ANKLE SPRAIN RISK FACTORS: A 5-MONTH FOLLOW-UP STUDY IN VOLLEY AND BASKETBALL ATHLETES

FATORES DE RISCO PARA ENTORSE DE TORNOZELO: ESTUDO DE 5 MESES DE ACOMPANHAMENTO EM ATLETAS DE VÔLEI E BASQUETE

FACTORES DE RIESGO DE ESGUINCE DEL TOBILLO: ESTUDIO DE SEGUIMIENTO DE 5 MESES EN ATLETAS DE VOLEIBOL Y BALONCESTO

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Adriana Moré-Pacheco[1]
(Physiotherapist)
Flávia Meyer[1]
(Physician)
Ivan Pacheco[2]
(Physician)
Cláudia Tarragô Candotti[1]
(Physiotherapist and Physical Education Professional)
Juliana Adami Sedrez[1]
(Physiotherapist)
Renata Fanfa Loureiro-Chaves[1]
(Physiotherapist)
Jefferson Fagundes Loss[1]
(Electrical Engineer)

1. Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.
2. Grêmio Náutico União (GNU), Porto Alegre, RS, Brazil.

Correspondence:
Adriana Moré Pacheco.
Escola de Educação Física, Fisioterapia e Dança. Universidade Federal do Rio Grande do Sul (UFRGS).
Rua. Felizardo, 750, Porto Alegre, RS, Brazil. 90690-200.
adrimpacheco@ufrgs.br

ABSTRACT

Introduction: Ankle sprain is a frequent sports injury among volley and basketball players, and identifying risk factors is necessary to prevent injuries and prolong their careers. Objective: To identify intrinsic and extrinsic factors in basketball and volleyball players related to the risk of ankle sprain injury over a five-month follow-up period. Methods: Ninety-four Brazilian young competitive athletes (15.8±1.7 years, 47 basketball and 47 volleyball players) participated in this study. They were evaluated for intrinsic risk factors (previous history of ankle sprain, dominant lower limb, ankle ligament laxity, range of motion of the ankle-foot complex, electromyographic response time of ankle evertors, postural control and muscular torque of ankle invertors and evertors) and extrinsic risk factors (type of shoes worn, use of orthosis, previous injuries while training or competing, and the players' position). Results: During the study period, 18 (19%) athletes suffered unilateral sprains. Multivariate logistic regression analysis gave a final regression with four factors: dominant leg (p=0.161), type of shoes worn (p=0.049), player's position (p=0.153), and peroneus brevis muscle reaction time (p=0.045). There was an 86.1% probability of an ankle sprain if the athlete had a left dominant leg, wore shoes without vibration dampeners, or played in the small forward, wing/hitter spiker, middle blocker, or opposite spiker positions, and had a peroneus muscle reaction time longer than 80ms. However, only the player's position was significantly (p=0.046) associated with lesion occurrence. Conclusion: The player's position appeared to be a risk factor in both sports, and this result may help professionals to prevent ankle sprains. ***Level of Evidence I; High quality randomized clinical trial with or without statistically significant difference but with narrow confidence intervals.***

Keywords: Ankle injuries; Lower extremity; Athletes; Basketball; Volleyball.

RESUMO

Introdução: A entorse de tornozelo é uma lesão esportiva frequente em jogadores de vôlei e basquete, e a identificação dos fatores de risco é necessária para prevenir lesões e prolongar a carreira. Objetivo: Identificar fatores intrínsecos e extrínsecos em jogadores de basquetebol e vôlei relacionados com o risco de entorse de tornozelo ao longo de cinco meses de acompanhamento. Métodos: Noventa e quatro atletas brasileiros jovens e competitivos (15,8 ± 1,7 anos, 47 jogadores de basquete e 47 de voleibol) participaram do estudo. Foram avaliados os fatores de risco intrínsecos (história prévia de entorse de tornozelo, membro inferior dominante, frouxidão ligamentar do tornozelo, amplitude de movimento do complexo tornozelo-pé, tempo de resposta eletromiográfica dos músculos do tornozelo, controle postural e torques musculares dos inversores e eversores de tornozelo) e os fatores extrínsecos (tipos de calçado, uso de órteses, lesões prévias durante treinamento ou competição e posição dos jogadores). Resultados: Durante o período do estudo, 18 (19%) atletas sofreram entorses unilaterais. A análise de regressão logística multivariada forneceu a regressão final com quatro fatores: perna dominante (p = 0,161), tipo de calçado (p = 0,049), posição do jogador (p = 0,153) e tempo de reação do músculo fibular curto (p = 0,045). Constatou-se uma probabilidade de 86,1% de entorse de tornozelo se o membro inferior esquerdo fosse o dominante, se o calçado não tivesse amortecedores ou se a posição de jogo fosse ala, ponta, saída de rede, oposto e tivesse um tempo de reação dos músculos fibulares maior que 80 ms. No entanto, apenas a posição do jogador foi significativamente (p = 0,046) associada à ocorrência de lesão. Conclusão: A posição de jogo apareceu como um fator de risco em ambos os esportes e esse resultado pode ajudar os profissionais a prevenir entorses de tornozelo. ***Nível de evidência I; Estudo clínico randomizado de alta qualidade com ou sem diferença estatisticamente significante, mas com intervalos de confiança estreitos.***

Descritores: *Traumatismos do tornozelo; Extremidade inferior; Atletas; Basquetebol; Voleibol.*

RESUMEN

Introducción: El esguince de tobillo es una lesión deportiva frecuente en los jugadores de voleibol y baloncesto, y la identificación de los factores de riesgo es necesaria para prevenir lesiones y prolongar la carrera. Objetivo: Identificar factores intrínsecos y extrínsecos relacionados con el riesgo de esguince de tobillo a lo largo de cinco meses de seguimiento. Métodos: Noventa y cuatro atletas brasileños jóvenes y competitivos (15,8 ± 1,7 años, 47 jugadores de baloncesto y 47 de voleibol) participaron del estudio. Se evaluaron los factores de riesgo intrínsecos (historia previa de *esguince de tobillo, extremidad inferior dominante, lasitud del ligamento del tobillo, rango de movimiento del complejo tobillo-pie, tiempo de respuesta electromiográfica de los músculos del tobillo, control postural y el torque muscular de los inversores y eversores del tobillo) y los factores de riesgo extrínsecos (tipo de zapato, uso de ortesis, lesiones previas durante entrenamiento o competición y posición de los jugadores). Resultados: Durante el período del estudio, 18 (19%) atletas sufrieron esguinces unilaterales. El análisis de regresión logística multivariada proporcionó la regresión final con cuatro factores: pierna dominante (p = 0,161), tipo de calzado (p = 0,049), posición del jugador (p = 0,153) y tiempo de reacción del músculo peroneo corto (p = 0,045) Se constató una probabilidad de esguince de tobillo de 86,1% si la extremidad inferior izquierda era la dominante, si el zapato no tenía amortiguadores o si la posición de juego fuera alero, punta, delantero de red, opuesto y tuviera un tiempo de reacción de los* músculo *del peroneo de más de 80 ms. Sin embargo, solo la posición del jugador fue significativamente (p = 0,046) asociada a la ocurrencia de lesión. Conclusión: La posición de juego apareció como un factor de riesgo en ambos deportes y este resultado puede ayudar a los profesionales a prevenir esguinces de tobillo.* **Nivel de evidencia I; Estudio clínico aleatorizado de alta calidad con o sin diferencia estadísticamente significativa, pero con intervalos de confianza estrechos.**

Descriptores: *Traumatismos del Tobillo; Extremidad inferior; Atletas; Baloncesto; Voleibol.*

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INTRODUCTION

Ankle sprain is a frequent sport injury, with prevalence ranging from 10% to 30% amongst all modalities.[1] Ankle inversion is usually responsible for causing the sprain mostly during jumps, ground landings and very high intensity sprints.[1] These gestures are predominant in basketball and volleyball, and many young players who join these sports at competitive level are at great risk of ankle sprain.[2] The consequences of an ankle sprain may be deleterious for joint stability and increase the risk for future sprains, including complete ligament rupture which can lead to capsular loosening.[1] The identification of risk factors for ankle sprain in these modalities is therefore necessary to help prevent future injuries and prolong the career of the athlete.

Studies,[3] have already indicated several risk factors for ankle sprain and have classified them as intrinsic (related to individual characteristics) and extrinsic (related to external or environmental conditions) factors. In addition, it is intriguing that preventive actions do not seem to be effective in decreasing ankle injuries. In Brazil, there is little scientific evidence related to young basketball and volleyball athletes and prophylactic exercises. It is of extreme importance that the athletes are followed up during the entire carrier to prevent serious injuries, especially considering how important sports are in Brazil regarding social aspects. Thus, the purpose of this study was to identify intrinsic and extrinsic risk factors that are predictors of ankle sprain in young basketball and volleyball athletes over a period of five months follow-up. It is expected that the results of this study clarify which variables enable a better prediction of ankle sprain occurrence. Therefore, health care and sport professionals will be able to establish recommendations and direct their programs to prevent this injury in the future.

METHODS

This is a cohort single-blinded study that followed-up basketball and volleyball young athletes over a period of five months. The follow up period was established as five months due to sports club calendar. The sample size was calculated assuming a margin of error of 7% and a confidence level of 95% as previous medical records was reviewed to identify a 13% of ankle sprains occurrence over the past five years.

The study was approved by the University Research Ethics Committee where the study was carried out under nº. 2.006.564.

The participants entered the study after signing an informed consent form. Inclusion criteria were: training for at least one year, having none or only one unilateral ankle sprain due to inversion mechanism (grade I or II). Athletes were therefore excluded in case they had a history of grade III sprains, fractures, or surgery on ankles, knees and hips. Athletes who suffered grade III sprains were excluded because they would not be able to perform the tests involved in the present study. Each eligible athlete who entered the study underwent an individual evaluation as described below and from that point they were followed for ankle sprain occurrence for the next five months. In case of an ankle sprain grade I or II, confirmed by the anterior drawer test performed by an experienced doctor, the athlete was questioned about the circumstances of injury occurrence. At the end of the five months, athletes were divided in two groups: the non-lesion group (n = 76), with those who had no sprain in either of the ankles, and the sprain group (n = 18), with those who suffered any grade I or II sprain in one ankle. Basketball and volleyball were grouped together as their training and playing characteristics were similar.

A total of 94 athletes were evaluated: 47 basketball (all males), and 47 volleyball (19 males and 28 females) athletes. Overall their mean±SD age was 15.8±1.7 years (range 13-21 years), body weight 70.7±11.7 kg, height 1.81±0.10 m, and BMI 21.4±2.2 kg.m^2. These players were already training for an average of four years, five days a week at a competitive national level, but still not professional.

The initial evaluation consisted of an anamnesis, carried out by the principal investigator, which focused on identifying the presence of some of the possible intrinsic (previous history of ankle sprain and dominant lower limb) and extrinsic (type of shoes, frequency of ankle sprain in practice and/or matches, orthosis during training and/or games and playing position) risk factors for ankle injury.

Thereafter, physical testing was performed to evaluate the following intrinsic factors: ligament laxity and range of motion (ROM) of ankle-foot complex, reaction time of ankle evertors, postural control, and muscular torque of the ankle invertors and evertors.

The ankle laxity ligament was evaluated using the bilateral anterior drawer test, which is considered a good indicative of the condition of the anterior talofibular ligament. The test was conducted by an orthopaedic surgeon with over 10 years of experience. In addition, the active ROM for ankle plantar flexion, dorsiflexion, abduction and adduction were evaluated using a goniometer.

To evaluate the time response of the evertor muscles, an electromyography (EMG) system of eight channels (Bortec Electronics Incorporation, Canada) with a sampling frequency of 2.000 Hz per channel was used. The electrodes had a bipolar configuration and were placed on the peroneal muscles (longus and brevis). The motor points were identified to place the using isometric contraction of ankle evertors to show the muscle prominent portion. A ground electrode was placed on the anterior tuberosity of the left tibia. The skin was gently cleansed with alcohol and shaved to reduce the impedance between electrodes, which was accepted when less than five kΩ.

To simulate an ankle sprain movement, independently for each foot, a platform that allowed a lateral inclination of 30° in the frontal plane was used. The movement of the platform occurred by pushing a button, which also transmitted an electric signal to guarantee that all equipment were synchronized. As shown in Figure 1, the athlete was kept in a standing position, with bared feet in parallel, and arms crossed over their chest. The athlete was unaware of the moment and the side of platform movement. After the athlete was positioned, the researcher waited at least three seconds to trigger the movement which consisted of four inversions for each ankle in a random order. (Figure 1)

The EMG signal was filtered using a band-pass 4th order Butterworth filter 20-400 Hz. During resting, a 0.5 second window was selected to calculate the mean and standard deviation. The activation threshold was considered when the signal reached mean value plus three times the standard deviation. The time difference between the beginning of the fall of the platform and the first electrical activity of each muscle was considered as the EMG response time.

The assessment of postural control was carried out through the analyses of the Centre of Pressure (COP) using a force platform (Advanced Mechanical Technology Inc. Watertown, Massachusetts, USA), with sampling frequency of 1000 Hz. Athletes were positioned on single leg support, with hip and knee flexion of the contralateral leg and arms crossed over their chest. They were instructed to look at a fixed point at about 80 cm away and to avoid any movement during 30 seconds. The COP analysis was performed separately in the anteroposterior direction (COPy) and mediolateral (COPx) based on the standard deviation and amplitude. The COP was normalized by height of the athletes and calculated between the 10th and the 20th second.

To evaluate the muscular torque, a computerized multi-joint isokinetic dynamometer (CYBEX, model NORM Lumex & Co., Ronkonkoma, New York, USA) was used with the athlete in a supine position with hip and knee flexion. The knees and ankles were positioned at 20° and 30° of flexion and plantar flexion, respectively.

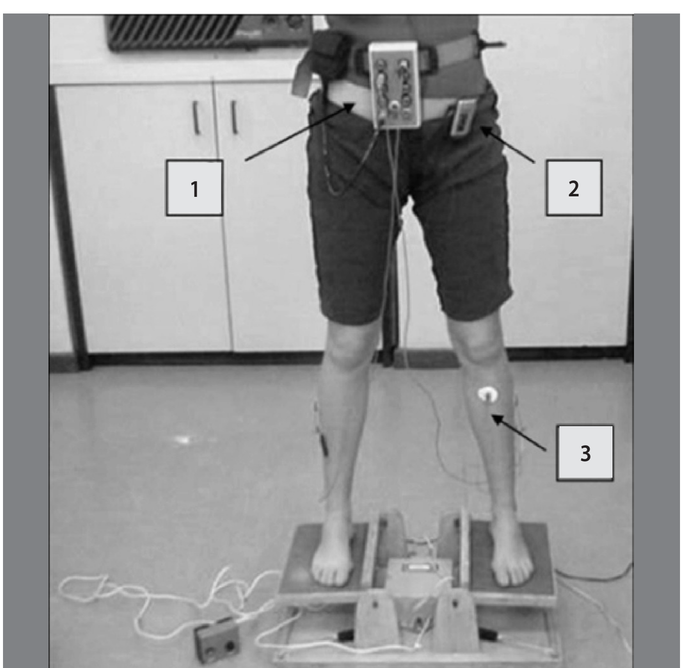

Figure 1. Athletes position on the electronic platform: (1) = EMG patients unit; (2) = Radio-phone gear; (3) = Ground electrode.

The subjects familiarized with the dynamometer through three movements of concentric/ eccentric contractions of the invertors and evertors with the speed of 30°/s. The protocol consisted of three repetitions of maximum concentric/eccentric isokinetic contractions of evertors and invertors at an angular velocity of 30 °/s, with 2 minutes between each repetition. Standardized verbal encouragement was used as a stimulus for athletes.

The values of peak torque were obtained for each ankle movement at each leg. The average of three maximal isokinetic contractions measures were calculated to consider the highest peak torque of each muscle group for both eversion and inversion of the ankle-foot complex in each leg.

Statistical analysis

SPSS (Statistical Package for Social Sciences) version 10.0 was used. To evaluate data normality the Kolmogorov-Smirnov test was used. To compare groups of athletes with and without sprain Pearson's chi square or Fisher's exact test (categorical variables) and t Student's t-test for independent samples (continuous symmetrical distribution) or Mann-Whitney test (continuous asymmetric distribution) were used. To compare the limbs with and without sprain Student's t-test for paired samples or Wilcoxon were used.

Multivariate logistic regression analysis was used to investigate the combination of prediction variables of ankle sprains in each group of athletes. The criteria for entry of the variables in the model was a smaller sample descriptive level than 0.20 in the bivariate analysis, but in the final model only those with the smallest sample descriptive levels and considered confounding factors were included due to the small number of athletes injured. The method used in the logistic regression model was the Enter and the test applied for statistical significance of the factors was Wald. The significance level for all tests was $\alpha \leq 0.05$.

RESULTS

During five months follow-up, 18 athletes (19.1%) suffered an ankle sprain, always in a single ankle. The left foot counted for 61.1%, 72.2% were grade II while 27.8% grade I. All sprains happened during inversion, and 94.4% occurred during training. A total of 61.1% of sprains occurred when landing on the opponent's foot after a jump and 22.2% after a bipedal landing on the ground, 16.7% occurred during rebound or running. The results show 61.1% of athletes reported not having performed any kind of prevention in training, while 38.9% had proprioception exercises prescribed as prevention.

Table 1 shows that when comparing the groups, the type of shoes showed a significant difference (p = 0.049), indicating that the use of shock absorber can be a protective factor for ankle sprains. Table 2 shows the EMG response time of the peroneus brevis of the injured leg which was longer (p = 0.045) compared to the opposite leg in the group of athletes with sprains. Table 3 presents the multivariate logistic regression analysis to assess predictors of lower limb injury. The reliability of prediction for the variables presented in the final model was 80.6%. Although six variables were selected as injury risk factors, only four remained in the final model because they had the lowest descriptive sample levels (p value) with no loss of model explanation (dominant leg, shoes type, player's position, and muscle EMG response time of the peroneus brevis) . Of these four variables, only the position of the player (Ala /Outside Hitter/Output Network /Opposite) was significantly associated with sprain occurrence (p=0.046). Table 4 shows the odds of sprain that were calculated considering the four variables, either alone or combined. The position of the players alone resulted in 38.1% probability of sprain when considering the left lower limb as dominant. The combination of shoes without shock absorber and the position of the players increased the probability over 80%.

Table 1. Comparison in the number of athletes (%) between groups with and without sprain for the presence of the suggested risk factors.

Risk factors	Group with Sprain (n=18)	Group without Sprain (n=76)	P
Dominant Lower Limb - n (%)			
Right	7 (38.9)	46 (60.5)	0.161[b]
Left	11 (61.1)	30 (39.5)	
Ligament Laxity- n (%)			
Yes	3 (16.7)	15 (19.7)	1.000[c]
No	15 (83.3)	61 (80.3)	
History of previous sprains - n (%)			
Yes	12 (66.7)	38 (50.0)	0.312[b]
No	6 (33.3)	38 (50.0)	
Previous Injuries - n (%)	n=12	n=38	
Training	9 (75.0)	26 (68.4)	0.889[b]
Competitions	2 (16.7)	8 (21.1)	
Both	1 (8.3)	4 (10.5)	
Shoes Type– with or without dampers - n (%)			
Yes	13 (72.2)	69 (90.8)	0.049[c]
No	5 (27.8)	7 (9.2)	
Use of brace - n (%)			
Yes	4 (22.2)	21 (27.6)	0.772[b]
No	14 (77.8)	55 (72.4)	
Player's Position - n (%)			
Setter /Forward /Libero	2 (11.1)	23 (30.3)	0.153[b]
Ala/Point/Output Network /Opposed	10 (55.6)	26 (34.2)	
Pivot/Middle Net	6 (33.3)	27 (35.5)	

[a] student test for paired samples; [b] Pearson's chi square; [c] Fisher's exact Test; [d] Mann-Whitney test.

DISCUSSION

The present study examined the presence of intrinsic and extrinsic factors for ankle sprains occurrence over a five month period of follow-up in basketball and volleyball athletes. Ligament laxity, previous history of ankle sprain, occurrence of injuries in practice and matches, use of orthosis, ROM of the ankle-foot complex, postural control, ankle inversion and eversion muscular torque were variables that did not present statistically significant results as risk factors for ankle sprain. The only variable that reached a statistically significance as risk factor was the playing position of the athlete.

Among the athletes who had sprains within this five months period, increased ligament laxity was not a significant factor as over 80% of the athletes did not show such clinical finding. Barret et al. also showed that the ligament laxity of the ankle joint does not predict sprains.[4] Denegar et al concluded that laxity was commonly found following the ankle sprain in collegiate student-athletes.[5] Beynnon et al showed a tendency towards the ligament laxity being associated with increased risk of ankle sprain in collegiate athletes who participated in soccer, lacrosse, or field hockey.[6] Such statement is supported by Chomiak et al, who reported a high incidence of ankle sprains in soccer players who had an increased anterior drawer test.[7] Thus, the relationship between ligament laxity and

Table 3. Multivariate Logistic Regression Analysis to evaluate predictors sprain ankle.

Variables / category	$OR_{adjusted}$ (IC 95%)	P
Dominant lower limb / left	2.84 (0.88-9.10)	0.080
Type of footwear/ Without dampers	0.35 (0.09-1.39)	0.135
Position /		
Setter /Forward /Libero	1.00	
Ala/Point /Output Network /Opposed	5.69 (1.03-31.5)	0.046
Pivot/Middle Net	2.75 (0.47-16.2)	0.263
Electromyographic response time peroneous brevis muscle >80ms	1.23 (0.39-3.91)	0.721

Table 2. Results of the suggested intrinsic risk factors by groups (with and without sprain) and between limbs within the injured group (means±SD).

Variables	Group with ankle sprain (n=18)	Group without ankle sprain (n=76)	p	Group with ankle sprain		P
				Injured limb (n=18)	Not injured limb (n=18)	
ROM (º)						
Neutral Position	55.3±10.6	55.3±9.06	1.000[a]	54.3±11.3	52.2±9.42	0.411[c]
Plantiflexion	31.9±14.1	31.7±11.2	0.916[a]	31.0±11.1	27.4±11.8	0.240[c]
Dorsiflexion	98.2±9.25	97.6±10.8	0.772[a]	97.4±10.5	97.9±9.51	0.868[c]
Aduction	32.1±8.91	34.1±10.3	0.214[a]	35.1±9.66	35.1±11.4	0.988[c]
Abduction	23.9±9.49	24.1±9.50	0.924[a]	24.0±9.82	23.0±10.8	0.718[c]
Electromyography of ankle evertors (ms)						
Peroneous Brevis	81.3±24.0	66.6ms ± 22.8	0.045[a]	74.3±22.6	71.2±21.5	0.587[c]
Peroneous Longus	76.1±17.8	67.3ms ± 24.0	0.260[a]	69.9±23.6	69.8±21.5	0.997[c]
Centre of Pressure X (cm)						
Standard Deviation	0.27 (0.21-2.26)	0.32 (0.25-1.99)	0.647[b]	0.30 (0.22-2.20)	0.32 (0.21-2.54)	0.857[d]
Amplitude	1.32 (0.96-11.1)	1.53 (1.07-9.89)	0.811[b]	1.35 (0.96-10.5)	1.34 (1.08-12.2)	0.727[d]
Centre of Pressure Y (cm)						
Standard Deviation	0.37 (0.32-2.26)	0.49 (0.31-1.95)	0.472[b]	0.49 (0.31-2.59)	0.43 (0.30-3.11)	0.935[d]
Amplitude	1.65 (1.29-10.0)	2.33 (1.46-10.1)	0.223[b]	2.38 (1.31-12.2)	1.91 (1.32-15.2)	0.970[d]
Inversion Torque (Nm)						
Concentric	56.8±13.7	59.2±15.6	0.625[a]	56.0±13.9	58.1±23.4	0.711[c]
Eccentric	61.3±14.0	63.6±16.4	0.651[a]	61.1±14.4	64.2±24.3	0.602[c]
Eversion Torque (Nm)						
Concentric	48.3±11.0	46.8±19.6	0.732[a]	50.6±17.3	41.0±18.9	0.057[c]
Eccentric	52.4±11.1	51.3±19.6	0.794[a]	53.6±17.1	46.2±18.8	0.138[c]

[a] T test for paired samples; [b] Wilcoxon Test; [c] T test for independent samples; [d] Mann-Whitney Test.

Table 4. Ankle sprain occurrence probability assessment according to the number of risk factors.

Grouping of risk factors	Probability of ankle sprain	%
1	Left lower limb dominance	23,5%
	Footwear without dampers	23,7%
	Ala/Point /Output Network /Opposed Position	38,1%
	Peroneous brevis electromyographic response time > 80 ms	11,8%
2	Left lower limb dominance and footwear without dampers	46,8%
	Left lower limb dominance and Ala/Point/ Output Network/Opposed Position	63,6%
	Left lower limb dominance and peroneous brevis electromyographic response time > 80 ms	27,4%
	Footwear without dampers and Ala/Point / Output Network/Opposed Position	63,9%
	Footwear without dampers and peroneous brevis electromyographic response time > 80 ms	27,7%
	Ala/Point /Output Network/Opposed Position and peroneous brevis electromyographic response time > 80 ms	43,1%
3	Left lower limb dominance, footwear without dampers and Ala/Point /Output Network/Opposed Position	83,4%
	Left lower limb dominance, footwear without dampers and peroneous brevis electromyographic response time > 80 ms	52,1%
	Left lower limb dominance, Ala/Point /Output Network/Opposed Position and peroneous brevis electromyographic response time > 80 ms	68,3%
	Footwear without dampers and Ala/Point /Output Network/Opposed Position and peroneous brevis electromyographic response time > 80ms	68,5%

ankle sprain is still unclear and may be related to variability of the joint clinical evaluation and to the sport modality.[8]

In most cases, authors relate the incidence of ankle sprains with previous similar injuries.[9-12] In the present study, previous history of ankle sprain was not statistically higher in the injured group, although the percentage was somewhat higher (67 vs 50%). In contrast, Baumhauer et al found no increase in risk of sprain for basketball and soccer players.[4] According to Barrett et al, previous history of ankle sprains is not necessarily a risk for a new injury.[4] This inconsistency between studies may be related to joint conditions after the injury, which does not depend primarily on the severity of the injury, but also due to other factors such as those related to the management and evaluation techniques.[8]

In general, the literature points that joint injuries in athletes occur more often during competition than during practice since they tend to behave more aggressively.[8,13,14] However, in the present study we did not find any difference which could be explained by the fact that athletes were not at the professional level, and their time spent in practice (5 times a week, 3 hours per day) was much longer than in games or competitions (from 4 to 7 times year). A professional high level athlete could be involved in a more demanding routine regarding average of practices and competitions.

There was also no significant difference in the results for the use or not of the orthosis when the two groups of athletes were compared. In the present study, there is no relation between the use of brace or not and the presence of injury. However, there seems to be a consensus on the reduction of ankle sprains related to the use of braces.[15,16] Thus, a possible explanation for the divergent result of the present study is that the subjects of the other studies were being selected intentionally to test the use of the brace to prevent ankle sprains. In addition, less than half of the athletes in the present study reported not using braces.

The results of active ROM of the ankle-foot complex were not significant in both comparisons (between groups with and without sprain and between the injured and uninjured ankles within the injured group). Most studies[6,10,13] corroborate this finding, but others[3,17] have reported a relationship between the joint ROM and injuries.

In the present study, postural control was similar between groups. Other authors[3,6] also found no significant results related to postural control. On the other hand, some authors have reported significant results for postural control.[18,19] There is still a great controversy in the literature on this topic, requiring further studies using also dynamic tests.

As for the results of muscular torque of ankle invertors and evertors, significant differences between groups were not found. Similar results were obtained by Buckley et al evaluating subjects with joint instability.[20] However, the literature reports that ankle evertors have an important role in preventing ligament injuries, providing a support to the structure of the joint.[17,21] To avoid a sudden ankle inversion, Lee stated that the ankle evertors are recruited eccentrically to counteract the fall tendency.[22] Another factor that can be a point of contention between the studies is the position efficiency of the athlete in the dynamometer, plus the attempt to isolate some muscle groups and isolated use of the segment to be evaluated. In addition it is still difficult to compare results because of a great methodological variability among studies.

Groups were not statistically different regarding the dominant leg; however, the left dominant leg was somewhat more frequent among the group with sprain. Furthermore, in the final regression model, the left lower limb being the dominant was a predictor of ankle sprain injury. According to Murphy et al, usually the association between the dominant leg and the injury is controversial.[8] Surve et al reported that soccer players do not show differences in the incidence of ankle sprains between dominant and nondominant limbs.[23] Seil et al found no association between dominance and injury in handball players.[24] Also, Beynnon et al and Chomiak et al reported no risk of ankle sprain for the dominant leg.[6,7] In contrast, other studies have reported an association between dominance and injury.[25,26] In this line, Baumhauer et al reported that the left leg, when dominant, is more prone to ankle sprains, corroborating this study, which also points the dominant left leg as the most injured limb[7]. However, the controversy already appeared in the literature, which can be associated with a factor such as population, methods used or the various data analyses employed.

Another risk factor listed was the use of shoes without dampers, which showed a significant difference when comparing the groups with and without sprain. The relationship between the type of shoes and ankle injuries has been poorly investigated. Milgrom et al found no significant difference in incidence of ankle sprains between two military groups: one used basketball shoes and the other military boots.[27] Similarly, Barrett et al found no correlation between three types of shoes (high-soled, low and shock absorbers) and the incidence of ankle sprains in basketball players.[4] McKay et al found that athletes who wore shoes with dampers showed increased risk of ankle sprain.[28] Although there are only few studies, literature seems to show that there is no link between the use of dampers and ankle sprains. This study does not point to this fact, by suggesting that the use of dampers seems to be a protective factor against ankle sprains. Moreover, one of the limitations of the present study is that we did not include a full screening of the kind, shape and material of the dampers used.

The third factor identified as lesion predictor in the regression model was the position of the player. The position that involves performing jumps recurrently has been associated with an increased risk of sprains.[1,2] For some authors, however, the positioning of the players seems to have no relation with ankle sprains,[29] It is important to note that in any of the modalities studied the movements performed by the players were closely linked to their positioning. Furthermore, Peres et al[1] argue occurrence from 21 to 25% of ankle injuries after a jump, either individually or together.

The last predictor of ankle sprain pointed in the multivariate logistic regression model was the reaction time of the peroneus brevis being higher than 80ms. In comparison between legs in the sprain group, the peroneus brevis of the injured leg showed a significantly later electromyographic response compared to the uninjured leg. Similar results from the study of Karlsson and Andreasson indicate an increase in electromyographic response times of the fibular muscles in the group with joint instability.[30] However, a recent meta-analysis did not support this assumption; and further studies did not show that a significant increase in the electromyographic response time is associated with ankle sprain.[3,6,17] It is noteworthy that perhaps the crucial difference between the studies is the platform tilt angle, since the studies using 30° of inclination found significant results when comparing the groups with and without sprain.

Finally, the likelihood of ankle sprains may be greater than 80% when there is a combination of predictors such as dominance in the left lower limb, shoes without damper and playing position. In this study other variables, such as jumping height, feet size and speeds of displacement, landing and braking were not evaluated to compose the model, which could be a limitation. Therefore, more studies are still necessary to expand the role of other risk factors related to ankle sprain in basketball and volleyball athletes.

CONCLUSION

The prediction model of this study included four risk factors for ankle sprain with 80.6% reliability. The intrinsic factors included were: the left dominant leg and the peroneus brevis electromyographic response time greater than 80ms. The extrinsic factors were: use of shoes without dampers and playing positions. The position of the athlete on the court appeared as the most important risk factor for ankle sprain. Still, the likelihood of ankle sprains was 83.4% when three factors (dominance in the left lower limb, shoes without damper and Ala / Point / Output Network / Opposite) were combined.

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