

**The epidemiology of injuries in Portuguese women's
volleyball players of a team: a two-year analysis.**

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Abstract

Background: Volleyball is one of the most played sports worldwide, classified as a non-contact sport, it is played with fast and explosive full-body movements across the court and in the vertical resulting in different types of injuries.

Aim: Analyse the pattern of injuries across athlete's position, nature, anatomic regions and location, severity and number of treatment sessions required in a first division Portuguese women volleyball team during two seasons.

Methods: A epidemiologic study was performed in a Portuguese women senior team of first division during two full seasons (n=18). Using a modified version of the *Fédération Internationale de Volleyball (FIVB)* - Injury Surveillance System all the injuries were recorded and collected. Calculation of the incidence rate of injuries, the frequency, type of injuries, location, and distribution along the season and for athlete's specific position.

Results: Of the 18 athletes 93,8% suffered injuries during training. These athletes presented an incidence rate of 11 injuries per 1000 athletes-hour exposure. The severity of reported injuries was mainly minor and only (20,5%) required more than 1 week of treatment sessions. The majority (57,7%) of the lesions was of overuse. Spikers were the athletes that presented more injuries and of those middle-blocker were mostly affected. Injuries of the shoulder complex were experienced mainly by the players with the position opposite, while setters had the higher percentage of the ankle joint injuries.

Conclusion: Athletes presented a higher incidence rate of injuries during training. The severity was minor, and the nature of injuries varied depending on the athlete's court position.

Clinical relevance: Identifying injury patterns in female volleyball athletes at 1st division team level allowing for more efficient planning by technical and medical departments allowing for the develop of individualized injury prevention protocols.

Keywords:

Volleyball, injury; female athletes;

Resumo

Introdução: O voleibol é uma das modalidades, mais praticadas a nível mundial. É classificada como uma modalidade de não contato com movimentos corporais rápidos e explosivos com deslocações por todo o campo e na vertical, resultando diferentes tipos de lesões.

Objetivo: Analisar as lesões em relação a posição das atletas, tipo, região e localização anatómica, severidade e número de sessões de tratamento necessárias numa equipa da primeira divisão portuguesa feminina de voleibol durante duas épocas.

Métodos: Foi realizado um estudo epidemiológico numa equipa portuguesa de seniores da primeira divisão durante duas épocas (n=18). Usou-se uma versão modificada da *Fédération Internationale de Volleyball (FIVB) - Injury Surveillance System* que permitiu registar e recolher todas as lesões. Foram calculadas as taxas de incidência, frequências do tipo de lesão, localização e distribuição das mesmas a longo da época e das posições das atletas.

Resultados: Das 18 atletas, 93,8% reportaram lesões durante o treino. As atletas apresentaram uma taxa de incidência de 11 lesões por 1000atletas-hora de exposição. A severidade das lesões foi principalmente *minor* e apenas (20,5%) necessitaram de mais de 1 semana de sessões de tratamento. As lesões de sobre-uso (57,7%) representaram a maioria das lesões. As atacantes foram as atletas com mais lesões e destas as centrais foram as mais afetadas. As lesões do complexo do ombro ocorreram nas atletas que ocupam a posição de campo definida como oposta e as lesões na articulação da tibiotársica aconteceram com uma elevada percentagem nas atletas passadoras/distribuidoras.

Conclusão: As atletas evidenciaram uma taxa elevada de lesões durante os treinos. Maioritariamente, as lesões foram classificadas como de severidade *minor*, e a natureza das lesões variou dependendo da posição em campo das atletas.

Relevância clínica: A identificação da distribuição das lesões em voleibolistas do género feminino pertencentes à 1ª divisão clubes permite um planeamento mais eficiente por parte dos departamentos técnicos e médicos, de modo a possibilitar a criação de protocolos preventivos e individualizados.

Palavras-chave:

Voleibol, lesões, atletas femininas;

Introduction

Volleyball is one of the most played sports worldwide ^[1, 5, 33, 40]. In 2020 the *Fédération Internationale de Volleyball* (FIVB) had 220 national affiliated Federations ^[20]. Despite being considered a relatively safe sport, the injury risk exists and results from its requirements and design ^[34]. It comprises a set of skills, like jumping, landing, and blocking and spiking, associated with explosive movements that require a great deal of neuromuscular control of the musculoskeletal elements ^[12]. Coordinating the entire body in movements that involve high vertical and horizontal forces results unavoidably in the occurrence of injuries ^[43]. Volleyball movements result primarily from jumping, landing and ball action, such as spiking and blocking ^[17]. These highly technical demanding skills make the athlete more prone to injury risk ^[10]

Athletes can play in frontcourt, near the net, and in the backcourt. We can divide them into 3 main positions in volleyball according to the more predominant set of skills they use. Liberos that only play in the backcourt court, their function is to pass or dig the ball sending it to the setter, although other backcourt-row players and sometimes frontcourt may receive the ball, this function is primarily of the libero. The setter has the function to receive the ball, normally from backcourt-row and set it overhead to the spikers. Spikers (wing-spiker, middle-blocker and opposite) have an offensive role, through the spike they send the ball to the opposing court and a defensive role using the block (setters also block) to protect their court. All players must serve, the skill that is used to begin every rally, except for liberos (adapted from FIVB the Game ^[22]).

The spiking action specifically is characterised by a high height jump to allow time for different types of action and to maximize the sharp ball trajectory and velocity and make the ball effectively fall on the opponent's court ^[23, 45].

Volleyball is the only non-contact ball sport played by teams ^[9, 37], it is expected to have different injury patterns and injury rates ^[37]. Different studies do not agree in terms of injury rates, describing them as low ^[9] and others as high ^[40]. The supposed lack of direct contact, because of the net separating both teams, would make us expect a lower incidence of injuries than in contact sports. However, the contact between athletes from the same team and opponents under the net changes this broad generalization and interpretation ^[2]. In these “dangers spots” we have the frontcourt players during offensive rallies jumping to spike, and in the defense, blocking or receiving the ball ^[37].

Elite volleyball players have high exposure, on practices and games, leading to an increased stress on joints and muscles and making them more prone to injury ^[10]. The

high volume of training hours and games during the a season, anywhere between 450-400 sessions (700-800 hours) and 80-100 games, creates a special context for volleyball injuries [33]. Several papers report an incidence of 1,7 to 2,5 injuries per 1000 hours of exposure [5, 8, 10, 12]. Nevertheless, Bere et al.[12] in their study from 2015 presented values that rise almost 5 times the previous incidence rate, to 10,7 per 1000 hours. Therefore, if we take this into consideration volleyball can be considered a high-risk sport [2]. During the 4 years analysis using the FIVB Injury Surveillance System (FIVB-ISS) 20,7% of injuries resulted from overload problems, 23,0% were traumatic in nature and 17,3% were non-contact injuries [12].

The shoulder joint is specially recruited during volleyball movements, when compared to other joints, its action occur specially in the overhead position, on setting, spike, block and serve [18]. The increment of the number of rallies in games/training also increases the load in the soft tissues resulting in a higher number of overuse injuries [1]. As previously stated, a higher incidence of injuries occurs on fingers, ankles and knees joints, the majority resulting from block and spiking movements in games and during training [43]. The volleyball spike and serve are a result of overhead throwing, similar to baseball pitching and football throwing [19]. Poorly performed techniques may increase the risk of injury [27]. The dynamic nature of the spike movement implies adaptation on athletes' position, on ball speed that is moving, and relation to the net. The blocking also requires adaptation of the upper limbs leading to overload and injuries [27].

Movements that happen in the limit and beyond the physiologic range of motion, occur during many of the overhead actions, endangering soft tissue stabilizers and the ability to keep articular congruence [32]. Shoulder injuries can result from a simple traumatic situation, but the majority results from overuse stress [25] that increases the risk of injuries in this joint, as a result of repeated movements [31], and also high-speed movements [27]. The majority of volleyball basic skills are influenced by the ability to jump [44]. Blocking and spiking are involved in a great number of injuries but another important part of the same action, landing and jumping, are also significant risk factors [43]. Several authors [41, 42, 45] say that the jump of the spike should be launched by a horizontal approach that allows the body to initiate the vertical acceleration. During the take-off and landing the knees and ankle joints are more susceptible to injuries as are the fingers, hand and wrist during the ball impact [43]. Middle-blockers are especially vulnerable during landing due to the proximity of teammates and/or adversaries feet's [43].

Knee joints overuse injuries were reported at 0,1-0,3 per 1000athlete-hour exposure [28]. Many ankle injuries happen on account of contact with other players (59%)^[40], nevertheless, non-contact injuries come in second ^[12, 40].

Of all the acute injuries, the major ones, happen in the knee (33%), ankle (17%) and shoulder (17%) ^[28]. Overuse injuries are primarily located in the knee 24% and shoulder 12% ^[28] and problems in the fingers and ankle are normally traumatic in nature ^[2].

Understanding the nature and rate of occurrence of injuries, their locations, time of absence and players position allow for more efficient planning by technical and medical departments making it easier to plan the season and help to develop individualized injury prevention protocols to better serve the athletes.

This epidemiologic study purpose is to analyse the pattern of injuries across athletes' positions, nature of the injury, anatomic regions, and location as well as severity and treatment session required in women senior volleyball athletes during two consecutive seasons of a Portuguese first division team.

METHODS

Design

Data from this epidemiologic descriptive study was collected during two consecutive seasons (2014-2015 and 2015-2016) in women seniors athletes from the same team performing in the Portuguese first division national competition.

Sample

The sample was composed of senior women athletes with a total of 18 players season 14-15 (n=18) and 15-16 (n=14).

Instruments and procedures

Biologic and training characteristics were provided by the technical department, from the data collected at the beginning of the season. Data referent to injuries was recorded by elements of the medical department, medical physician, and physiotherapist (B.M.) over the course of seasons 2014-2015 and 2015-2016. The data comprised results from clinical assessment and evolution inquiries from all injuries. In the year 2020, the investigator consulted the database in order were to fill in a modified version of the FIVB Injury Surveillance System (FIVB-ISS)^[21]. According to the FIVB ISS for each injury, it must

be recorded several details such as athletes' position, the moment of injury, injury location, type, and cause, estimated time to return to play. In our modified database, we also include laterality of injury, nature of the injury, real-time to return to play, conditionate practise and total duration of athlete complaints/treatment (physiotherapy). An injury was considered a newly musculoskeletal complaint regardless of the need for medical attention, absence or not from training/game by the athlete ^[4]. In injuries were also included joint blocking which was designated as joints dysfunction, and illness in the athletes comprehended all situations where musculoskeletal elements were not injured. And re-injury was a second injury of the same nature and same joint with less than 6 months apart. Acute injuries result from sudden event and overuse injuries that didn't result from a single event ^[40] our without an identifiable event by the athlete ^[24]. Ligament and tendon injuries were graded as 1st degree – light local tenderness, no instability ^[5] and no functional impairment; 2nd degree – notable sewing, tenderness ^[5] and functional limitation in sports; 3rd degree – significant swelling and instability ^[5], and total functional incapability.

The dominant arm was defined as the arm used in spike/serve. Training hours resulted from the association of both situations where players were on the playing field and in the gym room, and games were all official competitions that took place on the playing field. A minor injury comprehended loss time being less than 1 week, moderated 2-4 weeks and more than 4 weeks a major injury ^[33].

The collection and analysis of the data were performed years apart, being that the used data in the study was pre-existing in the clinical department and was accessed with the written informed consent of the athletes. The used data of the presented study is of the responsibility of the author and in total compliance with health ethical patterns compelled by clinical practice.

Ethics

The data used in this study were collected by the medical and technical departments that consented to the use of the same. All participants were informed about the nature and objectives of the studies, they were also informed that all collected data would be used for study and confidentiality and anonymity would be respected.

Data display was done in a group manner allowing for the confidentiality and anonymity of the athlete's identity to be maintained. A written informed consent was obtained from

athletes following the guidelines stated in the Declaration of Helsinki.

Statistical Analysis

Analyses of the data were done using IBM®SPSS® (SPSS V.27.0). To characterize the sample in terms of biological and training, the mean, standard deviation, minimum and maximum were used. The relative frequencies (%) was also used for descriptive for the variables of the study. To compare the biological and training characteristics of injured and non-injured athletes the test Mann-Whitney was applied. A significance level of $p < 0.05$ was considered. Incidence rate and epidemiology incidence proportion were also calculated [29], with an interval of confidence of 95%.

RESULTS

The observation period of this study was of two sports seasons. The duration of each season was of 10 months, beginning in August and ending in May, with official competitions beginning in mid-October. On the first season assessed we had 18 athletes and in the second 14 athletes making up the team group. Athletes had an average of $23,8 \pm 6,37$ years of age and $13,4 \pm 6,19$ of playing experience. The dominant upper limb was the right in all athletes.

Biologic and training characteristics of the sample are described in table 1.

Table 1: Descriptive analyses for biologic and training characteristics.

n=18	Mean (Std. Dev)	Minimum-Maximum
Age (years)	$23,8 \pm 6,37$	17- 43
Weight (Kg)	$70,2 \pm 10,4$	57 - 100
Height (m)	$1,79 \pm 0,05$	1,72 – 1,92
BMI (Kg/m ²)	$21,6 \pm 2,77$	17,2 - 29,9
Weekly training (hours)	9 ± 1	-
Experience (years)	$13,4 \pm 6,19$	3 - 33

The distributions of the athletes per position were libero = 2, setters = 3; middle-blockers = 5, wing-spikers = 4 and opponents = 4. In the first reported season, 83% of the athletes were students and in the second 57%.

To be able to quantify the amount of time allocated in training we analyse the exposure of athletes to training per season (Table 2).

Table 2: Number of athletes, exposition training hours, games by season

Sports seasons	Total players	Exposition (training hours)	Total games
2014-2015	18	390	48
2015-2016	14	410	41

During the 2014-2015 and 2015-2016, the senior athletes performed a total of 800hours of training and played 89 games. Most athletes experienced injuries (93,8%), however when comparing injured and non-injured players concerning biological characteristics using the non-parametric Mann-Whitney we didn't found a statistical difference between groups ($0,125 < p < 1,00$).

During the two seasons we recorded a total of 137 injuries, 54,7% of all injuries were sustained in the 1st season.

In table 3 we can analyse the injury incidences of the women athletes that make up our sample.

Table 3: Incidence rate and incidence proportion by seasons

	Incidence rate (per 1000h athlete)	SE	IC	Incidence proportion (%)	SE	IC
2014 -2015	11	0,0012	(8,27 ; 13,10)	50	0,1179	(0,27; 0,73)
2015 - 2016	11	0,0014	(8,11 ; 13,49)	78,5	0,1097	(0,57 ; 1)

Note: standard error (SE) and Interval confidence (IC)

The incidence rate for each season was 11 injuries per 1000athlete-hour exposure. Incidence proportion values were for the season 14-15 of 50% and in season 15-16 season for 78,5%.

Most injuries happened during training sessions (70,0%), only few injuries (8%) reported to situations where players didn't remember the cause. No athlete sustained injuries during games, but 22,0% of all injuries resulted from activities extra-volleyball. In the overall injuries and player function, most injuries were sustained by middle-blocker players (32,1%) and wing-spiker players (22,6%), the less injured players were the liberos (10,2%).

A great number of injuries (75,2%) corresponded to simple complaints from the players, requiring only training adaptations from the coaching plan, without limiting the players training when compared with other teammates. Regarding injuries sustained by the

opposite 6,3% of injuries required more than 2 weeks (major injuries) absence of training followed by the middle-blocker where 2,3% of injuries required the same absence. Libero, wing-spiker, and setter absence from training never exceeded 1 week (minor injuries).

The injury location that presented the most limitation on sports activity with several trainings affected were injuries on the thigh, knee, and ankle joint (Table 4).

Table 4: Major injury site by time of conditionate practise

	Shoulder complex	Thumb	Ankle joint	Knee	Thigh
Non substantial	21 (15,3%)	1 (0,73%)	2 (1,4%)	7 (5,1%)	14 (10,2%)
Minor (less 1 week)	4 (2,9%)	1 (0,73%)	7 (5,1%)	5 (3,0%)	5 (3,0%)
Moderate (2-4week)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1,4%)

Note: Non substantial: no training affected

Only 4,8% of all injuries implied more than 2 weeks of conditionate practise (including limitations non-sequential trainings). The majority (97,8%) need to be absent for less than 1 week (minor).

Depending on the injury the treatments time (sessions) needs may vary (Table 5).

Table 5: Frequency of injuries by treatment session

	Injuries
0 treatment session	21 (15,3%)
1 treatment session	38 (27,7%)
2 treatment session	26 (18,9%)
3 treatment session	11 (8%)
4 treatment session	5 (3,6%)
1 week treatment session	8 (5,8%)
2 weeks treatment session	8 (5,8%)
3 weeks treatment session	10 (7,3%)
1 month treatment session	3 (2,2%)
2 months treatment session	2 (1,4%)
3 months treatment session	1 (0,73%)
4 months treatment session	2 (1,4%)
6 months treatment session	2 (1,4%)

79,3% of treatments corresponded 0 days - 1 week of physiotherapy sessions and 15,3% of all these injuries reported by athletes required only instructions by the medical department.

Requiring 0 - 1 week of treatments were the larger number of the injuries on the shoulder complex 80,8% only 3,8% required more than 4-week treatment. Most knee injuries needed only 1-week of treatments (57,1%).

In the analyse of the types of injury, we found different needs in the number of treatment sessions (Table 6).

Table 6: Treatment session needed for each injury

	Up to 1 week	2-4 weeks	More than 4 weeks
Other bone injuries	0 (0%)	1 (0,73%)	2 (1,4%)
Sprain	8 (5,8%)	3 (2,2%)	0 (0%)
Muscular strain or micro-rupture	1 (0,73%)	1 (0,73%)	0 (0%)
Contusion Hematoma	4 (2,9%)	1 (0,73%)	0 (0%)
Tendinopathy	8 (5,8%)	3 (2,2%)	2 (1,4%)
Bursitis tenosynovitis	3 (2,2%)	0 (0%)	0 (0%)
Fasciitis aponeurosis injurie	2 (1,4%)	1 (0,73%)	0 (0%)
Skin lesion	1 (0,73%)	0 (0%)	0 (0%)
Myalgia	47 (34,3%)	6 (4,4%)	0 (0%)
Joint dysfunction	10 (7,3%)	0 (0%)	0 (0%)
Periostitis	1 (0,73%)	1 (0,73%)	0 (0%)
Joint block	2 (1,4%)	0 (0%)	0 (0%)
Traumatic arthritis	2 (1,4%)	0 (0%)	0 (0%)
Fatigue	2 (1,4%)	0 (0%)	0 (0%)
Systemic	19 (13,9%)	0 (0%)	0 (0%)

The injury with higher demand on treatments sessions were myalgias. When we allocate the treatment session for the injuries presented by the athletes, the injuries that required more time in treatment were tendinopathies, myalgia, and sprains. And the one's that needed fewer treatments were also sprains, tendinopathies and muscular strains, joint dysfunction, and aponeurosis injuries.

The majority (96,7%) of acute injuries led to an absence of training of 1-week (minor) while 3,2% needed an absence higher than 4 weeks (major). Similarly, a large part of overuse injuries needed up to 1 week of absence (97,5%). This also happened with the

number of treatment sessions needed. Only a small percentage of acute injuries (22,5%) and overuse injuries (26,5%) need more than 2 weeks.

Re-injury episodes resulted in 11% of all injuries, which made up 16% of all cases of injuries in wing-spikers and 18,8% of setters.

Table 7 displays the anatomic location of the frequently re-injured joints.

Table 7: Re-injuries (n) by injury locations and seasons

	Shoulder complex	Ankle joint	Knee
2014 - 2015	4	0	3
2015 - 2016	2	1	0

Season 15-16 had fewer re-injuries when compared with the previous season, having no cases in the knee joint.

The occurrence of acute, overuse and others are displayed in table 8.

Table 8: Number of injuries by category and by season duration (months)

		Acute	Overuse	Others
1st trimester	August	1 (0,73%)	0 (0%)	0 (0%)
	September	4 (2,9%)	9 (6,6%)	2 (1,4%)
	October	4 (2,9%)	10 (7,3%)	4 (2,9%)
2nd trimester	November	7 (5,2%)	13 (9,4%)	5 (3,6%)
	December	3 (2,2%)	5 (3,6%)	1 (0,73%)
	January	4 (2,9%)	8 (5,8%)	5 (3,6%)
3rd trimester	February	4 (2,9%)	7 (5,1%)	3 (2,2%)
	March	1 (0,73%)	13 (9,5%)	4 (2,9%)
	April	3 (2,2%)	12 (8,8%)	3 (2,2%)
	May	0 (0%)	2 (1,4%)	0 (0%)

Most injuries happened during the last part of the 1st trimester of the season (September, October, and November) also in the last part of the 3rd trimester (March and April) of the competitive season.

Most injuries occurred in the dominant side, even when splitting by players positions most injuries still happened in the dominant side, all very close or above 50% (libero 41,1%, opposite 59,3%, middle-blocker 47,7%, wing-spiker 51,6% and setter 43,7%).

Different court positions can lead to different injuries in location (Table 9) and anatomical regions (Fig.1)

Table 9: Injuries by region and by player position

	Libero	Opposite	Middle-blocker	Wing-spiker	Setter
Axial skeleton	4 (28,6%)	2 (6,2%)	8 (18,2%)	4 (12,9%)	0 (0%)
Upper limb	3 (21,4%)	11(34,4%)	11 (25,0%)	9 (29,0%)	5 (31,2%)
Lower limb	5 (35,7%)	13 (40,6%)	16 (36,4%)	16 (51,6%)	9 (56,3%)
Illness	2 (14,3%)	6 (18,8%)	9 (20,4%)	2 (6,4%)	2 (12,5%)

Most injuries occur in the lower limb (43,1%) followed by the upper limb (28,5%) and illness (15,3%). Assorting the location of injury by position resulted in middle-blocker presenting 36,4% of injuries in the lower limb and 25,0% in the upper limb, setters 56,3% in the lower limb and 31,2% in the upper limb and wing-spikers 51,6% in the lower limb and 29,0% in the upper limb. The most injured locations were the knee joint (10,2%) and ankle joint (6,6%) and thigh (14,6%) and in the upper limb was the shoulder complex (19,0%) of all injuries. Of all shoulder complex injuries, 91,6% were reported by spikers. Finger injuries were 1,4% of all injuries and all were acute and equally divided by libero, middle-blocker, and wing-spiker.

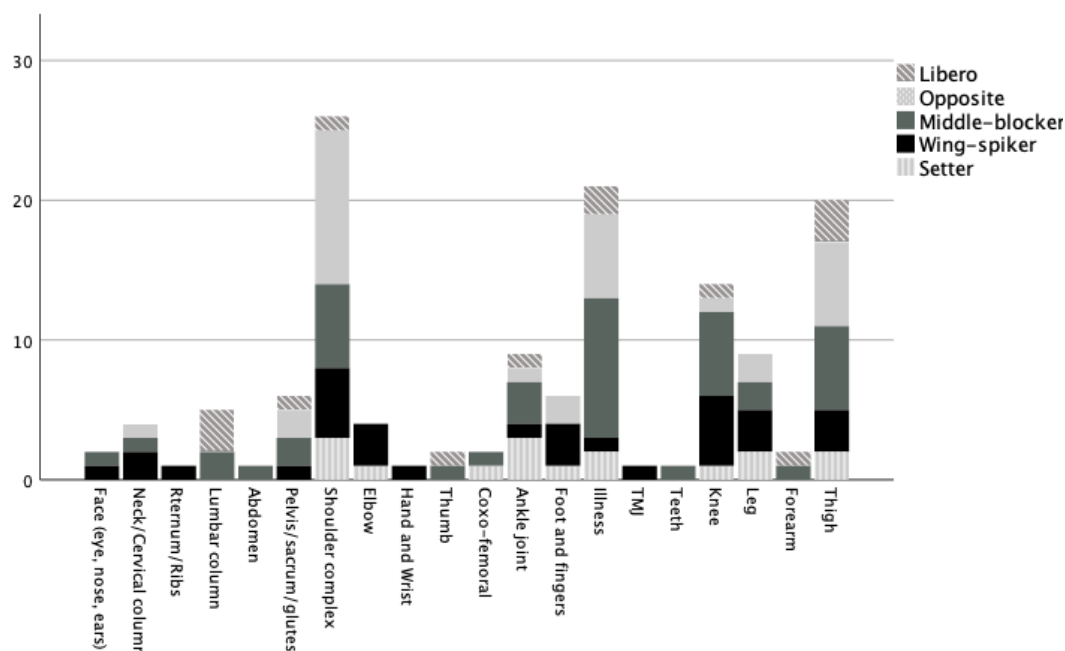


Figure 1: Number of Injuries by injury site and by athlete's position

When analysing injury by location and by players position (Figure 1), liberos had one of the higher percentages of injuries in the lower limb with 35,7% off all liberos injuries.

The most troubled areas were the thigh 21% and the knee joint 7% similar observation was made on wing-spiker spikers (16,1% knee joint and 9% in the thigh). Opposite spikers had 34% of the injuries located in the shoulder complex and 9% in the thigh. Setter's had injuries primarily in the lower limb (18% ankle joint and 12,5% in the thigh) and 18,8% in the shoulder complex. Middle-blocker players had a more distributed had 13,6% injuries in the shoulder complex, 13,7% in the knee joint and 13,6% in the thigh. Middle-blockers were also the positions that had the higher number of situations on illness during both seasons (20,4%).

The large number of injuries reported were of overuse nature (57,7%), and from those opposite (27,8%) and middle-blocker (29,1%) had the more elevated values. In the acute injures the wing-spiker had the higher values 32,2% and the middle-blockers 25,8%. Setter and liberos had the lower values for acute and overuse injuries (acute: libero 19,3%, setter 9,6%; overuse: libero 6,4% and setter 11,8%). Almost all shoulder complex injuries were of overuse (91,7%) as the majority of knee joint injuries (85%), all finger injuries were acute and the majority of ankle joints (94,1%) were also acute.

The following figure (Figure 2) represents the distribution of the different types of injuries by court positions.

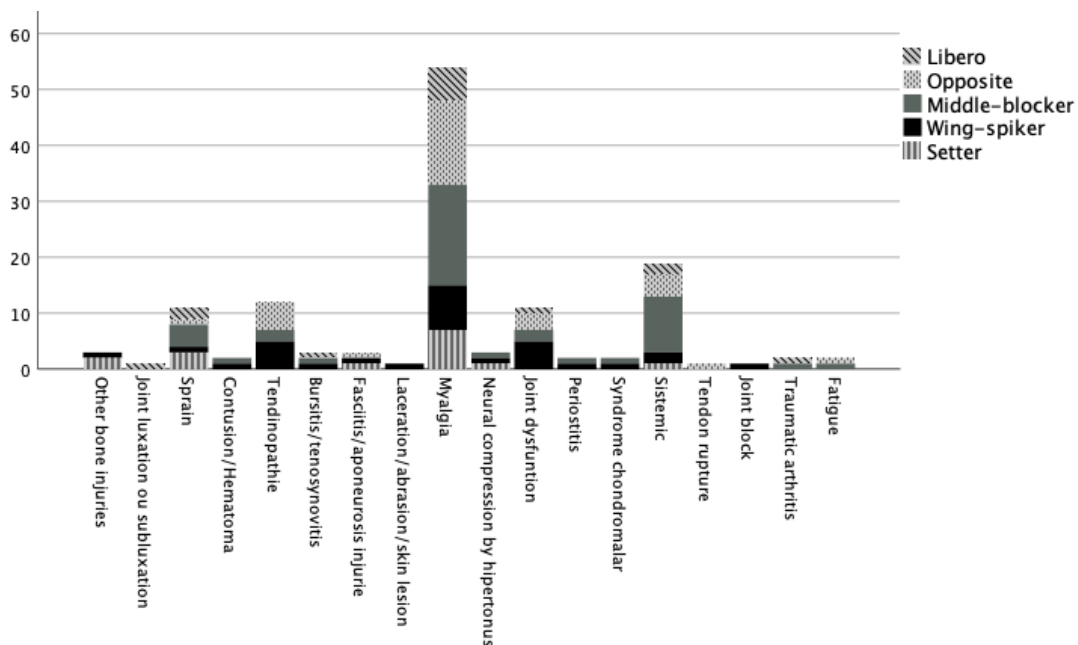


Figure 2: Number of injuries by type and by athlete's position

Most injuries 39,4% were myalgias. Values reported for tendinopathies were 8,7% and on sprains 8,0%. A similar distribution has verified when the sample was divided by player's position, myalgia has higher values (opposite 46,9%, setters 43%, libero 42,9%, middle-spikers 40% and wing-spiker 25%) followed by tendinopathies (16% wing-spiker, 15% opposite and 5% middle-spikers) and sprains (setter 18%, libero 14%, wing-spiker 9% and 3% on opposite and middle-spikers).

Injuries corresponding to 2nd and 3rd degree were very few (2,2%). Injuries could also be divided concerning as overuse of gradual onset 27,7% or with student onset 16,1%, non-contact trauma 4,4%, impact with a stagnate object 6,6% and the same value 6,6% for overloads from other sports activities with no relation to volleyball.

Different aetiology of injuries require different times of treatment, as can be verified in figure 3.

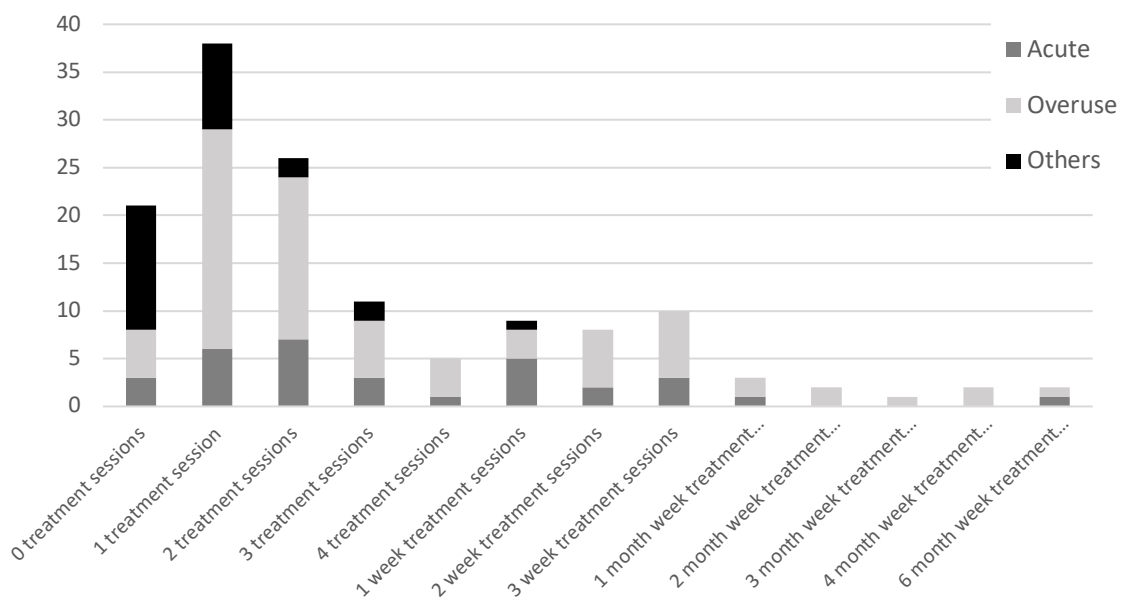


Figure 3: Duration of treatment sessions by injury category

Since most injuries reported by the athletes only comprehended complaints this situation needed a small amount of treatments sessions 1 day 27,7%, 2 days 18,9% and 3 days 8% between 2-4 weeks 13,8% and more than 1 month (4,9%).

DISCUSSION

In Vanderlei et al.^[39] study the difference between injured athletes and non-injured was statistical significant in the following variables age, BMI, height, height and years of practicing volleyball. We didn't find statistical differences between injured and non-injured athletes, so our sample results can't support authors that state that players that have higher experience playing volleyball also present higher numbers of injuries^[16].

Our athletes had an average of 400h training, a number that's higher than that presented from elite Danish players with an average of 334,1 (\pm 12,9) hours of training^[2]. Musculoskeletal injuries present a clear relation with hours of exposure to the sport^[39]. In order to have a better assessment of injuries the hours of exposure must be used to normalize values. Aagaard et al.^[2] reported that Danish volleyball men players have an injury incidence of 3,8 per 1000 hours of training, similar incidence was found in men 4,38 and 4,1 for women during a 6 seasons study^[33]. In our study, the athletes had higher values (11 injuries per 1000 athletes hours of training). We didn't include games in this calculation, since not all players had the same exposure to games.

Athletes that have complaints as injuries have a higher frequency than those injuries that need medical attention and injuries with missing games/practice had even lower occurrences similar results were presented by Bahr et al.^[7].

Injury severity can be assessed by the time needed for a player to return to complete and normal training/games. In our study, most injuries lead to an absence of training lower than 1 week (minor). Similar results were presented by Pastor et al.^[33] with 77,4% of all injuries needing less than a 1-week to return completely to trainings/games, but Solgard et al.^[37] verified that 44% of injuries lead to more than 1 month of sports activity absence. Wing-spikers were the athletes that had higher values, 32,4%, concerning needing more than 4 weeks of treatment^[30]. Contrary to this when analysing the loss time by athletes' positions, we found that our middle-blockers and opposite were more absent from training.

Using only the absence of trainings to define injury severity creates a bias since the same injuries (location and degree) in two players can have different outcomes, while one can stop training/game the other may keep going on training^[11]. This is particularly true for overuse injuries in most sports^[11]. Analysing our athlete's treatments sessions numbers some players have treatments up to 6 months. Overall, 20,5% of the injuries needed more than a 1-weeks of treatments but only 1,4% had training limitations for more than 1 week.

In the analysis of our group overuse injuries needed absence of more than 1 week, Pastor, et al. [33], found lower values of 2,17 days per player. Acute injuries lead to a longer time of activity stop [33], we demonstrated that acute injuries, although in lower numbers, needed long periods apart from the playing court. In terms of treatments duration, acute and overuse had very identical values when needing more than 2 weeks of treatments (overuse 26,4% and 22,5%).

Shoulder complex injuries rarely lead to a bigger absence of games and training [14], losses of sports time can be hidden, since volleyball athletes can keep playing even in the presence of pain and discomfort [26], by making small changes on the overhead movement. Possibly this was what happened in our study since only a minority of shoulder injuries needed more than 1-week absentee from trainings, but almost 20% of the injuries underwent treatment for more than a 1 week.

The rate of injuries do not simply result from the risk of injury in sports but also other activities that players perform in their daily life [39], in this epidemiological analysis from all injuries that athletes experienced (22,0%) resulted from non-volleyball injuries.

The majority of injuries takes place during the competitive season (79,8%) [10], identical situation was found in this study, with higher values of injury occurring during the 1st and 2nd parts of the competitive season. We could hypothesize that injury's, especially overuse, occurred in school exams periods and most of our players were students.

Spikers in the study sustain 70% of all injury's, being in line with previous studies that claim that frontcourt players are more vulnerable to injury since the more important part of the rallies happen at the net [1] and have more contacts with teammates and opponents [12].

Pastor et al. [33] verified an injury distribution of 79 injuries for wing-spiker, 58 for middle blockers resulting from jumps exposition (setter with 16 injuries, opposite with 23 injuries and libero with 10 injuries). Other authors report that the most injured athletes are wing-spiker with values of 22,6% [30] and 31% [10]. In this study middle-blocker also had more injuries (44 injuries) and our opposites (32 injuries) and wing-spikers (31 injuries). The wing-spiker and middle-blocker players are the positions that represent a higher number of jumps and net displacements that can explain high numbers of injured [30].

The shoulder complex is subject to high loads mainly during the spike and serves [2] injuries vary from 8-20% of all injuries [14].

Similar values were exhibit in our study, 16% of all injuries affected the shoulder complex. Kilic et al.[28] systematic review reported that incidence of shoulder joints

injuries ranged from 2,1-42%, on the majority of the studies having an incidence above 20% (2,1% [35]; 12% [8]; 22% elite e 42% amateurs [11]; 30% [10]; 27% [30]). Although our data is in line with the studies, we have lower values than most studies.

Spikers have more shoulder pain during the season than setters and liberos (64% vs 49%) [34]. We had a similar pattern since almost all shoulder complex injuries were reported by spikers. Shoulder complex injuries are the 3rd most common injury after ankle and knee joints on the study of 16 years by the National Collegiate Athletic Association Injury Surveillance System [3], this is in agreement with our results.

The elevated numbers of injuries in the knee joint can result from the high number of jumps intrinsic to the sport [13]. Verhagen et al.[40] knee joint injury presented a total of 12% of all injuries, and 40% of knee injuries resulted in a sports activity pause for more than 3 months [39]. In our case, knee joint injuries presented an identical value in the overall presentation of injuries but had no limitations of sports above 1-week although having 21,4% of knee injuries requiring more than 4-weeks of treatment.

Injuries at the ankle joints normally result from landing after blocking or spiking [1, 2, 13, 17, 37] directedly on the floor or in other players feet [1, 2, 17]. The dynamic nature of movements such as landing, break, blocking and spike can make the athletes contact other athletes feet leading to sprain ankles joint [3]. Beneka et al.[11] reported that 25% of ankles sprain were the result of landing on a teammate's foot in the block, leading to conclude that the player with major risk were middle-blockers and wing-spikers [11]. But in the present study setter were the position with more injuries at the ankle joint, the large difference in values from our study and the last-mentioned study could be the result on the different number of players of the sample since theirs had 407 athletes.

Bahr et al.[5] formulated that the high re-incident on ankle injuries shown in several studies is the result of altered proprioceptive function leading to re-injuries. And low values of ankle injuries can be linked to prevention training [33]. Volleyball players that have a history of previous ankle injury raise the risk of re-injury in the following 12 months [39]. We had 1 re-injury in the ankle joint that represented 11,1% of all ankle's joint injuries.

There's no association with personal or training variables for finger injuries [39], but the ball can explain this type of injury [37]. Sports that required hand handling of the ball inevitably are prone to finger acute injuries [38]. During the block action, players are vulnerable to traumatic loads at the tips of the fingers and hyperextension of the finger during ball contact [38]. Most finger injuries in volleyball players have minor

consequences and rarely need absence from training ^[13]. Our group of athletes presents injuries in thumb and fingers, very low values when compared with Solgard et al.^[37] which had 56,3% of all injuries in women players.

Training sessions record a higher number of injuries when compared with games ^[10, 11, 30, 39], as a result of the more elevated number of hours in trainings than in games ^[11, 39]. In games, not all athletes play and the trainings everyone is practising. Senior players due to the higher exposure have higher numbers of injuries in training ^[17], this also happened in our group. As previously compared to elite athletes our sample had all injuries occurring during trainings. Higher values of incidence in training may be a result of more repetitive movements ^[1]. Greater load and fatigue can predispose players to more injuries ^[11] condition that happens in training. In the study done by Bere et al.^[12] a predominance of injuries occurred during games (62,5%). We believe that this data results from the competitions where the sample was assessed, which were national teams in international tournaments where exposure to training is lower than in normal club seasons. In international games, we can deduce that higher intensity resulting in a risk factor for injury in games vs training ^[6, 36]. Beneka et al. ^[11] also stated that athletes deal with high physical and psychological pressure that results contributing to anxiety and tension.

Overuse injuries were responsible for 47,3% of all injuries ^[30] in our sample we had higher values. Wing-spiker spikers were the ones with the majority of overuse injuries (26,7%) ^[30], we had very identical values, but in our case the position that had the higher value for overuse were middle-blockers and overuse was the cause of the majority of injuries data. These injuries dominate over acute since they can result from a high number of repetitions, type of playing surfaces and inaccurate technical performance ^[17]. A great number of acute injures was located on the ankle joint and finger and overuse on the knee and shoulder complex, similar results were presented in the study done by Aagaard et al. ^[1] reporting 4 major locations for volleyball injuries, they were shoulder complex (90% overuse) and knee joint (88% were overuse) and ankle joint (68% acute) and fingers (87% acute). Values that are similar to ours, with exception to the fingers, as in our study all fingers' injuries were acute. It was also been suggested that fatigue in the elite player could be an important factor in the report of a high number of overuse injuries ^[11], and our athletes had a higher number of hours trainings when compared with elite players, being a factor that could influence the number of overuse injuries.

Tendinopathies and sprain injuries were the injuries that required a greater number of treatments but also the ones that required fewer treatments. We can associate this event

with the fact that these injuries have degrees and low degrees need fewer treatments and were the more frequent and 3rd degree need more treatments. Myalgia presented itself as the major's source of complaint by the athletes but represented almost no absence from volleyball training. This condition was primarily located in the thigh, which are allocated essential muscles to jumping, a basic skill in volleyball. The lower limb eccentric contraction involved in several movements can lead to muscle damage ^[15], resulting in myalgia. As seen previously these athletes underwent higher values of training hours than elite players, which could lead to this situation.

Our athletes presented a decline in re-injuries between the two seasons like reported by Pastor et al. ^[33] in the first season a large number of players were new to the club and were not used to make individual trainings with, focus on prevention. All players had physical training where global needs were attended and where was also possible to include individual training as a result of clinical assessments or previous injuries, this was also similar to what Pastor et al. ^[33] stated, being the basis of all gyms training planning during the two seasons. This work was planned by the two departments (medical and technical) where the global and individual needs of the athletes were attended. Prevention of ankle injuries is a hard subject since most injuries happen as a result of incorrect landings, either on the floor or other player feet ^[1], this was the only cause of a joint that had an increase of re-injuries between the two seasons.

CONCLUSION

Most injuries in the athletes of this study happened in training. The severity of reported injuries were predominately minor and few injuries required treatments for more than 1 week and even less needed absence of trainings for more than 1-week. The greater number of injuries resulted from overuse and on the overall joints with more injuries were shoulder complex, knee, and ankle joints. In terms of court position spikers were the ones with the higher number of injuries, and of those middle-blockers are the most affected. Concerning anatomical location lower limb had a higher number of injuries and tendinopathies, myalgia e sprains were the type of injuries the higher frequency.

Injuries of the shoulder complex were experienced mainly by opposites while setters had the higher percentage of ankle joint injuries.

Limitation of the study

The sample of this study was far from being representative of the women Portuguese population playing in official competition in the senior category in the first division.

Not all athletes were professional players, and extra activities varied from non-physical activities to highly active activities that presented a risk of injury.

All data collection was performed by the elements composing the clinical department using clinical assessments, diagnostic imaging techniques were done very rarely, only in severe cases.

Exposure to games was not calculated since not all athletes play in all games and the duration of the games is very variable (from 1,5hours to more than 2hours).

Future studies

Compare patterns of injury in other teams of women senior players with a different types of training plans. Trying to delimitate the risk factor of injuries enabling input on the prevention of injuries and optimize athlete's sports performance.

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