# 09 - ASSOCIATION BETWEEN INJURIES OCCURRENCE AND NUMBERS OF JUMPS IN AMATEUR COURT GAME ATHLETES DURING MATCHES

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## 1 Introduction

Sports injuries can occur in many ways, but their incidence are related to the characteristic of each sport. The prevalence of injuries is considered as one of the main causes of the athlete's retirement from competitive sport (HERNANDEZ, 2006) and, although its severity varies, even the ones that don't risk the athlete' life, they can temporarily avoid practice. The higher the level of the team's performance, the higher are training requirements, so athletes are more susceptible to injuries. On the other hand, injuries are not exclusive to high-level athletes because, amongst others studies, Santos et al. (2007a) show high prevalence of injuries in amateur athletes.

The injuries suffered by athletes concern coaches and athletes of all levels, because they interrupt the evolutionary process of systematic adaptations imposed by training (KETTUNEN et al., 2001). The most frequent mechanism of injury, in accordance with Pastre et al. (2005), come from exhausting exercises done desorientedly or inappropriately. Among these mechanisms, the overuse worry athletes and, according to Elliott (1999), such injuries are caused by repeated micro traumas in the musculoskeletal system, where a repeated number of forces exceed the limit of the muscle fibers and produce a combination of stress in the fibers for a long period.

According to Nigg (1985), there are two types of injuries caused by overuse. The first one relates to a low number of repetitions, but requires a higher ability, like jumps in the Olympic gymnastics. The second one is related to a high number of repetitions in an specific activity, like long training sessions, through constant landing impact against a fixed surface, where many internal forces are generated and absorbed by the muscular tissue or where there is a high number of rotations, like the shoulder's articulation.

The impact injuries, from practices that involve impact like landings or shock against other athletes are common in all sports levels (SALCI et al., 2004). In this way, mechanical shocks, when combined with repetitive moves like frequent jumps during a long period of training, can generate damages to biomaterial components, caused by overuse (ELLIOTT, 1998). In addition, Parkkari et al. (2001) pointed that, although facts such as overweight, weakened muscles and lack of flexibility can expose athletes to overuse injuries. Type, frequency, intensity and duration of the training session play the main role in the etiology of this kind of injuries.

Since most court games are the combination of basic moves such as running, jumping and landing, of which include acceleration, deceleration and change of direction, alone they become harmful potentials to injuries (SILVA et al., 2007). As stated by Hagedorn et al. (1996), each basketball player jumps two to three vertical jumps, with maximum effort per effective minute during the game, in 80 to 100 jumps per game. According to Barbanti (1986), around 200 jumps in volleyball are spikes and blocks. In handball, high level athletes do about 48.000 jumping throws per season (LANGEVOORT et al., 2007) and the landing of these jumps, according to Salci et al. (2004), can be considered as one of the main causes of overuse injuries, being the knees and the ankles the main targets.

Although the numbers mentioned above correspond to high-level sports, it is essential to know the frequency of which amateur athletes train jumping skills, so that the possible association with the prevalence of injuries is verified. For that, this study investigates the characteristics of injuries in the inferior limbs of amateur athletes that play court games (volleyball, handball and basketball). Specifically aiming to verify the number of injuries in the inferior limbs of these athletes; to identify the number of jumps per athlete during three games; to compare the number of jumps to the number of injuries between the sports; to relate the number of injuries with the number of jumps per athlete, in the sports mentioned.

## 2 Methods

This is a descriptive study, using technical procedures of a correleted research, accomplished in two stages. In the first stage, a questionnaire had been used to investigate the profile of the athletes and the description of injuries for the last two years. In the second stage, recordings of three game were used to describe the number of jumps per athlete, from the skills related to each sport (spikes and block, rebound and jump shot, dribble and throw).

37 male amateur athletes were part of this study, being 14 volleyball, 14 basketball and 9 handball athletes (Table 1). The athletes were intentionaly selected by non-probabilistic sample by accessibility, with a minimum practice of twice a week for the last two years.

**Table 1.** Characteristics of amateur volleyball, basketball and handball athletes.

| | Volleybal | Basketball | Handball |
|---|---|---|---|
| Age (years) | 23.8±2.9 | 16.1±1.7 | 22.2±1.4 |
| Height (cm) | 186.2±3.6 | 185.37±10.25 | 182.0±0.08 |
| Weight (kg) | 82.9±9.9 | 77.62±8.42 | 83.2±10.1 |
| Practice time (years) | 7.7±3.6 | 3.4±1.0 | 7.1±2.7 |

The instruments used were: a questionnaire, built to investigate the profile and the description of the injuries, submitted to a validation process, in which it reached an index of 93% for validation and 100% for clarity; a Panasonic® video camera (30 fps) to record of the number of jumps of each athlete during three games, and a form to register the frequency of jumps from the analysis of the images recorded during practice sessions.

The project was approved by the Ethics Committee in Research with Human Beings of the Santa Catarina Federal

University, process # 073/2007. After signing a permission term, the data was collected as follows: the athletes, in the places of practice of each sport, filled out the questionnaire; the recordings were made in three sessions of training of each sport, were the video camera was placed in a spot where it could record both teams; numbers identified the athletes.

The statistical analysis used were: test of Shapiro-Wilk, to verified the normality of the data; descriptive statistic (average, standard deviation SD, variation coefficient VC, and simple frequency); analysis of variance (ANOVA one way) with a test of multiple comparison of Tukey and simple linear regression, in which it was considered the number of injuries as dependent variable and the number of jumps as independent variable. The level of significance adopted for the tests was 5%.

**3 Results**

The prevalence of injuries in the inferior limbs, as well as type and place of injuries suffered by athletes is presented at Table 2.

**Table 2.** Frequency and places of injuries in the inferior limbs of amateur athletes in volleyball, basketball and handball.

| | Injuries frequency (f) | | | |
|---|---|---|---|---|
| **Places** | Volleyball | Basketball | Handball | TOTAL |
| Knee | 11 | 7 | 5 | 23 |
| Ankle | 8 | 25 | 3 | 36 |
| Thigh | 2 | 2 | 1 | 5 |
| Feet | 3 | 0 | 1 | 4 |
| Calf | 0 | 1 | 0 | 1 |
| TOTAL | 24 | 35 | 10 | 69 |

Table 2 shows that basketball athletes, followed by volleyball ones, presented the highest number of injuries in the inferior limbs, being the knee and the ankle the places more affected in all sports.

On Table 3, the average number of jumps by each athlete, during the three games analyzed.

**Table 3.** Number of jumps by volleyball, basketball and handball athletes per game training.

| Jumps by athlete (n) | Average | SD | CV (%) |
|---|---|---|---|
| Volleyball | 48.3 | 22.0 | 45.7 |
| Basketball | 56.3 | 28.5 | 56.7 |
| Handball | 9.4 | 2.1 | 23.4 |

According to Table 3, the data variability can be considered high (<30%) according to the criteria established by Gomes (1990).

Table 4 displays the comparison between the number of jumps and the number of injuries in each sport.

**Table 4.** Comparison between number of jumps and number of injuries

| Sport | Number of jumps | Number of injuries |
|---|---|---|
| Volleyball | 48.3 | 2.3 |
| Basketball | 56.3 | 2.9 |
| Handball | 9.4* | 1.2 |

*difference between handball and the other two sports; $p \leq 0.5$

Table 4 shows that the number of jumps per athlete in handball is significantly lower than that of basketball and volleyball. There were no differences between the amounts of injuries suffered by the athletes when comparing each sport.

Regarding the linear regression, a significant relation was verified ($R^2$=0.20, p=0.02), in which the number of jumps explain 20% of the number of injuries suffered by the athletes, considering all sports.

**4 Discussion**

In this study, the prevalence of injuries in the inferior limbs was high (Table 2) in all sports when compared with recent studies on prevalence of injuries in the inferior limbs in high level basketball (MOREIRA al., 2003; Et HISSES al., 2007; BORIN et al., 2008), volleyball (AUGUSTSSON et al., 2006) and handball athletes (OLSEN et al., 2006).

Basketball presented the highest number of injuries in the inferior limbs, followed by volleyball, maybe due to the characteristics of skills, specially attack and defense. Handball, although a sport that involves more body contact, did not show a high number of injuries in the inferior limbs, possibly because it demands less jumps for the execution of its skills, specially considering the level of the athletes.

Among the most injured places, the ankle and the knee were the most described by athletes (Table 2). These results agree with many studies about high-level sports, for example Valiant and Cavanagh (1985) when mentioning that in volleyball 15 to 45% of all injuries are in the ankle, and are responsible for 25% of the athlete's absence. Agaard et al. (1996) pointed that the incidence of injury in the ankle in volleyball is between 1.7 and 4.2 for 1000 hours of game, being the sequence of jumping and landing (spike and block) responsible for 63% of all injuries. Sylvester and Rasp (2003) say that in basketball, 21% to 53% of the injuries are ankle twists. Alozza and Ingham (2003) also verified in handball athletes that the knee, leg and ankle were the main targets for injuries. In addition, Seil et al. (1998) found out that the places with the most incident of injuries were the knee and the shoulder, being 19/35 injuries in the shoulder and 16/30 injuries in the knee related to overuse.

Possibly, a high repetition of skills is responsible for injuries, including the jumps. As Table 3 shows, there is a high number of jumps per game, especially by basketball and volleyball athletes.

In volleyball 50 to 60% of the motor actions are jumps, of those, around 200 are spikes and blocks (BARBANTI, 1986). For Lian et al. (1996), 30 to 40% of volleyball actions are jumps that happen in a frequency of approximately 60 jumps per hour. Santos et al. (2007a) registered an average of 26 jumps per athlete for the skills of attack and block for the female team and 22 and 26 jumps per athlete in the same skills for the male team, respectively. As stated by Iglesias (1994), the setters jump about 269 times, the liberos 223, the right side hitters 197 and the left side hitters 128 jumps, in an average of 194 jumps during a game. In volleyball around 50% of moves are blocks, regarding that three athletes can jump simultaneously (ESPER, 2003).

Some studies (COLLI and FAINA, 1987; BRANDÃO, 1992; MOREIRA et al., 2003) found out that basketball has a high number of jumps, around 30 to 65, depending on the position. According to Hagedorn et al. (1996), each basketball player

jumps two or three vertical jumps at maximum effort per effective minute of game, what results in at least 30 seconds between jumps.

The high numbers in the variation coefficient (56.7%) of jumps per basketball athletes are related to the characteristic assumed by each player. Since the centers are the players who jump the most due to their specific function to get rebounds, what makes them jump repeatedly during short spaces of time, followed by the forwards and the guards (DIAS NETO, 1996). It is also observed in basketball athletes that, despite less practice time, they presented the highest number of injuries, fact that can be linked to the higher number of jumps. Elliott (1999) points that, in sports such as basketball, the injuries are more often associated to overuse due to the repeated jumps than with the landing impact.

The characteristics of the games explain the low number of jumps per handball athlete when compared to basketball and volleyball (Table 4). In handball, the main skills (dribble, marking and throw) do not demand jumping at all to be efficient. However, in basketball and volleyball, the main skills (rebound and throw, spike and block, respectively) are extremely dependent to jumping (BARBANTI, 1986). A moderated variability in jumps observed in this study (VC=23.4%) discloses that handball athletes of all positions (backcourts, wingmen and pivot) accomplish jump shots during a game, although number of jumps per athlete is low compared to the others sports.

The significant association between the number of jumps and the prevalence of injuries for the investigated sports ($R^2$=0.20) has support the findings of Solgard et al. (1995) that the landing is one of the main sources of injuries in volleyball. In addition, Santos et al. (2007a) verified that the main mechanisms of injuries in male and female volleyball athletes were the block and spike, which together represent more than twice the other mechanisms of injuries in both teams. Moreover, the main injuries observed in athletes were in the inferior limbs, possibly from repetitive jumping, from land impacts, or the combination of both.

Souza et al. (2007) found a relation between the number of jumps in amateur basketball and the magnitude of impacts in rebounds measured in the ankle and knee, or else, the repeated jumps in short spaces of time added to the magnitudes of land impact can increase the risk of injuries. Still, the same authors point that the athletes who rebounds more during the game present the higher magnitude of impacts measured in laboratory for the same variable (rebound).

In the sports investigated in this study, the impact level can be considered moderate (<100g), according to studies that analyzed the land impact in the skills in amateur volleyball (SANTOS et al., 2005), basketball (SOUZA et al., 2007) and handball athletes (SAINTS et al., 2007b). However, due to high number of repetitions, the contribution of the impacts in the process of body damage becomes very evident. The correct landing technique is very important to prevent impact injuries. Generally, in court games, the landing phase can envolve one or both feet, however, when two feet are used, it increases the contact area with the ground that distribute the impact forces between the inferior limbs (PAPPAS et al., 2007). For Derrick (2004), the dumping process keeps the contact with the ground the possible longer time, in order to disperse most of the energy to the ground, otherwise, most of the shock is absorbed by the organism.

Although it is hard to establish the amount of jumps and the period of time necessary to cause injuries, Santos et al. (2007b) affirm that mechanisms of prevention to overuse injuries can be adopted by improving performance techniques, the use of individual protection equipment (IPE), and by improving muscular force and physical conditioning.

Although the athletes investigated in this study are amateur, the incidence of injuries in the inferior limbs are similar with those of high level athletes (MOREIRA et al., 2003; AUGUSTSSON et al., 2006; OLSEN et al., 2006; SILVA et al., 2007; BORIN et al., 2008). These results suggest a higher concern by coaches and athletes, therefore different facts like a weak performance technique, the lack of physical condition and muscular force, the use of inappropriate sneakers, among others, can be responsible for injuries occurrence.

**Conclusions**

From the results found, it can be considered that: the basketball, followed by volleyball athletes presented a higher amount of injuries in the inferior limbs, being the knee and the ankle the places more affected in all sports. Handball athletes jumped less than volleyball and basketball athletes during games; it seems that there is no difference in the amount of injuries between the sports investigated; the amount of injuries are related to the number of jumps per athlete.

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**ASSOCIATION BETWEEN INJURIES OCCURRENCE AND NUMBERS OF JUMPS IN AMATEUR COURT GAME ATHLETES DURING MATCHES**

**ABSTRACT**

In professional athletes, sports injuries are common due to high demands of practice. However, they are not exclusive to top athletes. This descriptive study aimed to investigate some inferior limb injuries characteristics in amateur sports that involve jumping (volleyball, basketball and handball). 37 male amateur athletes participated in the study: 14 volleyball players (age 23,8±2,9), 14 basketball players (age 16,1±1,7) and 9 handball players (age 22,2±1,4) with practice time of 7,7±3,6; 3,4±1,0 and 7,1±2,7 years, respectively. A questionnaire was used to investigate the characteristics of the injuries; a video camera and a form were used to record the number of jumps of each athlete during a period of three game-trainings in each sport. The data were analyzed by descriptive statistics (average, standard deviation and variation coefficient) and inferential statistics (ANOVA one way and simple linear regression) with 5 % significance level. The number of injuries was higher in basketball athletes (35), followed by volleyball (24) and handball (10). The average number of jumps for athlete was significantly lower in handball (9,4±2,1), and it had no differences between volleyball (48,3±22) and basketball (56,3±28,5). There was a significant relationship between jumps and injuries numbers, considering all the sports together ($R^2$=0,20; p=0,02). We can conclude that the injuries number suffered by amateur athletes in the inferior limbs was high, and that this occurs probably due to the lack of landing techniques used during jumping.

Keywords: injuries, repeated stress, sports.

**L'ASSOCIATION ENTRE LES BLESSURES ET LE NUMÉRO DE SAUTS RÉALISÉS PAR LES ATHLÈTES AMATEURS DES SPORTS COLLECTIFS PENDANT LES MATCHES.**

**RESUMÉ**

Pour les athlètes professionnels, les dommages sportifs sont courants à cause des grandes exigences de l'entraînement. Cependant, ils ne sont pas exclusivité des athlètes professionnels. Ainsi, cette étude descriptive a visé à étudier quelques caractéristiques des blessures dans les membres inférieures des athlètes amateurs des sports qui comprennent des sauts (volley-ball, basket-ball et handball). 37 athlètes masculins ont participé à cette étude: 14 joueurs de volley-ball (âge 23,8±2,9), 14 joueurs de basket-ball (âge 16,1±1,7) et 9 joueurs de handball (âge 22,2±1,4) avec un temps de pratique de 7,7±3,6, 3,4±1,0 et 7,1±2,7 années respectivement. Un questionnaire a été employé pour étudier les caractéristiques des blessures; une caméra de vidéo et une fiche ont été utilisées pour enregistrer le numéro de sauts de chaque athlète au cours d'une période de trois matches d'entraînement dans chaque discipline. Les données ont été analysées avec une statistique descriptive (moyenne, déviation standard et coefficient de variation) et une statistique inférencielle (ANOVA et la régression linéaire simple) avec le niveau de signification de 5 %. Le numéro de blessures a été plus haut dans les athlètes de basket-ball (35), suivis de ceux du volleyball (24) et du handball (10). Le numéro moyen de sauts par l'athlète a été significativement inférieur au handball (9,4±2,1) et il n'a pas eu aucune différence entre le volleyball (48,3±22) et le basket-ball (56,3±28,5). Il y a eu une association significative entre les sauts et le numéro de blessures, vu tous les modalités sportives ensemble (R2=0,20 ; p=0,02). Nous pouvons conclure que le numéro des blessures subies par les athlètes amateurs dans les membres inférieurs ont été hauts et que ça arrive probablement en raison de la manque de techniques d'atterrissage employées pendant les sauts.

Mots-clés : Blessures, Stress répété, Sports.

**ASOCIACIÓN ENTRE LESIONES Y NÚMERO DE SALTOS EJECUTADOS EN JUEGO EN ATLETAS AFICIONADOS DE MODALIDADES COLECTIVAS**

**RESUMEN**

En atletas de alto rendimiento las lesiones deportivas son frecuentes, debido a las altas demandas de la práctica. Sin embargo, no son exclusivas de los atletas de alto nivel. Así, con el objectivo de contemplar el deporte aficionado este estudio descriptivo buscó investigar algunas características de las lesiones en los miembros inferiores en modalidades que envuelvan saltos (voleibol, baloncesto y balonmano). Hicieron parte del estudio 37 atletas aficionados del sexo masculino, siendo 14 jugadores de voleibol (edad 23,8±2,9), 14 jugadores de baloncesto (edad 16,1±1,7) y 9 jugadores del balonmano (edad 22,2±1,4) con el tiempo de práctica de 7,7±3,6; años 3,4±1,0 y 7,1±2,7; respectivamente. Un cuestionario fue utilizado para investigar las características de las lesiones; una cámara de vídeo y una ficha de scoult fueron utilizadas para registrar el número de saltos de cada atleta durante un período de tres juego-entrenamientos en cada deporte. Fue utilizada estadística descriptiva (media, desvio padron y coeficiente de variacion) y inferencial (regresión linear simples y ANOVA one way) con nivel de significancia de 5%. El número de lesiones fue más alto en los atletas del baloncesto (35), seguidos del voleibol (24) y del balonmano (10). El número medio de saltos por atleta fué significativamente más bajo en el balonmano (9,4±2,1), no tiendo diferencia entre el voleibol (48,3±22) y el baloncesto (56,3±28,5). Hube una relación significativa entre los saltos y los números de lesiones en todos los deportes (R2=0,20; p=0,02). Fue possible concluir que el número de lesiones sufridas por los atletas aficionados en los miembros inferiores fueran altas y que ocurren probablemente debido a la carencia de las técnicas de aterrizaje utilizadas durante el salto.

Palabras clave: lesiones, tensión , deportes.

**ASSOCIAÇÃO ENTRE O ACOMETIMENTO DE LESÕES EM ATLETAS AMADORES DE MODALIDADES COLETIVAS COM O NÚMERO DE SALTOS REALIZADOS EM JOGOS**

**RESUMO**

Em atletas de alto rendimento as lesões esportivas são freqüentes, devido ao grau de exigência do treinamento, porém as mesmas não são exclusividade do alto nível. Assim, visando contemplar o esporte amador é que se realizou este estudo descritivo com o objetivo de investigar algumas características das lesões nos membros inferiores em modalidades que envolvem saltos (voleibol, basquetebol e handebol). Participaram do estudo 37 atletas amadores do sexo masculino, sendo 14 de voleibol, 14 de basquetebol e nove de handebol, cuja média de idade foi de 23,8±2,9; 16,1±1,7 e 22,2±1,4 anos e média de tempo de prática de 7,7±3,6; 3,4±1,0 e 7,1±2,7 anos, respectivamente. Utilizou-se um questionário para investigar o perfil das lesões; uma filmadora e uma ficha de escalte para registrar o número de saltos realizados pelos atletas durante três jogos-treino de cada modalidade. Os dados foram tratados por estatística descritiva (média, desvio padrão e coeficiente de variação) e inferencial (ANOVA *one way* e regressão linear simples) com nível de significância de 5%. O número de lesões foi maior em atletas do basquetebol (35), seguido do voleibol (24) e handebol (10). O número médio de saltos por atleta foi significativamente menor no handebol (9,4±2,1), não tendo diferença entre o voleibol (48,3±22) e o basquetebol (56,3±28,5). Houve associação significativa entre o número de saltos e o número de lesões para as modalidades investigadas ($R^2$=0,20; p=0,02). Pode-se apontar que, o número de lesões nos membros inferiores sofridos pelos atletas foi alto, comparando-se a equipes de alto nível e, que provavelmente estas são conseqüência da deficiência da técnica de aterrissagem utilizada para os fundamentos que envolvem saltos.

*Palavras-chave*: lesões, estresse repetido, esportes.