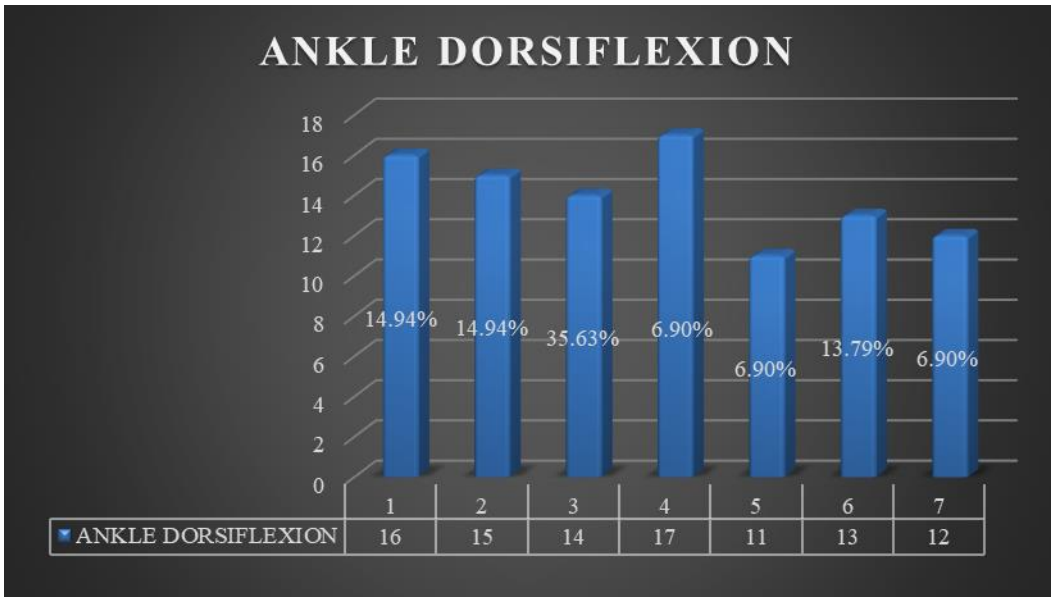
Table 2[Observation table for FAAM outcome with mean, standard deviation and p value]



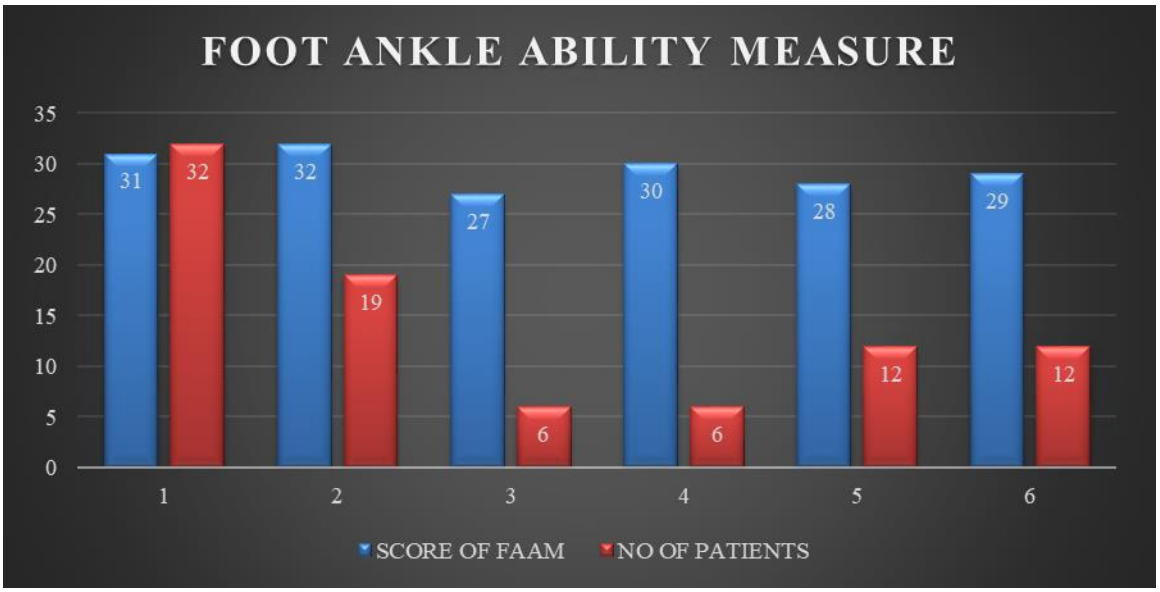
Graph 1 [Illustrating gender wise distribution of professional runners population]



Graph 2 [Illustrating the agewise distribution of the population]



Graph 3 [Illustrating the measurement percentile of Ankle Dorsiflexion for the sample size]



Graph 4[Illustrating the FAAM score obtained from the sample size]

DISCUSSION

Our study conducted was a observational study with 87 professional runners between age group of 18 to 25 years as subjects. In these runners 80% were males and 20% were females. The purpose of this study was to study the prevalence of restricted dorsiflexion in professional runners. The dorsiflexion ankle range of motion of professional runners values had mean of 14.172 with the standard deviation of 1.549 and p value of <0.0001 which is extremely significant. This depicts positive prevalence of restricted dorsiflexion in professional runners. As loss of joint range of motion (ROM) is a common dysfunction in athletes and may be a predisposition to musculoskeletal injury. Numerous factors can contribute to loss of ROM, including poor flexibility, previous injury and immobilization. Researchers have suggested that a lack of ankle-dorsiflexion (DF) ROM is a predisposing factor that increases the likelihood of a wide

variety of lower extremity injuries. Specifically, having less than 20° to 30° of closed chain DF impedes normal gait and may cause compensatory gait patterns, leading to pathologic conditions throughout the foot and ankle and up the kinetic chain.

This study aims to investigate the cause of dorsiflexion restriction in professional runners. A lack of ankle DF can predispose a healthy athlete to injuries and conditions such as genu recurvatum,early heel lift, excessive subtalar joint pronation, metatarsalgia ankle sprains, medial tibial traction periostitis, medial tibial stress syndrome, Achilles tendinopathy, plantar fasciitis,anterior knee pain, gastrocnemius strains and anterior cruciate ligament injuries.One cause of restricted DF is lack of flexibility within the triceps surae. The foot ankle ability measure [FAAM] of professional runners values had mean of 30.183 with the standard deviation of 1.596 and p value of <0.0001 which is extremely significant. This depicts positive prevalence of restricted dorsiflexion motion in atheletes leading to its impact on their functional activities. It can be because the subtalar joint, as a "mitered hinge," was also one of the crucial joints of the lower limbs, and the limitation of the subtalar joint was also a potential factor affecting ankle kinematics. The movement of the subtalar joint usually occurs in three planes of the foot simultaneously, called three-plane joint movement. During the movement, ankle dorsiflexion and abduction were caused by the interconnection of subtalar joint pronation and supination with calf rotation. The ankle would be sprained if the interconnection was broken. Maximum dorsiflexion of the ankle joint caused the talus to rotate outward, which limited the talocrural joint's ability to slide medially. Maximum dorsiflexion would reduce bone flexibility, meaning a higher risk of ankle inversion sprain and limitation to functional activities related to sports.

Previous investigations suggest that the ankle dorsiflexes approximately 20 degree during the stance phase of running.This means that if the available dorsiflexion range of motion of an athlete was approximately 20 degree, their ankle would need to be stressed very close to its dorsiflexion limit with every step during running. Overtime,this may lead to injury. Prior studies had reported restricted ankle motion, especially dorsiflexion in professional footballers. This has been attributed to structural adaptations and was thought to be protective against injury by reducing excessive move ments to which the joint is subjected. Depicting positive prevalence results in this study brings out the risk of increased prevalence of joint instability, soft tissue injuries and traumatic injuries to the ankle joint. In future to train there professional runners improvised training programmes are required. As physiotherapist being important part of sports model leads to better rehabilitation and avoidance of further injuries to these professional runners.

Previously, Drewes et al. (2009) found that limited ankle dorsiflexion mobility due to chronic ankle instability was reflected in the time of maximal dorsiflexion during jogging and gait.[5] However, it is also important to consider this issue in athletes without ankle instability in order to prevent injuries and enhance their performance. Furthermore, since there are differences in kinematic and kinetic characteristics between foot-strike patterns when running.

Some previous studies had differences which may be partly explained by the way dorsiflexion was measured. The dorsiflexion range of motion in our study was somewhat decreased than that found by these studies. Mahieu et al. measured dorsiflexion both actively and passively in a supine (gravity-resisted) position, with the knee bent 45 degree.[8] But we used a supine and high sitting position with

the knee bent 90 degree, which may explain the range of motion found in our study. Although measuring ankle dorsiflexion range of motion with the knee bent approximately 40 degree may be more representative of the functional demands during running, we believe the high sitting 90 degree knee flexion position, allows the examiner to use his/her body weight more effectively in order to stretch the ankle fully into its DF limit. In the study by Kaufman et al. neither the position of the measurement, nor whether active or passive motion was measured, were specified.[7] Finally, while no information regarding measurement reliability was provided by these previous investigations, our technique has been previously proven reliable when performed by the examiners involved in this study. The study has fairly large sample size of highly trained young professional runners being evaluated, giving greater solidity to the results obtained, and may be considered a representative sample of such population. Due to overall positive prevalence this study has strong clinical implications in sports rehabilitation. It provides picture of altered biomechanics in running due to restricted dorsiflexion rendering it to be a useful part of further rehabilitation.

CONCLUSION

It was concluded that restricted ankle dorsiflexion mobility and reduced fuctional abilities in sports were observed in this study. There was positive prevalence of restricted dorsiflexion in professional runners.

FUTURE SCOPE AND CLINICAL IMPLIMENTATION

This was a preliminary study and so the sample size was limited, a much larger sample size would have allowed for a more generalized application of the findings. In addition, this study proposes ankle dorsiflexion restriction based on reliable outcomes in order to prevent injury and enhance athletic performance. Designing the future atheletic rehabilitation will be very useful due to this study.Identification of biomechanical cause due to dorsiflexion restriction and correction of that biomechanical cause is very necessary. Alteration of sports model of athelete will be necessary to implement changes in his/her daily sports training precisely moving towards tailor made sports rehabilitation for atheletes biomechanical causes.

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