Upper extremities functional disability and pain intensity in female volleyball athletes: cross-sectional study

Incapacidade funcional de membro superior e intensidade de dor em atletas de voleibol do sexo feminino: estudo transversal

Érika Camila Oliveira Miranda[1], Isabela Almeida Ramos[1,2], Geórgia Danila Fernandes D'Oliveira[1], Erika Baptista Gomes[1,3], Claudia Dias Leite[1,2]

DOI 10.5935/2595-0118.20220046-en

ABSTRACT

BACKGROUND AND OBJECTIVES: In volleyball, the high demand for shoulder sports makes it susceptible to injuries due to the repetition of sporting gestures. The presence of pain in the shoulder can lead to the disability to perform movements correctly, resulting in reduced sports performance. The study aimed to evaluate and correlate the presence of pain and functional disability of the upper extremity in volleyball athletes.

METHODS: Cross-sectional descriptive study, developed with 30 female volleyball athletes. Functional disability was assessed using the Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) and pain intensity using the Visual Numeric Scale (VNS). The study was conducted in an online format. The IBM SPSS 21.0 statistical package for Windows was used, where descriptive measures, Wilcoxon, and Spearman correlation tests were performed, adopting p≤0.05.

RESULTS: Nineteen athletes reported mild to moderate pain to perform daily activities, and 21 athletes reported pain to perform sporting gestures, with pain being significantly more intense in the dominant shoulder in the spike movement (p<0.001), serve (p<0.001), and blocking (p=0.03). Athletes did not present functional limitations in the DASH, but the opposite, outside hitter, and middle blocker, presented mild limitations in the DASH sport. There was a strong correlation between DASH and day-to-day pain (*rs*=0.79; p<0.001) and a moderate correlation between sports DASH and pain in the dominant shoulder in the spike (*rs*=0.67; p<0.001) and in the serve (*rs*=0.60; p<0.001) movements.

CONCLUSION: Evaluated athletes presented shoulder pain, higher functional disability to performer the sports activity, and pain and functional disability were positively correlated

Keywords: Athletes, Physical functional performance, Shoulder pain, Volleyball.

RESUMO

JUSTIFICATIVA E OBJETIVOS: No voleibol, a alta exigência da articulação do ombro torna-o suscetível a lesões devido à repetição dos gestos esportivos. A presença de dor no ombro pode gerar incapacidade para executar os movimentos corretamente, ocasionando redução do desempenho esportivo. O estudo teve como objetivo avaliar e correlacionar a presença de dor e incapacidade funcional de membro superior em atletas de voleibol.

MÉTODOS: Estudo transversal, descritivo, desenvolvido com 30 mulheres atletas de voleibol de quadra. A incapacidade funcional foi avaliada por meio do *Disabilities of the Arm, Shoulder and Hand Questionnaire* (DASH) e a intensidade de dor pela Escala Visual Numérica (EVN) de 10 pontos. A pesquisa foi conduzida no formato on-line. Utilizou-se o programa estatístico IBM SPSS 21.0 para Windows, pelo qual foram realizadas as medidas descritivas, o teste de *Wilcoxon* e a correlação de *Spearman* adotando p≤0,05.

RESULTADOS: Dezenove atletas relataram dor leve a moderada para realizar as atividades diárias, e 21 atletas para realizar os gestos esportivos, sendo a dor significativamente mais intensa no ombro dominante em movimentos para ataque (p<0,001), saque (p<0,001) e bloqueio (p=0,03). As atletas não apresentaram limitação funcional no DASH geral, mas no DASH esporte as opostas, ponteiras e centrais foram classificadas com limitação leve. Houve correlação forte entre DASH e dor no dia a dia (*rs*=0,79; p<0,001) e correlação moderada entre DASH esporte e dor no ombro dominante no ataque (*rs*=0,67; p<0,001) e no saque (*rs*=0,60; p<0,001).

CONCLUSÃO: Atletas avaliadas apresentaram dor no ombro, maior incapacidade funcional na atividade esportiva, e dor e incapacidade funcional estavam positivamente correlacionadas.

Descritores: Atletas, Desempenho físico funcional, Dor de ombro, Voleibol.

Érika Camila Oliveira Miranda – https://orcid.org/0000-0003-1759-0222;
Isabela Almeida Ramos – https://orcid.org/0000-0003-3651-9966;
Geórgia Danila Fernandes D'Oliveira – https://orcid.org/ 0000-0001-9707-0045;
Erika Baptista Gomes – https://orcid.org/0000-0002-0704-2030;
Claudia Dias Leite – https://orcid.org/0000-0002-8062-7916.

1. UniProjeção University Center, Physical Therapy Course, Brasília, DF, Brazil.
2. Catholic University of Brasília, Graduate Program in Physical Education, Brasília, DF, Brazil.
3. Catholic University of Brasília, Physical Therapy Course, Brasília, DF, Brazil.

Submitted on February 05, 2022.
Accepted for publication on September 13, 2022.
Conflict of interest: none - Sources of funding: none

HIGHLIGHTS

- Overhead movements such as serve and spike contribute to shoulder pain in volleyball players;
- The functional disability of the upper limbs is positively correlated with the intensity of pain to perform daily activities and sports;
- The kinetic-functional diagnosis is important to minimize the risk of injury, rehabilitate injured athletes and provide an adequate return of the athlete to sports practice.

Correspondence to:
Claudia Dias Leite
E-mail: msc.claudiadias@gmail.com

INTRODUCTION

Volleyball is a team sport characterized by explosive actions with jumps, accelerations and decelerations to perform the elements of the game such as serving, reception, lifting, attacking, blocking and defending, which are repetitively executed with strength, speed and power, demanding a lot from the musculoskeletal system of its practitioners[1,2]. Moreover, movements such as serving, spiking, setting, and blocking that are performed above the head contribute to a high number of injuries in the shoulder region[1,3].

Among the factors related to the high rates of shoulder injuries in volleyball are internal rotation deficit of the glenohumeral joint, scapular dyskinesis, altered biomechanics of the attack movement[4], and muscle imbalance between external and internal rotators[5]. Moreover, joint anatomy, injury history, training overload, and repetitive movements with high stress loads make the shoulder more susceptible to biomechanical changes and cause instabilities[6-8].

The combination of acute and chronic shoulder injuries represents 8% to 20% of all volleyball-related injuries[8], and most of them are caused by repetitive strain, responsible for approximately 19% of all injuries that occur in this sport and result in a longer time away from the sport practice[9]. For example, the attack movement in volleyball is an aerial movement performed very frequently by professional athletes, and may be performed up to 40,000 times a year[6]. During the attack, the athlete is in the air and strikes the ball with the upper limb without the support of the lower limbs, which exposes the player's shoulder to an excessive load, predisposing the risk of injuries[4,6].

Among the shoulder injuries that occur in volleyball, the rotator cuff tendinopathy, impingement syndrome, SLAP-type injuries, and suprascapular nerve compression, which can lead to atrophy of the supraspinatus and infraspinatus muscles can be mentioned[10-13]. At the elbow, the most common are collateral ligament injuries (especially the medial one), tendinitis, and, at the wrist and hand, scaphoid fractures, ligament injuries, dislocation, and finger fractures[12]. These injuries also contribute to the appearance of upper limb pain in volleyball players[9,10]. In addition, the presence of non-traumatic shoulder pain can be represented by low levels of pain for long periods, but it does not prevent the player from continuing his or her sports practice[14].

When shoulder injuries are not properly diagnosed and treated, they result in longer periods of absence from training and sports competitions, negatively impacting the player's performance and, in more severe cases, they can prematurely interrupt the athlete's career. Therefore, the role of sports physiotherapy is to perform the kinetic-functional diagnosis, aiming to minimize the risk of injury, rehabilitate injured athletes and provide an adequate and safe return to sports practice[15].

Therefore, it is important to understand the possible association between pain and functional disability of the upper limbs. Studies in the sports context showed that in master athletes with and without rotator cuff lesions, the greater the shoulder pain, the worse the shoulder function[16]. On the other hand, in Crossfit athletes with and without shoulder pain, upper limb function was inversely associated to pain[17]. Finally, preliminary evidence indicates an association between shoulder pain and functional disability with the shorter pectoralis minor muscle length in women swimmers, which may influence scapular kinematics[18]. Specifically in volleyball modality, authors[19] verified that athletes with rotator cuff lesions presented higher general and specific functional disability when compared to athletes without lesions. A study[20] showed a greater functional disability of the upper limb in female athletes practicing volleyball, when compared to softball and swimming athletes, and they did not find a significant difference in handball athletes, considering the similarity of attack and throwing movements.

A study[21] evaluated 15 volleyball athletes in the juvenile category, associating pain by the Visual Analog Scale (VAS) and by the Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH), and identified low pain intensities and little functional limitation, with no significant difference in the general and specific functional performance related to the sport. There was also no correlation observed between pain during and after training and specific functional performance. The association between pain and functional disability is predictable clinically, but in the sports context it still generates discussion and controversy, because the pain coping strategies adopted by athletes on a daily basis, in training and competitions, are different from those of non-athletes, and are related to gender, time of experience, and age.

In view of the above, the present study had as objectives: 1) to evaluate the functional disability of the upper limb of female volleyball athletes; 2) to evaluate and compare the intensity of pain reported by athletes in the dominant and non-dominant shoulder when performing volleyball sports gestures; and 3) to verify the association between the intensity of pain reported in daily activities and sports gestures and the functional disability of the upper limb. As a hypothesis of the study, it was expected that the athletes would report pain when performing the sportive gestures, such as serve and attack, and that they would present functional limitations related to the sportive activity, and that the greater the intensity of pain in the shoulder, the greater the functional disability.

METHODS

Cross-sectional study with a descriptive approach on pain intensity and functional disability of the shoulder in volleyball athletes, based on the recommendations for observational studies (Strengthening the Reporting of Observational Studies in Epidemiology - STROBE)[22].

A convenience sample was selected, consisting of female volleyball athletes between 18 and 55 years old. The inclusion criteria were to play in the adult or master category, to participate in regional and/or national championships, and to be affiliated to the Volleyball Federation. The exclusion criteria were athletes who had recently undergone shoulder surgery and/or were in the rehabilitation phase during the research period.

The DASH, translated and validated into Brazilian Portuguese[23], measures the physical function and symptoms in individuals with upper limb musculoskeletal disorders[24]. The general DASH is composed of 30 items that evaluate the difficulty encountered by the individual in performing various activities (items 1 to 21), the intensity of pain, activity-related pain, tingling, weakness, and stiffness

(items 24 to 28), the influence of these problems on social activities, work, and sleep (items 22, 23, 29), and their psychological impact (item 30) in the last week. Each item is rated on a 5-point Likert scale, ranging from 1 (no difficulty) to 5 (unable to do the activity). The items are summed to obtain a scale score ranging from 0 (no limitation) to 100 (very severe limitation). The participants also completed the sport DASH, composed of four items that measure the difficulty encountered by athletes with upper limb dysfunction in their sports activities (also scored from zero to 100)[23]. After applying the formula, the participants were classified with: no limitation (1-20), mild limitation (21-40), moderate limitation (41-60), severe limitation (61-80) and very severe limitation (81-100). DASH is a self-applicable instrument and has proven to be reliable and valid in individuals with upper limb functional disability[23,25].

Pain intensity was measured by means of the Visual Numerical Scale (VNS), a reliable and validated unidimensional measure[26-28], obtained through the individual's report that indicates the intensity of pain on a continuous scale (zero-10), with zero being no pain and 10 being the worst possible pain[26,28]. The participants were asked to evaluate the intensity of pain to perform the sportive gestures of volleyball.

The survey was conducted in an online format, with questionnaires being made available on the Google Forms platform. A link was generated and shared electronically to the participants (email, WhatsApp, and Instagram) between October and December 2021. Initially, the athletes needed to mark "yes" on the Free and Informed Consent Term (FICT) to agree to participate in the research, and then access the anamnesis to provide information pertinent to the research, such as age, body mass, height, category, position on the team, time of practice, weekly training frequency in days, participation in championships, dominant upper limb, and history of shoulder injuries. After that they filled out the general DASH, sport DASH and VNS.

This study was approved by the Research Ethics Committee of the Brasília Child Hospital / Child Cancer and Specialized Pediatrics Institute (*Hospital da Criança de Brasília-HCB / Instituto do Câncer Infantil e Pediatria Especializada-ICIPE*), opinion number 5.082.659. The sample size was estimated at 26 individuals, calculated using the G*Power 3.1 software, determined to achieve a statistical power of 80%, moderate effect size of 0.5 and α=0.05, using a bivariate normal model, defined a priori.

Statistical analysis

The data were analyzed in the statistical program IBM SPSS 21.0 for Windows, in which descriptive measures were taken to characterize the sample, represented by mean, standard deviation, and percentage. Data normality was evaluated by the Shapiro-Wilk test. To compare pain intensity in the dominant and non-dominant shoulders during sportive gestures, Wilcoxon's test was performed and Spearman's correlation (Rs) was used to correlate the variables of pain intensity (day to day and sportive gesture) and shoulder functional disability (general DASH and sport DASH). The significance level was $p \leq 0.05$.

RESULTS

The sample was composed of 30 women athletes, 43% of whom reported having injured their shoulder while playing volleyball. The characteristics of the sample are presented in Table 1.

Nineteen athletes (63%) reported shoulder pain when performing daily activities with a mean intensity of 3.68 ± 2.58 (1-10). On the other hand, 21 athletes (70%) reported shoulder pain when performing some sportive gesture of volleyball. Pain was significantly more intense in the dominant shoulder during attacking ($p<0.001$), serving ($p<0.001$) and blocking ($p=0.03$). Effect sizes were strong for attacking and serving, and moderate for blocking[29] (Table 2).

The data related to the general classification of functional disability of the upper limb in the general DASH and sport DASH are described in table 3. It was observed that in general the Opposite, Middle and Attack positions presented mild limitation for the

Table 1. Characterization of the sample by category

	Adult category (n=16)	Master category (n=14)	Total (n=30)
Age (years)*	25.75 ± 6.52	39.29 ± 5.43	32.07 ± 9.07
Body mass index (kg) *	71.50 ± 8.72	80.29 ± 13.74	75.60 ± 11.99
Height (cm) *	172.38 ± 6.10	171.86 ± 7.04	172.13 ± 6.44
Time in practice (years) *	10.94 ± 6.03	24.46 ± 8.86	17.00 ± 10.00
Weekly training (days) *	3.06 ± 1.48	1.69 ± 0.75	2.45 ± 1.38
Position			
Libero	1 (6%)	0 (0%)	1 (33%)
Setter	3 (19%)	2 (14%)	5 (17%)
Opposite spiker	3 (19%)	3 (21%)	6 (20%)
Middle-blocker	5 (31%)	4 (29%)	9 (30%)
Attacker	4 (25%)	5 (36%)	9 (30%)
Dominant upper limb			
Right-handed	16 (100%)	13 (93%)	29 (97%)
Left-handed	0 (0%)	1 (7%)	1 (3%)

*Data presented as mean ± standard deviation.

Table 2. Comparison of the mean pain intensity of the dominant and non-dominant shoulder during the execution of sportive gestures

Sportive gestures	Dominant shoulder (n=21)	Non-dominant shoulder (n=21)	Z-value	P-value	Effect size
Attack	3.95 ± 3.09 (0-10)	0.67 ± 2.01 (0-9)	-3.76	<0.001*	0.82
Serve	3.76 ± 2.97 (0-10)	0.71 ± 2.05 (0-9)	-3.64	<0.001*	0.79
Block	0.95 ± 1.88 (0-7)	0.38 ± 1.32 (0-6)	-2.23	0.03*	0.49
Set	0.52 ± 0.98 (0-3)	0.14 ± 0.36 (0-1)	-1.84	0.07	0.40
Forearm pass	0.24 ± 0.70 (0-3)	0.05 ± 0.22 (0-1)	-1.34	0.18	0.30

Table 3. General classification of shoulder functional limitation by position.

Position	General DASH		Sport DASH	
	Score	Classification	Score	Classification
Libero	6.67 ± 0.00	No limitation	18.75 ± 0.00	No limitation
Setter	2.67 ± 2.15	No limitation	1.25 ± 2.80	No limitation
Opposite-spike	12.92 ± 19.86	No limitation	27.08 ± 38.26	Mild limitation
Middle-blocker	8.52 ± 10.44	No limitation	20.14 ± 18.16	Mild limitation
Attacker	15.19 ± 15.58	No limitation	23.61 ± 10.20	Mild limitation
Total	10.36 ± 13.64	-	19.38 ± 23.06*	-

*p<0.05 significant difference compared to DASH.

Table 4. Classification of shoulder functional limitation by category

Classification DASH	Adult category (n=16)		Master category (n=14)	
	General DASH	Sport DASH	General DASH	Sport DASH
No limitation	14 (87.5%)	11 (69%)	12 (86%)	9 (64%)
Mild limitation	2 (12.5%)	5 (31%)	0 (0%)	1 (7%)
Moderate limitation	0 (0%)	0 (0%)	2 (14%)	3 (21%)
Severe limitation	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Very severe limitation	0 (0%)	0 (0%)	0 (0%)	1 (7%)

practice of volleyball. The functional disability score in the sport DASH (19.38 ± 23.06) was significantly higher (p=0.009) than the functional disability in the general DASH (10.36 ± 13.64), indicating greater limitation to perform the sport activity than the daily activities.

In relation to the general classification of functional limitation of the upper limb by category, the master athletes presented mild (7%), moderate (21%) and very severe (7%) limitation to practice volleyball, while in the adult team 31% of the athletes presented mild limitation (Table 4).

A strong positive correlation (rs=0.79; p<0.001; r2=0.62) was found between daily pain intensity and shoulder functional disability (general DASH). In the sport DASH, a positive and moderate correlation was observed with dominant shoulder pain in serving (rs=0.60; p<0.001; r2=0.36) and attacking (rs=0.67; p<0.001; r2=0.45), and with non-dominant limb pain and attacking (rs=0.43; p=0.02; r2=0.18).

DISCUSSION

The present study sought to evaluate and correlate the functional disability of the upper limb and the presence of pain in the execution of sportive gestures in women court volleyball athletes, showing, in general, that the athletes reported mild to moderate pain in the dominant shoulder, both to perform daily activities and to execute the sportive gestures, especially in serving, attacking, and blocking. In addition, the athletes who occupied the opposite, midfielder and center positions presented mild functional disability in the sport DASH. There was a positive correlation between functional disability and pain in both daily activities and sports activities. These findings corroborate the hypothesis of the study.

In sports that present sporting gestures above the head, such as volleyball, repetitive movements, such as serve and attack, impose significant loads and forces on the player's shoulder, increasing the risk of injuries, especially in the dominant limb[6,30-32]. The attack has three phases: preparation, in which the athlete performs abduction with external rotation of the shoulder; acceleration, in which there is adduction and internal rotation to strike the ball with strength and speed that can reach over 100 km/h; and, finally, deceleration[21,33]. The serve may be floating or suspended, and the floating serve exerts less force on the shoulder due to the smaller range of motion, speed, and angulation during execution[6,33].

These movements performed above the head may compress joint structures such as bursae and tendons due to the reduction of subacromial space[34]. Therefore, functional, structural, and biomechanical changes in the shoulder, as well as excessive mechani-

cal overload during games, can influence neuromuscular control, generate compensatory movements, trigger pain, and create dispositions to injuries[4,6,30,32].

It is important to highlight that these specific demands are also related to the player's positions on the court. With the exception of the libero, who is a defensive player and performs few movements above her head, all other positions participate in actions such as serving, attacking, and blocking. The plays are thought out and distributed by the setter, who mainly plays sets and forearm passes, sometimes blocking, and rarely attacking. The offensive actions are in charge of three positions: a) the opposite player, who specializes in attacking and is usually the team's high ball player; b) the middle-blocker, who attacks mainly fast balls through the middle; and c) the attacker, who specializes in attacking actions both in the defense zone (attacks from the back of the court) and in the attacking zone (near the net), besides participating in the defense actions[35]. Therefore, the athletes responsible for the offensive actions presented a greater functional limitation of the shoulder to perform sports activities in this study.

All the athletes reported feeling pain in the present study, especially in the dominant shoulder, to perform the sportive gestures of volleyball. These results corroborate a study[36] conducted with nine athletes who play as forwards (pointers and opposites), in which all of them reported feeling pain in the dominant shoulder. Furthermore, no correlations were observed between pain intensity, flexibility of the shoulder rotator muscles, and the number of offensive blows. Another study[19] with 24 amateur volleyball athletes did not identify any significant difference in pain intensity between athletes with and without rotator cuff lesions. Regarding the specific functional disability (sport), the athletes with rotator cuff lesions presented from a mild to a very severe limitation. This fact is in agreement with the results presented in the present study, although the volleyball athletes assessed did not present a rotator cuff lesion. In the sport DASH, 31% of the athletes from the adult team presented mild limitation, while in the master team 35% presented mild to very severe limitation.

The results showed a positive correlation between pain intensity and functional disability of the upper limb in daily and sports activities. In opposition to the results found, the study[21] carried out with 15 volleyball athletes from the youth category did not show correlations between pain during and after training and specific functional performance.

Intrinsic factors (e.g. range of movement, muscle weakness, previous injuries) and extrinsic factors (e.g. position, training load) have been described as risk factors that can be associated to the presence of pain and shoulder injuries in athletes who perform sports gestures above the head, as it happens in volleyball[37]. Thus, injury prevention programs must cover all categories, aiming to improve range of motion, muscle strength, core stability, joint stability and neuromuscular control, in addition to training adequacy[37,38,39]. It is worth highlighting the importance of a thorough evaluation of the shoulder joint and an analysis of the execution of sportive gestures to direct interventions with the objective of minimizing the occurrence of injuries in volleyball athletes.

The limitations of this study are the absence of image evaluations and functional tests to corroborate the information obtained through the questionnaires, as well as the size of the sample, which made it impossible to compare the pain and functional disability of the upper limb among the five playing positions. Future studies should include other instruments and tests for diagnosis, the evaluation of athletes from other categories, as well as the evaluation of the kinematics of sportive gestures.

CONCLUSION

The volleyball athletes evaluated who played in the positions of opposite side, bridge and center showed mild functional disability in the sport DASH module. There was no functional limitation of the upper limb in the general DASH. The intensity of pain in the dominant shoulder was greater in the sports gestures of attacking, serving and blocking. Furthermore, the greater the functional disability of the upper limbs, the greater the intensity of pain to perform daily activities, as well as the sportive gestures, especially attacking and attacking.

Comprehending the association between pain intensity, functional disability, and the fundamentals of the sport will help physical therapists and physical education professionals who work in sports to have a different look at the impairment of the execution of the sport gesture due to pain and functional disability, guiding the rehabilitation process, as well as preventive actions to minimize the risk of injury and improve the athlete's sports performance.

AUTHOR'S CONTRIBUTIONS

Érika Camila Oliveira Miranda
Data Collection, Conceptualization, Research, Methodology, Writing - Preparation of the original, Writing - Review and Editing, Validation, Visualization

Isabela Almeida Ramos
Conceptualization, Project Management, Methodology, Writing - Preparation of the original, Writing - Review and Editing, Validation, Visualization

Geórgia Danila Fernandes D'Oliveira
Conceptualization, Methodology, Writing - Preparation of the original, Writing - Review and Editing, Validation, Visualization

Erika Baptista Gomes
Conceptualization, Project Management, Research, Methodology, Writing - Preparation of the original, Writing - Review and Editing, Supervision, Validation, Visualization

Claudia Dias Leite
Statistical analysis, Data Collection, Conceptualization, Project Management, Research, Methodology, Writing - Preparation of the riginal, Writing - Review and Editing, Supervision, Validation, Visualization

REFERENCES

1. Kilic O, Maas M, Verhagen E, Zwerver J, Gouttebarge V. Incidence, aetiology and prevention of musculoskeletal injuries in volleyball: A systematic review of the literature. Eur J Sport Sci. 2017;17(6):765-93.
2. Tavares F, Simões M, Matos B, Smith TB, Driller M. Wellness, muscle soreness and neuromuscular performance during a training week in volleyball athletes. J Sports Med Phys Fitness. 2018;58(12):1852-8.
3. Kamonseki DH, Cedin L, Costa VS, Peixoto BO. Avaliação da rotação de ombro e a

relação com o tempo de prática do voleibol. J Health Sci Inst. 2017;35(4):272-5.
4. Shih YF, Wang YC. Spiking kinematics in volleyball players with shoulder pain. J Athl Train. 2019;54(1):90-8.
5. Mendonça LM, Bittencourt NFN, Anjos MTS, Silva AA, Fonseca ST. Avaliação muscular isocinética da articulação do ombro em atletas da Seleção Brasileira de voleibol sub-19 e sub-21 masculino. Rev Bras Med Esporte. 2010;16(2):107-11.
6. Challoumas D, Stavrou A, Dimitrakakis G. The volleyball athlete's shoulder: biomechanical adaptations and injury associations. Sports Biomech. 2017;16(2):220-37.
7. Nascimento WM, Costa RM, Santos JOLS, Rossato M, Gheller RG. Isokinetic peak torque at the shoulder joint in young volleyball athletes with and without injury history. J Phys Educ. 2018;29(e2925):1-6.
8. Mazza D, Iorio R, Drogo P, Gaj E, Viglietta E, Rossi G, Monaco E, Ferretti A. Did the prevalence of suprascapular neuropathy in professional volleyball players decrease with the changes occurred in serving technique? Phys Sportsmed. 2021;49(1):57-63.
9. Seminati E, Marzari A, Vacondio O, Minetti AE. Shoulder 3D range of motion and humerus rotation in two volleyball spike techniques: injury prevention and performance. Sports Biomech. 2015;14(2):216-31.
10. Saccol MF, Almeida GP, de Souza VL. Anatomical glenohumeral internal rotation deficit and symmetric rotational strength in male and female young beach volleyball players. J Electromyogr Kinesiol. 2016;29:121-5.
11. Gouttebarge V, Zwerver J, Verhagen E. Preventing musculoskeletal injuries among recreational adult volleyball players: design of a randomised prospective controlled trial. BMC Musculoskelet Disord. 2017;18(1):333.
12. Cohen M, Abdalla, RJ. Lesões nos esportes: diagnóstico, prevenção e tratamento. ed. Revinter: Rio de Janeiro; 2003. 714-8p.
13. Cools AMJ, Reeser JC. Shoulder injuries in volleyball. Handbook Sports Med Science. 2017. 93-108.
14. Frisch KE, Clark J, Hanson C, Fagerness C, Conway A, Hoogendoorn L. High Prevalence of nontraumatic shoulder pain in a regional sample of female high school volleyball athletes. Orthop J Sports Med. 2017;5(6):2325967117712236.
15. Challoumas D, Artemiou A, Dimitrakakis G. Dominant vs. non-dominant shoulder morphology in volleyball players and associations with shoulder pain and spike speed. J Sports Sci. 2017;35(1):65-73.
16. McMahon PJ, Prasad A, Francis KA. What is the prevalence of senior-athlete rotator cuff injuries and are they associated with pain and dysfunction? Clin Orthop Relat Res. 2014;472(8):2427-32.
17. Silva ER, Maffulli N, Migliorini F, Santos GM, de Menezes FS, Okubo R. Function, strength, and muscle activation of the shoulder complex in Crossfit practitioners with and without pain: a cross-sectional observational study. J Orthop Surg Res. 2022;17(1):24
18. Harrington S, Meisel C, Tate A. A cross-sectional study examining shoulder pain and disability in Division I female swimmers. J Sport Rehabil. 2014;23(1):65-75.
19. Silva CG, Meneguci J, Garcia-Meneguci CA. Lesões de manguito rotador em atletas amadoras de voleibol. Arq Cien Esp. 2019;7(4):157-60.
20. Arabi E, Nazemzadegan GH. Comparison of upper limb disability in overhead women athletes of handball, volleyball, softball, and swimming. Phys Treat. 2021;11(2):103-10.
21. Cangussu DFR, Rodrigues DCM, Reis D, Venturini C. Estudo da associação entre a dor e desempenho funcional do membro superior de jogadores de vôlei. Rev Bras Ci Mov. 2008;15(1):15-20.
22. Malta M, Cardoso, LO, Bastos FI, Magnanini MM, Silva CM. STROBE: initiative: guidelines on reporting observational studies. Rev Saude Publica. 2010;44(3):559-65.
23. Orfale AG, Araújo PM, Ferraz MB, Natour J. Translation into Brazilian Portuguese, cultural adaptation and evaluation of the reliability of the Disabilities of the Arm, Shoulder and Hand Questionnaire. Braz J Med Biol Res. 2005;38(2):293-302.
24. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. The Upper Extremity Collaborative Group (UECG). Am J Ind Med. 1996;29(6):602-8.
24. Desai AS, Dramis A, Hearnden AJ. Critical appraisal of subjective outcome measures used in the assessment of shoulder disability. Ann R Coll Surg Engl. 2010;92(1):9-13.
25. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res (Hoboken). 2011;63(Suppl 11):S240-S252.
26. Karcioglu O, Topacoglu H, Dikme O, Dikme O. A systematic review of the pain scales in adults: Which to use? Am J Emerg Med. 2018;36(4):707-14.
27. Ritter PL, González VM, Laurent DD, Lorig KR. Measurement of pain using the visual numeric scale. J Rheumatol. 2006;33(3):574-80.
28. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. Hillsdale, NJ: Erlbaum, 1988.
29. Cools AM, Johansson FR, Borms D, Maenhout A. Prevention of shoulder injuries in overhead athletes: a science-based approach. Braz J Phys Ther. 2015;19(5):331-9.
30. Seminati E, Minetti AE. Overuse in volleyball training/ practice: a review on shoulder and spine-related injuries. Eur J Sport Sci. 2013;13(6):732-43.
31. Zuzgina O, Wdowski M. Asymmetry of dominant and non-dominant shoulders in university level men and women volleyball players. Human Mov. 2019;20(4):19-27.
32. Marques Junior NK. Biomecânica dos fundamentos do voleibol: saque e ataque. Rev Univers Educ Fís Desp. 2019;12(1):28-40.
33. Lippert L. Cinesiologia clínica e anatomia. 5ª ed. Guanabara Koogan: Rio de janeiro; 2013. 115-128p.
34. Priess FG, Gonçalves OS, Dos Santos APM. Metodologia do voleibol. 1nd ed. SAGAH: Porto Alegre; 2018. 79-90p.
35. Helfenstein RP, Rother RL. Flexibilidade de rotadores do ombro, presença de dor e quantidade de golpes na bola: um estudo em atacantes do voleibol feminino de base. RIPS. 2020;3(3):105-10.
36. Tooth C, Gofflot A, Schwartz C, Croisier JL, Beaudart C, Bruyère O, Forthomme B. Risk factors of overuse shoulder injuries in overhead athletes: a systematic review. Sports Health. 2020;12(5):478-87.
37. Gouttebarge V, Barboza SD, Zwerver J, Verhagen E. Preventing injuries among recreational adult volleyball players: Results of a prospective randomised controlled trial. J Sports Sci. 2020;38(6):612-8.
38. Ejnisman B, Lara PHS, Ribeiro LM, Belangero OS. Ombro do arremessador: artigo de atualização. Rev Bras Ortop. 2021;56(3):275-9