

Scapular dyskinesia was not associated with pain and function in male adolescent athletes

Discinesia escapular não está associada à dor e função no ombro dos adolescentes atletas

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ABSTRACT

BACKGROUND AND OBJECTIVES: Scapular dyskinesia has been associated to shoulder injuries and pain. However, this relationship with adolescent athletes is not well established. The objective of this study was to evaluate scapular dyskinesia in young athletes and its association with pain or shoulder function.

METHODS: 178 male adolescent athletes (14.58±2.16 years) were evaluated. The subjects completed the Quick Disability Arm Shoulder Hand questionnaire. Body mass, height, shoulder internal rotation and Closed Kinetic Chain Upper Extremity Stability test were measured. A dynamic visual method was applied to assess dyskinesia. Binary logistic regression was applied to analyze the association between dyskinesia and other variables. The comparison between groups with and without dyskinesia was made by the Mann-Whitney and *t*-test, accepting a statistical significance of $p < 0.05$.

RESULTS: The dyskinesia prevalence was 56.7% and this condition was not associated with shoulder pain. Younger athletes are 159% more likely to have dyskinesia, while those who practice more than one hour a day for three times a week are 77% more likely to have the same outcome. No difference in shoulder function was found.

CONCLUSION: Scapular dyskinesia is not associated with pain and does not affect shoulder function in adolescent athletes. Sports modality, age and training volume seem to induce changes in scapula movement.

Keywords: Adolescents, Athletes, Athletic performance, Pain, Shoulder.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A discinesia escapular tem sido associada a lesões e dor no ombro, no entanto essa relação em adolescentes atletas ainda não é bem definida. O objetivo deste estudo foi avaliar a prevalência de discinesia escapular em adolescentes atletas amadores e sua associação com a dor e medidas de função no ombro.

MÉTODOS: 178 adolescentes do sexo masculino (14,58±2,16 anos) participaram do estudo. Os sujeitos responderam ao questionário *Quick Disability Arm Shoulder Hand*. Também foram avaliados massa corporal, estatura, rotação interna do ombro e *Closed Kinetic Chain Upper Extremity Stability*. Para avaliação da discinesia escapular, utilizou-se o método visual dinâmico. A regressão logística binária foi utilizada para analisar a associação entre discinesia e as demais variáveis. A comparação entre os grupos com e sem discinesia foi feita pelo teste *t* e Mann-Whitney, sendo aceita significância estatística quando $p < 0,05$.

RESULTADOS: A prevalência de discinesia foi de 56,7% e essa condição não teve associação com dor no ombro. Atletas mais jovens têm 159% mais chances de apresentar discinesia, enquanto aqueles que treinam mais de uma hora por dia, durante três vezes por semana, têm 77% mais chances de ter o mesmo desfecho. Nenhuma diferença na função do ombro foi encontrada.

CONCLUSÃO: A discinesia escapular não está associada à dor e não altera medidas de função no ombro em adolescentes atletas. Modalidade, idade e volume de treinamento parecem induzir mudanças na movimentação escapular.

Descritores: Adolescente, Atletas, Desempenho atlético, Dor, Ombro.

INTRODUCTION

Sports modalities requiring constant use of the upper limb increase the joint overloads on this segment, especially in the shoulder complex.¹ It has been well documented in the literature that movements at high speed, repetition, and load trigger joint adaptations such as disproportion between internal and external shoulder rotation amplitudes and changes in humeral and scapular positioning¹⁻⁵. Specifically, the modification in the scapula positioning, called scapular dyskinesia, has been studied because it presents possible relations with the presence of pain and shoulder injuries in athletes^{2,6-8}.

Most of the studies state the relation between shoulder pain/injury and scapular dyskinesia^{2,7,9-11}. Such research ensures that

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changes in scapular kinematics may result in structural and functional changes in the glenohumeral and acromioclavicular joints, decreased subacromial space, changes in the scapular muscles activation and, consequently, leading to dysfunctions such as shoulder-rotator cuff syndrome, rotator cuff tendinopathies, glenohumeral instability, and other conditions. On the other hand, there is evidence that scapular asymmetries are also observed in asymptomatic subjects, and for this reason, it is not possible to clearly and accurately infer a cause-effect relationship between pain and dyskinesia, making it impossible to state which of these factors precedes the other¹²⁻¹⁶. It is noteworthy that a good part of these studies¹²⁻¹⁶, stating that there is a relationship between pain and dyskinesia, refers to the adult population or high-level competition athletes, which, possibly, by the repetitive motor movements and training overload may make this association more evident. Thus, it is possible to speculate if younger athletes, and with fewer sports requirements, would behave similarly to previous studies, but evidence that supports this inquiry is still insufficient^{17,18}.

Therefore, this study aimed at estimating the scapular dyskinesia prevalence in young amateur athletes, as well as evaluating the possible association between scapular dyskinesia and shoulder pain and identifying whether this condition influences the shoulder function of adolescent athletes.

METHODS

This is a cross-section, observational, descriptive and correlational study. The sample consisted of male adolescents, practicing the following sports: volleyball, swimming, handball, basketball, and judo from the city of Petrolina, PE. The inclusion criteria were: be between 10 and 19 years old and have been practicing sports for at least one year. Exclusion criteria were not submitting the Informed Free and Informed Consent Form (FICT) signed by the legal representatives together with the Free and Informed Acknowledgment Form, who refused to perform the tests and/or inadequately completed the questionnaire.

Three hundred and seventeen adolescents were evaluated, aged between 10 and 19 years, of both genders, randomly selected after a probabilistic sampling procedure, determining a minimum sample of 290 athletes based on the representativeness of the five modalities. However, this study's sample was composed only of male adolescents (n=180), since the female athletes did not feel comfortable to perform the dyskinesia evaluation. Therefore, for the purpose of this analysis, the sampling power calculation was performed *posteriori* using the GPower software.

Initially, a questionnaire containing personal and sports data (age, sports modality, total sports practice time, training frequency on days per week, duration of the training session in hours per day, the presence of shoulder pain) was applied. The subjects answered questions from the Corlett's Body Diagram¹⁹ to check for the presence or absence of shoulder pain. In addition, the Quick-DASH (Quick Disability Arm Shoulder Hand) questionnaire was applied with its optional practicing module (Quick-DASH optional). This instrument was translated and validated for adolescents²⁰ which evaluates the upper limb as a functional unit and

presents internal consistency of $\alpha=0.91$ ²⁰. The anthropometric variables (body mass and height) according to the International Society for the Advancement of Kinanthropometry (ISAK) standardization and body mass index (BMI) were calculated using the equation $BMI = \text{Body Mass}/(\text{Height})^2$. The criteria suggested by the International Obesity Task Force (IOTF) were used to classify adolescents' nutritional status²¹.

The range of motion of the internal shoulder rotation was measured using the passive motion technique with a goniometer. For this, the subjects remained in the supine position bent knees and hips, abducted arm and elbow bent at 90°^{21,22}. The goniometer axis was aligned in the olecranon process, the arm fixed perpendicularly to the floor and the mobile in parallel to the styloid process of the subject's ulna. The final range of motion criteria for internal rotation was the combination of end feel and visualization of scapular compensation (anterior tilt). In the cases of subjects with shoulder pain, the range limit was established by the initial (reported or expressed) sensation of pain. The measurement was performed by a single evaluator. Three measurements were performed on both limbs, and a final value was taken from the angles average. The calculation of the glenohumeral internal rotation deficit was taken by subtracting the internal rotation values of the dominant and non-dominant limbs. According to Wilk et al.²⁴, it was established a difference greater than 18° to categorize the volunteers with internal rotation deficits.

Scapular movement was evaluated by the dynamic observational method. In this method, the volunteer was asked to remain in the orthostatic position and perform three repetitions of the bilateral arm elevation movement in the scapular plane up to 90°. The movement speed was standardized in three seconds for concentric phase and three seconds for eccentric phase through examiners verbal command. The movement execution was recorded in a posterior view by a digital camcorder with a sampling frequency of 60 Hz (SONY model DCR-SX21), positioned on a tripod 1.00m high in relation to the floor and at 2.85 meters from the subject. Ground markings were used to standardize the position of the camcorder and the volunteers²⁵.

The categorization of the scapular dyskinesia type was performed according to Kibler et al.²⁶ guidelines. The visualization of the prominence of the scapula's lower angle was interpreted as type I; type II, those representing the medial edge prominence increase; type III those characterized by upper angle excessive elevation; and type IV those indicating the absence of scapular dyskinesia. Once the asymmetry was identified in several planes, a duly qualified evaluator classified dyskinesia in one of these four types, based on the predominant pattern¹³. In a second moment, all the volunteers classified with scapular dyskinesia (types I to III) were grouped into a single category: "with scapular dyskinesia" and those classified as type IV were included in the "without scapular dyskinesia" category¹³.

Finally, to assess the upper limb stability, the volunteer was asked to perform the Closed Kinetic Chain Upper Extremity Stability Test (CKCUES-Test). In that test, the volunteers remained in the push-up position with their hands resting on two tapes fixed to the ground at a distance of 36 inches (91.4cm). The volunteer should hold this position while alternately performing the move-

ment of touching the opposite hand for 15 seconds. Three maximal repetitions with a 45-second interval between trials were performed. Before performing the test, the volunteers performed three submaximal tests in order to familiarize them with the task. One evaluator was responsible for counting the touch number and the other for measuring time and verbally informing the first evaluator of the test start and end. The touch mean obtained was multiplied by 68% of the body weight in kilograms and divided by 15 to obtain the test power score²⁷.

Prior to data collection, a pilot test was conducted with 25 adolescents to verify the level of agreement between the measures (with a one-week interval between evaluations). For the numerical variables we used the Intraclass Correlation Coefficient (ICC) test, and for the dyskinesia categorization, the Kappa's index. Numerical variables showed coefficient body mass and height of 0.99, Quick-DASH of 0.81, optional Quick-DASH 0.73, CKCUES-test of 0.87 and internal rotation of 0.82 for the right shoulder and 0.91 for the left shoulder. Kappa's index for scapular dyskinesia presence or absence was 0.99. All measurements indicate excellent reliability. These 25 volunteers were not part of the final sample of the study, and the same evaluator who performed those measurements was responsible for them out in the larger study.

This study was approved by Ethics Committee of the University of Pernambuco CAAE 38321114.0.0.0000.5207.

Statistical analysis

Data's statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software version 20. Categorical data description was represented by absolute and relative frequency and mean/median values and interquartile standard deviation/range were used to describe the numerical data depending on the normality of data distribution. For this, the data distribution inferential analysis was carried out by the Kolmogorov-Smirnov test. In addition, the Chi-square test, t-test for independent samples and Mann-Whitney were used to

observe the differences between the analyzed variables and subjects with and without scapular dyskinesia. In order to verify the association between the dyskinesia presence and the personal, sports and pain characteristics, a bivariate model of association between dyskinesia presence and each independent variable was constructed in order to observe which variables would enter the model ($p < 0.20$). In this analysis, odds ratios (ORs) and 95% confidence intervals were used to express the association degree between variables. Then, binary logistic regression was performed to explore possible confounding and interaction factors, and to identify the need for analyzes statistical adjustment.

Binary logistic regression with a step-by-step strategy for the analysis was chosen. Only the variables presenting $p < 0.20$ were inserted into the final model. Omnibus test and Hosmer-Lemeshow value were analyzed to confirm the model's validity. Finally, for shoulder function measurements comparison in adolescents with and without scapular dyskinesia, the Mann-Whitney test was used. All tests considering a level of significance of less than 5%.

RESULTS

One hundred and eighty male adolescent athletes were included in the study. However, two volunteers were excluded by the exclusion criteria because they refused to perform scapular dyskinesia assessment, totaling 178 subjects. The *posteriori* sampling power, based on the final logistic regression model, indicates that for a $\alpha = 0.05$ with four predictors in the final model and $R^2 = 0.227$, the statistical power of this study represents 99%. The average age was 14.58 ± 2.16 years, and the most practiced sports by adolescents were handball and basketball. The description of the anthropometric data, sports characteristics and their respective frequencies according to the presence or absence of scapular dyskinesia is presented in table 1.

The prevalence of scapular dyskinesia in this sample was 56.7%. From these, 46.5% were classified with type I dyskinesia, 43.6% with type II and 9.9% with type III. Table 2 shows the associa-

Table 1. Personal and sports characteristics of the total sample and stratified by absence and presence of scapular dyskinesia. Numerical values represented in average and standard deviation and categorical in absolute and relative frequency (n=178)

Personal characteristics	Total	Without dyskinesia	With dyskinesia	p value
Age (years)	14.58 (2.16)	14.78 (2.26)	14.44 (2.07)	0.206
Body mass, (kg)	63.27 (15.52)	65.10 (15.03)	61.88 (15.82)	0.167
Height (m)	1.70 (0.12)	1.70 (0.12)	1.70 (0.12)	0.639
Body mass index (kg/m ²)	21.62 (3.92)	22.39 (3.94)	21.03 (3.81)	0.011*
Sports characteristics				
Modalities				
Basketball	44 (24.7%)	13 (16.9%)	31 (30.7%)	0.012*
Handball	48 (27.0%)	21 (27.3%)	27 (26.7%)	
Judo	18 (10.1%)	7 (9.1%)	11 (10.9%)	
Swimming	32 (18.0%)	14 (18.2%)	18 (17.8%)	
Volleyball	36 (20.2%)	22 (28.6%)	14 (13.9%)	
Practice time				
1 year	43 (24.2%)	25 (32.5%)	18 (17.8%)	0.037*
More than 1 year	135 (75.8%)	52 (67.5%)	83 (82.2%)	
Years of practice	4.76 (2.99)	4.77 (3.04)	4.75 (2.98)	0.980

Continue...

Table 1. Personal and sports characteristics of the total sample and stratified by absence and presence of scapular dyskinesis. Numerical values represented in average and standard deviation and categorical in absolute and relative frequency (n=178) – continuation

Personal characteristics	Total	Without dyskinesis	With dyskinesis	p value
Frequency of training (times/week)				
Up to 3	135 (75.8%)	58 (75.3%)	77 (76.2%)	1.000
More than 3	43 (24.2%)	19 (24.7%)	24 (23.8%)	
Duration of training session (hours/day)				
Up to 1 hour	30 (16.9%)	16 (20.8%)	14 (13.9%)	0.308
More than 1 hour	148 (83.1%)	61 (79.2%)	87 (86.1%)	

*Statistical difference.

tion between dyskinesis presence and the independent variables. Only the variables age (10 to 14: OR = 2.59; CI 95% = 1.27 - 5.26); BMI (eutrophic: OR = 2.43; CI 95% = 1.16 - 5.09); modality (basketball: OR = 3.82; CI 95% = 1.41 - 10.35; handball: OR = 2.92; CI 95% = 1.09 - 7.80; judo: OR = 4.45; CI 95% = 1.20 - 16.52 and swimming: OR = 2.95; CI 95% = 0.96 - 9.05); and practice time and session duration (OR = 0.23; CI

95% = 0.08 - 0.66) remained in the final model. No confounding variable was found. The model validity was confirmed by the Omnibus test (p=0.001) with explanatory power of 89% by Hosmer-Lemeshow.

The comparison between upper limb function variables and scapular dyskinesis can be observed in table 3. No statistical differences were found between groups.

Table 2. Association of independent variables with the presence of scapular dyskinesis in adolescent athletes (n=178)

Independent variables	Dyskinesis presence n (%)	Dyskinesis absence n (%)	Bivariate OR [CI 95%]		Multivariate OR [CI 95%]
Age (years)					
10 to 14	51 (50.5)	29 (37.7)	1.69	[0.92 – 3.09]	2.59 [1.27 – 5.26]
15 to 19	50 (49.5)	48 (62.3)	1		
Body mass index					
Under weight	7 (6.9)	1 (1.3)	8.46	[0.97 – 73.64]	2.43 [1.16 – 5.09]
Eutrophic	70 (69.3)	47 (61.0)	1.8	[0.94 – 3.47]	
Overweight	24 (23.8)	29 (37.7)	1		
Modality					
Basketball	31 (30.7)	13 (16.9)	3.75	[1.48 – 9.52]	3.82 [1.41 – 10.35]
Handball	27 (26.7)	21 (27.3)	2.02	[0.84 – 4.87]	
Judo	11 (10.9)	7 (9.1)	2.47	[0.77 – 7.88]	
Swimming	18 (17.8)	14 (18.2)	2.02	[0.77 – 5.32]	
Volleyball	14 (13.9)	22 (28.6)	1		
Practice time					
1 year	18 (17.8)	25 (32.5)	0.45	[0.22 – 0.91]	0.23 [0.08 – 0.66]*
More than 1 year	83 (82.2)	52 (67.5)	1		
Frequency of training					
Up to 3 times	77 (76.2)	58 (75.3)	1.05	[0.53 – 2.10]	0.23 [0.08 – 0.66]*
More than 3	24 (23.8)	19 (24.7)	1		
Duration of session (hours/day)					
Up to 1 hour	14 (13.9)	16 (20.8)	0.61	[0.28 – 1.35]	0.23 [0.08 – 0.66]*
Over than 1 hour	87 (86.1)	61 (79.2)	1		
Shoulder pain					
No	46 (45.5)	33 (42.9)	1.12	[0.61 – 2.03]	0.23 [0.08 – 0.66]*
Yes	55 (54.5)	44 (57.1)	1		
GIRD					
Absence	92 (91.1)	67 (87.0)	1.70	[0.67 – 4.34]	0.23 [0.08 – 0.66]*
Presence	9 (8.9)	10 (13.0)	1		

*Value generated from the interaction "Duration per Frequency"; GIRD = glenohumeral internal rotation deficit.

Table 3. Median (interquartile range) of shoulder function measurements among adolescents with and without scapular dyskinesis (n=178)

Function measurement	With dyskinesis	Without dyskinesis	p value
Quick – DASH	6.80 (9.10)	9.10 (11.30)	0.288
Optional Quick – DASH	0.00 (12.50)	0.00 (12.50)	0.979
CKCUES-test	69.20 (35.60)	60.40 (25.40)	0.079
Internal rotation deficit	8 (8)	9.00 (10.00)	0.563

Quick-DASH = Quick Disability Arm Shoulder Hand; CKCUES-Test = Closed Kinetic Chain Upper Extremity Stability Test.

DISCUSSION

Differences regarding the relationship between dyskinesia and shoulder pain motivated this study. Results indicate that for a population of adolescent athletes with an amateur sports level, the dyskinesia prevalence is high; however, it is not associated with pain and does not seem to affect measures of upper limb function.

Although some studies support the relationship between pain/lesion and scapular dyskinesia^{2,7-11}, more than half of the current sample (56.7%) presented changes in scapular movement without, however, being associated with shoulder pain. The results of this study corroborate those of Oliveira et al.²⁸ who analyzed amateur male athletes with shoulder injury syndrome and observed no association between dyskinesia and shoulder pain. In addition, Uhl et al.¹³ analyzed the scapular dyskinesia presence through the observational and kinematic 3D method between groups with and without shoulder pain. The authors reveal that the dyskinesia prevalence between the two groups was similar and concluded that the presence of this condition should not be considered a pathological sign, but a compensatory mechanism for individuals who use the upper limb intensely. In addition, it is suggested that the asymmetry presence should not be the only factor that determines the clinical significance of scapular dyskinesia and that bilateral asymmetries are frequent. Thus, it is speculated that the scapular dyskinesia in amateur athletes may be attributed more to the adaptive attitudes of the sports movement than to the presence of pain itself.

Indeed, the lack of longitudinal studies makes it difficult to discern whether the observed changes in the scapular movement are compensatory attitudes of an already installed lesion or if the uncoordinated movement results in injurious mechanisms. Under this perspective, Myers, Oyama e Hibberd¹⁶ proposed to prospectively evaluate if scapular dyskinesia identified in the pre-season of adolescent baseball athletes could be a predisposing factor to the risk of shoulder injuries in athletes and could conclude that the dyskinesia presence does not increase the risk of upper limb lesions.

Sports factors are associated with scapular changes presence. In this study, it was possible to observe that adolescent athletes are more likely to be classified with dyskinesia according to the greater training volume, and in general, sports modalities also increase the probability of individuals having dyskinesia. Adolescents training in smaller magnitude (up to three times a week for less than one hour per day) are 64% less likely to have scapular dyskinesia. In the same vein, Madsen et al.¹⁵ proposed to evaluate the evolution of the scapular dyskinesia prevalence during a single training session in asymptomatic elite young athletes (14 to 22 years old). Authors used the observational method to evaluate the dyskinesia occurrence before, and at 25, 50, 75 and 100 minutes of training. Their results showed a cumulative dyskinesia prevalence of 82% in the last session interval (100 minutes of training), and suggest that scapular dyskinesia may be a result of muscle fatigue as a consequence of the high volume of training¹⁵. It was also found in this study that measures of shoulder function are similar among athletes with and without scapular dyskine-

sis. This condition's presence was not enough to reflect on upper limb functional impairment according to the questionnaires applied. In addition, the CKCUES-test power values and the internal rotation deficit, conditions that are related to the presence of shoulder pain in previous studies^{3,24,27} were not different between the groups with and without scapular dyskinesia. Thus, it is speculated that functional alterations may be related to pain complaint and not to changes in scapular positioning. However, the absence of studies regarding the influence of scapular dyskinesia on indicators of upper limb function in adolescent athletes limits the in-depth discussion of these results.

Since motor skills can be influenced by factors such as strength, flexibility and muscular endurance, and these are improved over time, kinematic differences in the scapula and muscle action are found in children and adolescents athletes compared to adults^{17,18,29}. In the present sample, younger athletes (10 to 14 years old) were 159% more likely to have dyskinesia. This reinforces the hypothesis that scapular dyskinesia in adolescents may be once again attributed to compensatory actions through motor action in sport combined with immaturity in motor skills. However, the appearance of a medium- or long-term pain as a result of this scapular dysrhythmia is still a limited and inconclusive questioning.

In the current sample, underweight and eutrophic adolescents were more likely to be classified with scapular dyskinesia. These results may not be related to the anthropometric characteristics themselves, but rather to the limitations of a proposed instrument for scapular dyskinesia analysis. Because it is a visual method, Uhl et al.¹³ confirm the difficulty in accurately observing the scapular movements under the underlying muscle and soft tissues. It implies, therefore, that subjects with less tissue adjacent to the scapula, either subcutaneous or muscular, allow a better visualization of the bony prominences, which has justified the high odds of identifying dyskinesia in these subjects in the current study. Although the observational method presents some limitations, it is considered the most applicable for clinical and sportive practice and presents good reliability and validity compared to the kinematic 3D analysis method^{13,16}.

This study was concerned with reducing possible biases due to the limitations found. The cross-sectional delineation is a factor that restricts further conclusions about cause-and-effect. However, information obtained through a representative sample may serve as a subsidy for future studies with longitudinal designs in adolescents. Another limitation refers to the extrapolation of the results found, which is directed to male amateur athletes of the evaluated modalities. This second limitation offers a field of study with both genders and/or with different sports levels. Other variables, which were not measured in this study, could also have influenced scapular dyskinesia, such as rotator cuff strength or cervicothoracic motion. Thus, not all potential variables were or could not be measured, but there may be evidence of its association with dyskinesia. Finally, another limitation is related to not having established a moment of pain symptoms occurrence in the shoulder. In this study, any occurrence of shoulder pain during the subject's life was analyzed, which may have overestimated the results.

CONCLUSION

Scapular dyskinesis is not associated with pain and does not alter measures of shoulder function in amateur adolescent athletes. Specific sports for upper limbs, age, and training volume may increase the chances of scapular movement, so the dyskinesis presence can be attributed to the compensatory mechanisms of motor movement, not necessarily to shoulder pain.

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