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ORIGINAL RESEARCH

To what extent do typical components of shoulder clinical evaluation explain upper-extremity disability? A cross-sectional study

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Abstract
Background: Physical therapists use several evaluation measures to identify the most important factors related to disability. However, the degree to which these evaluation components explain shoulder disability is not well known and that may detract clinicians from the best clinical reasoning.
Objective: To determine how much evaluation components explain shoulder function.
Methods: Eighty-one individuals with unilateral shoulder pain for at least four weeks and meeting clinical exam criteria to exclude cervical referred pain, adhesive capsulitis, and shoulder instability, participated in this study. Several typical clinical evaluation components were assessed as potential independent variables in a regression model using the Disabilities of the Arm, Shoulder, and Hand (DASH) score as a proxy to shoulder function. Two multivariate models were built to include (1) evaluation components from physical exam plus clinical history and (2) a model considering all previous variables and magnetic resonance imaging (MRI) data.
Results: Pain catastrophizing was the best variable in the model explaining at least 10% of the DASH variance. Sex and lower trapezius muscle strength explained considerably less of shoulder function. The MRI data did not improve the model performance.
Conclusion: The complexity of shoulder function is not independently explained by pathoanatomical abnormalities. Psychological aspects may explain more of shoulder function even when combined with physical components in some patients.

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Introduction

Patients with shoulder complaints are commonly assessed using magnetic resonance imaging (MRI) and patient self-reported measures such as pain intensity and duration of symptoms.[1,2] Range of motion and muscle strength are also frequent physical measures used in the typical clinical evaluation.[3–7] However, it is not clear how these clinical components combined explain shoulder function as no previous studies have comprehensively considered pain in combination with other evaluation components and imaging findings.

Previous studies have shown that pain intensity can negatively influence shoulder function, but the magnitude of this association has been variable across studies.[6] Psychological aspects such as pain catastrophizing defined as a set of negative and exaggerated cognitive and emotional schema in response to actual or potential pain is also related to shoulder function.[5,8] When combined with fear-avoidance, i.e., self-restriction of activities because of fear, pain catastrophizing explained up to 28% of shoulder function in a previous study.[9] However, other studies reported that pain catastrophizing explained only 9%[10] or even less[11] of shoulder function as measured with the Shoulder Pain and Disability Index (SPADI) score.

While some recent studies have reported data regarding psychological outcomes, traditionally there is a strong influence from the biomedical model focusing on pathoanatomical findings as the cause of pain during clinical evaluation. It has been reported that large rotator cuff tears are associated with worse shoulder function, however, most of these studies used questionnaires like the Constant-Murley score with items that contribute greatly to the final score, thus even patients with mild physical deficits may exhibit low function scores.[12] A systematic review[6] identified studies describing a small association between muscle strength[13] or range of motion[14,15] with shoulder function while other studies have found significant associations but with varying magnitude of association.[15–19]

As previous studies did not explore shoulder function, taking into account several evaluation components together, more studies are needed to provide a better understanding of how a patient's history, clinical examination, and imaging findings explain shoulder function. The objective of this study was to determine how much some of the most typical evaluation components assessed during clinical consultation explain shoulder function as measured by the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire.

Methods

Participants and eligibility criteria

This was a cross-sectional study in which participants were recruited using posts on local websites and printed flyers at the university and surrounding community from 2015 to 2016. All eligible participants had self-reported unilateral shoulder pain for at least four weeks. Individuals with bilateral pain, history of upper limb fractures or surgery, metallic implants in the head, thorax, or arms, shoulder instability, or history of recurrent shoulder dislocations, pseudoparalysis, or deficit in shoulder active range of motion, clinical signs of adhesive capsulitis[20] or limitation in shoulder passive range of motion, self-reported neck pain, or fibromyalgia were excluded from the study.[21] All individuals were evaluated by one physical therapist with five years of clinical experience treating patients with upper limb dysfunctions. This study was approved by the institutional review board of the Universidade Federal de São Carlos, São Carlos, SP, Brazil (protocol number 1.394.925) and all individuals signed a written consent before study enrollment. The strengthening the reporting of observational studies in epidemiology (STROBE) and the transparent reporting of a multivariable prediction model for individual prognosis or diagnosis (TRIPOD) were followed to ensure the quality of the study.[22,23]

Self-reported upper extremity function

Self-reported upper extremity disability was evaluated using the Brazilian version of the DASH questionnaire. The DASH is a self-reported questionnaire with 30 questions that assess the individual's ability to perform daily activities. Scores on the DASH can range from 0 to 100 with 0 best and 100 the worst possible score.[24] The DASH is widely used to assess individuals with shoulder pain[25–27] and demonstrates excellent reliability and responsiveness.[28] Moreover, the DASH is a wide-ranging instrument and the most linked to International Classification of Functioning, Disability and Health categories in comparison to other common self-reported or composite patient-reported outcome measurements.[29]

Muscle strength

The serratus anterior, lower trapezius, and infraspinatus muscle strength was evaluated. A detailed description and procedures for muscle strength testing can be found elsewhere.[30,31] For familiarization, individuals performed 1 submaximal repetition of each test. Three 5-second repetitions of maximum isometric contractions for each test were averaged.[32] The principal investigator gave standardized verbal encouragement to all individuals during muscle testing to facilitate maximal force production. Individuals repeated the test if any compensation with the trunk or legs occurred during the test performance.

Pathoanatomical findings

Individuals underwent a standardized MRI examination scheduled after the physical examination with a gradient-echo in T2 and spin-echo sequences in T1, T2, and proton density to determine the presence of structural abnormalities. All scans included slices with 3.5 to 4.0 mm of thickness in sagittal, coronal, and axial planes without contrast material. A 1.5 Tesla-MRI device

(Magnetom Essenza, Siemens®) with a dedicated shoulder array coil was used. MRI scans were interpreted by a board-certified orthopedic surgeon with 12 years of shoulder specialized experience after fellowship training. Pathoanatomical findings were grouped into inflammatory signs such as subacromial increased fluid or acromioclavicular joint osteoarthritis and rotator cuff tears such as partial- or full-thickness tear, defined as the presence of discontinuity of the tendon along its superior (bursal) or inferior (articular or undersurface) surface with an extra-articular fluid-filled gap (T2-weighted) and the presence of discontinuity of the tendon with a fluid-filled gap that extends from the articular to bursal surface observed mainly in T2-weightned sequences, respectively.[33–35]

Pain catastrophizing and demographics

Pain catastrophizing was assessed with the Brazilian version of the Pain Catastrophizing Scale (PCS). The PCS contains 13 statements related to thoughts and feelings that represent pain catastrophizing and its underlying constructs such as pain magnification, helplessness, and rumination.[36] This scale ranges from 0 to 52 with 0 as the best and 52 as the worst possible score. The PCS exhibits adequate construct validity and reliability. Age, sex, duration of the symptoms, body mass index, and presence of scapular dyskinesis using the scapular dyskinesis test[37,38] were recorded for all participants.

Statistical analysis

A linear regression analysis was used to verify how much evaluation components explain shoulder function. First, we grouped typical evaluation components in eight categories: a) demographics, b) range of motion, c) pain, d) pain catastrophizing, e) exposure, f) muscle strength, g) special tests and scapular dyskinesis, and h) MRI. Second, we verified the correlation between each evaluation component within all categories and the DASH. Third, the most correlated clinical component from each category was selected to be tested in the regression model. (Supplementary material). All clinical components tested as potential independent variables showed some individual contribution to shoulder function in previous studies.[6,16,39–42] The dependent variable was the DASH questionnaire.

Multicollinearity was verified before running the regression analysis by identifying highly correlated explanatory variables ($r \geq 0.7$). Multicollinearity between categorical explanatory variables was assessed by Phi and Cramer's V statistics and Chi-square test for independence. Collinearity was identified as a problem in the model by verifying condition index values greater than 30 and variance inflation factor (VIF) greater than 10 in the collinearity diagnosis table.[43] Linearity and outliers were also evaluated by looking at bivariate scatterplots and partial plots for each potential independent variable and the dependent variable. After these steps, serratus anterior strength and variables from pain category were considered unfit to the model due to a non-linear relationship to the dependent variable and the presence of important outliers. Lastly, the body mass index presented a very high condition index value and we decided to remove this variable from the model.[44,45]

Two models were tested. In the first model, only variables related to clinical history and physical examination were included as independent variables. In the second model, all variables from the first model and MRI variables were used as independent variables. The performance between the two models was compared using the adjusted total explained variance (adjusted-R^2) and Akaike Information Criterion (AIC). The model with the highest adjusted-R^2 and the smallest AIC was deemed to best explain the DASH variance.[46–48] The estimated sample size for adequate power in multivariate models may vary between 8 and 10 individuals per predictor or explanatory variable.[49,50] IBM SPSS Statistics, version 23 (IBM Corp, Armonk, NY) was used to perform all statistical analyses.

Results

Eighty-one individuals completed the study. Four individuals did not complete the MRI examination due to claustrophobia. Most participants were not involved in sports practice or physically demanding jobs and did not exhibit a well-distributed duration of symptoms. Most participants reported low pain intensity during arm elevation in the assessment day, but the average pain during the week was high. Therefore, no common gesture or maneuver was reported among the subjects, which is representative of the variability in the clinical setting. Additional participants' characteristics are presented in **Table 1**.

The first model without MRI data explained 37% of the DASH variance. Only PCS, lower trapezius strength, and sex showed statistical significance to the model explaining 12%, 4%, and 4% of the DASH variance, respectively. Sex and lower trapezius strength were inversely related to the DASH (**Table 2**). The independent variables from the MRI in the final model did not substantively change the model R^2 (35%) and the AIC was smaller for the first model suggesting that the first model had the best performance (**Table 2**).

Discussion

Our results indicated that PCS explained at least 10% of the DASH variance. In other words, a PCS score variation of 30 points, which classifies an individual as a "catastrophizer",[51] may influence up to 14 points change on DASH. Sex was the second most important independent variable in the model. In general, women exhibited approximately 9 points less than men on DASH, but there is low confidence in this result because of the wide confidence interval **(Table 2)**. The lower trapezius strength and sex were less important to the model explaining less of the DASH variance. In summary, the higher the pain catastrophizing, the worse the upper-extremity disability with little to no influence from sex or muscle strength, and that was not different in shoulders with signs of inflammation or in the presence of rotator cuff tears of any severity. We believe that PCS was the most important variable in the model because the DASH questionnaire incorporates more activities and body functions in comparison to other instruments.

The observed relationship between psychological variables and shoulder function is inconsistent.[9,10,52,53] Kromer et al.[10]

Table 1 Participants characteristics (n = 81).

	Mean ± SD or frequency	Minimum - maximum
Age (years)	41.8 ± 16.5	21 – 77
Sex	46 men / 35 women	
Duration of the symptoms (months)	35.4 ± 61.4	1 – 360
Body mass index (kg/m^2)	25.3 ± 3.0	18 – 34
Overhead work	20 yes / 61 no	
Presence of scapular dyskinesis	68 positive / 13 negative	
Pain intensity during arm elevation (0–10)	2.0 ± 2.7	0 – 10
Average pain during last week (0–10)	6.3 ± 1.4	3 – 10
Pain catastrophizing (0–50)	20.9 ± 12.1	1 – 50
Serratus anterior muscle strength (kgf)	16.4 ± 6.2	3.8 – 36.5
Lower trapezius muscle strength (kgf)	10.0 ± 4.9	3.8 – 36.5
Infraspinatus muscle strength (kgf)	8.2 ± 3.2	1.5 – 15.3
Inflammatory signs	65 positive / 12 negative	
Rotator cuff tears	33 positive / 44 negative	
Disabilities of the Arm, Shoulder, and Hand (0–100)	24.8 ± 16.5	1.7 – 79.2

reported no relationship between pain catastrophizing and shoulder function but that may be due to the low PCS scores (median = 9) of the sample. Consistent with our results, Coronado et al.[9] used an hierarchical multivariate analysis running several models and observed that higher levels of pain catastrophizing indicated worse shoulder function. Differences between our studies regarding how much of shoulder function is explained by pain catastrophizing may be due to how multivariate models were built (entry versus hierarchical). Also, the performance and accuracy of regression models may differ depending on the sample characteristics. Other studies exhibited a poor model performance[52] or a small contribution from psychological variables to shoulder function.[53]

The two MRI variables used in our study were grouped into two of the most prevalent categories clinicians use in practice. Usually, when focusing on pathoanatomical abnormalities in a typical clinical setting, clinicians deal mostly with inflammatory conditions or rotator cuff tears.[54,55] Therefore, we chose to group MRI data because of the high variability when analyzing unique tendon prevalence and tear types. Although that approach may conceal these details, grouping tendon data would most likely increase the contribution of MRI variables to the model and that did not happen. We and others have provided information suggesting MRI may be overused in the early management of patients with non-specific shoulder pain.[12,56–59] Imaging abnormalities are still important to clinical decision-making and prognosis in patients with shoulder pain as long as this information is judiciously considered with other components of clinical evaluation.

This study is not without limitations. We performed a pre-selection of independent variables instead of running a full model with all variables at the same time. Pre-selecting variables is one of the most popular practices used in regression analysis studies, but that might let relevant variables out of the model and compromise the external validity of the results. Variables such as employment status, education level, smoking habit, and additional yellow flags such as kinesiophobia and anxiety were not assessed. Scapular dyskinesis has been considered related to shoulder function and pain but there is conflicting evidence.[60–62] We believe the high variability for scapular dyskinesis that is typically observed in clinical evaluation limited the contribution of this component in the multivariate model, which also explains the inconsistency in the literature. The level of disability of the participants was lower than expected, but we believe the data are still representative as all individuals reported important average pain intensity in their last week. The association between pain and shoulder function may not follow a linear trend depending on the patient's characteristic and other clinical components interaction. Despite the study's limitations, a substantial portion of the DASH variance was explained by the retained variables, especially by pain catastrophizing. That highlights how other important components of the shoulder clinical evaluation may be overlooked in patients presenting non-specific shoulder pain in the general setting.

Conclusion

Pain catastrophizing was the clinical component that mostly explained shoulder function in our multivariate model. Sex and lower trapezius muscle strength exhibited marginal and inconsistent influence in the model. Shoulder inflammatory status and the presence of rotator cuff tear did not explain shoulder function. Our results suggested that a more holistic evaluation approach may be beneficial to understand how the various aspects of clinical presentation explain upper-extremity disability.

Conflict of interest

The authors declared no conflict of interest

Table 2 Multiple regression.

Variables in model	Adjusted R^2	AIC	Standardized B	Unstandardized B (95% CI)	Semipartial correlation	$Part^2$ (%)	p-value
Model 1	36.6%	424					
Pain catastrophizing			0.35	0.48 (0.23, 0.73)	0.34	12.07	<0.01*
Age			0.07	0.07 (−0.14, 0.29)	0.06	0.36	0.49
Infraspinatus strength			0.02	0.10 (−1.46, 1.66)	0.01	0.01	0.89
Lower trapezius strength			−0.28	−0.96 (−1.81, −0.11)	−0.20	4.06	0.02*
Sex			−0.29	−9.71 (−17.97, −1.46)	−0.20	4.36	0.02*
Dyskinesis			−0.11	−5.09 (−13.37, 3.19)	−0.10	1.19	0.22
Model 2	35.4%	427					
Pain catastrophizing			0.34	0.46 (0.21, 0.72)	0.32	10.62	<0.01*
Age			0.08	0.08 (−0.17, 0.33)	0.05	0.34	0.51
Infraspinatus strength			0	−0.03 (−1.65, 1.58)	0	0	0.96
Lower trapezius strength			−0.28	−0.98 (−1.84, −0.12)	−0.20	4.18	0.02*
Sex			−0.27	−9.17 (−17.61, −0.74)	−0.19	3.79	0.03*
Dyskinesis			−0.11	−5.33 (−13.71, 3.04)	−0.11	1.29	0.20
Inflammatory status			0.06	2.83 (−6.14, 11.82)	0.05	0.32	0.53
Presence of rotator cuff tears			−0.06	−2.13 (−9.44, 5.17)	−0.05	0.27	0.56

AIC, Akaike Information Criterion; CI, confidence interval; Std, Standard; $Part^2$, squared semipartial correlation; *, statistical significance.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.bjpt.2022.100423.

REFERENCES

1. Klintberg IH, Cools AMJ, Holmgren TM, et al. Consensus for physiotherapy for shoulder pain. *Int Orthop*. 2015;39 (4):715−720. https://doi.org/10.1007/s00264-014-2639-9.
2. Mitchell C, Adebajo A, Hay E, Carr A. Shoulder pain: diagnosis and management in primary care. *BMJ*. 2005;331 (7525):1124−1128.
3. Triffitt PD. The relationship between motion of the shoulder and the stated ability to perform activities of daily living. *J Bone Joint Surg Am*. 1998;80(1):41−46.
4. Harrington S, Padua D, Battaglini C, Michener LA. Upper extremity strength and range of motion and their relationship to function in breast cancer survivors. *Physiother Theory Pract*. 2013;29 (7):513−520. https://doi.org/10.3109/09593985.2012.757683.
5. Kuijpers T, van der Windt DAWM, Boeke AJ, et al. Clinical prediction rules for the prognosis of shoulder pain in general practice. Pain. 2006;120(3):276−285. https://doi.org/10.1016/j.pain.2005.11.004.
6. Kuijpers T, van der Windt DAWM, van der Heijden GJMG, Bouter LM. Systematic review of prognostic cohort studies on shoulder disorders. Pain. 2004;109(3):420−431. https://doi.org/10.1016/j.pain.2004.02.017.
7. van der Windt DA, Koes BW, de Jong BA, Bouter LM. Shoulder disorders in general practice: incidence, patient characteristics, and management. *Ann Rheum Dis*. 1995;54(12):959−964.
8. Quartana PJ, Campbell CM, Edwards RR. Pain catastrophizing: a critical review. *Expert Rev Neurother*. 2009;9(5):745−758. https://doi.org/10.1586/ERN.09.34.
9. Coronado RA, Simon CB, Lentz TA, Gay CW, Mackie LN, George SZ. Optimism moderates the influence of pain catastrophizing on shoulder pain outcome: a longitudinal analysis. *J Orthop Sports Phys Ther*. 2017;47(1):21−30. https://doi.org/10.2519/jospt.2017.7068.
10. Kromer TO, Sieben JM, de Bie RA, Bastiaenen CHG. Influence of fear-avoidance beliefs on disability in patients with subacromial shoulder pain in primary care: a secondary analysis. *Phys Ther*. 2014;94(12):1775−1784. https://doi.org/10.2522/ptj.20130587.
11. Menendez ME, Baker DK, Oladeji LO, Fryberger CT, McGwin G, Ponce BA. Psychological distress is associated with greater perceived disability and pain in patients presenting to a shoulder clinic. *J Bone Joint Surg Am*. 2015;97(24):1999−2003. https://doi.org/10.2106/JBJS.O.00387.
12. Russell RD, Knight JR, Mulligan E, Khazzam MS. Structural integrity after rotator cuff repair does not correlate with patient function and pain: a meta-analysis. *J Bone Joint Surg Am*. 2014;96(4):265−271. https://doi.org/10.2106/JBJS.M.00265.
13. Brox JI, Brevik JI. Prognostic factors in patients with rotator tendinosis (stage II impingement syndrome) of the shoulder. *Scand J Prim Health Care*. 1996;14(2):100−105.

14. Macfarlane GJ, Hunt IM, Silman AJ. Predictors of chronic shoulder pain: a population based prospective study. *J Rheumatol*. 1998;25(8):1612–1615.
15. Bartolozzi A, Andreychik D, Ahmad S. Determinants of outcome in the treatment of rotator cuff disease. *Clin Orthop*. 1994:(308):90–97.
16. Ekeberg OM, Bautz-Holter E, Juel NG, Engebretsen K, Kvalheim S, Brox JI. Clinical, socio-demographic and radiological predictors of short-term outcome in rotator cuff disease. *BMC Musculoskelet Disord*. 2010;11:239. https://doi.org/10.1186/1471-2474-11-239.
17. Uhl TL, Smith-Forbes EV, Nitz AJ. Factors influencing final outcomes in patients with shoulder pain: a retrospective review. *J Hand Ther*. 2017;30(2):200–207. https://doi.org/10.1016/j.jht.2017.04.004.
18. Croft P, Pope D, Silman A. The clinical course of shoulder pain: prospective cohort study in primary care. Primary Care Rheumatology Society Shoulder Study Group. *BMJ*. 1996;313 (7057):601–602.
19. Clausen MB, Witten A, Holm K, et al. Glenohumeral and scapulothoracic strength impairments exists in patients with subacromial impingement, but these are not reflected in the shoulder pain and disability index. *BMC Musculoskelet Disord*. 2017;18 (1):302. https://doi.org/10.1186/s12891-017-1667-1.
20. Kelley MJ, Shaffer MA, Kuhn JE, et al. Shoulder pain and mobility deficits: adhesive capsulitis. *J Orthop Sports Phys Ther*. 2013;43(5):A1–31. https://doi.org/10.2519/jospt.2013.0302.
21. Rubinstein SM, Pool JJM, van Tulder MW, Riphagen II, de Vet HCW. A systematic review of the diagnostic accuracy of provocative tests of the neck for diagnosing cervical radiculopathy. Eur Spine J. 2007;16(3):307–319. https://doi.org/10.1007/s00586-006-0225-6.
22. Erik von E, Dg A, M E, Sj P, Pc G, Jp V. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol*. 2008;61(4). https://doi.org/10.1016/j.jclinepi.2007.11.008.
23. Collins GS, Reitsma JB, Altman DG, Moons KGM. Transparent reporting of a multivariable prediction model for Individual Prognosis or Diagnosis (TRIPOD): the TRIPOD statement. *J Clin Epidemiol*. 2015;68(2):134–143. https://doi.org/10.1016/j.jclinepi.2014.11.010.
24. 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. doi:/S0100-879X2005000200018.
25. Haik MN, Alburquerque-Sendín F, Moreira RFC, Pires ED, Camargo PR. Effectiveness of physical therapy treatment of clearly defined subacromial pain: a systematic review of randomised controlled trials. *Br J Sports Med*. 2016;50(18):1124–1134. https://doi.org/10.1136/bjsports-2015-095771.
26. Camargo PR, Haik MN, Filho RB, Mattiello-Rosa SM, Salvini TF. Pain in workers with shoulder impingement syndrome: an assessment using the DASH and McGill pain questionnaires. *Braz J Phys Ther*. 2007;11(2):161–167. https://doi.org/10.1590/S1413-35552007000200012.
27. Roy JS, Esculier JF. Psychometric evidence for clinical outcome measures assessing shoulder disorders. *Phys Ther Rev*. 2011;16 (5):331–346. https://doi.org/10.1179/1743288X11Y.0000000043.
28. Roy JS, MacDermid JC, Woodhouse LJ. Measuring shoulder function: a systematic review of four questionnaires. *Arthritis Rheum*. 2009;61(5):623–632. https://doi.org/10.1002/art.24396.
29. Roe Y, Soberg HL, Bautz-Holter E, Ostensjo S. A systematic review of measures of shoulder pain and functioning using the International classification of functioning, disability and health (ICF). *BMC Musculoskelet Disord*. 2013;14:73. https://doi.org/10.1186/1471-2474-14-73.
30. Michener LA, Boardman ND, Pidcoe PE, Frith AM. Scapular muscle tests in subjects with shoulder pain and functional loss: reliability and construct validity. *Phys Ther*. 2005;85 (11):1128–1138.
31. Cools AM, De Wilde L, Van Tongel A, Ceyssens C, Ryckewaert R, Cambier DC. Measuring shoulder external and internal rotation strength and range of motion: comprehensive intra-rater and inter-rater reliability study of several testing protocols. *J Shoulder Elbow Surg*. 2014;23(10):1454–1461. https://doi.org/10.1016/j.jse.2014.01.006.
32. Hurd WJ, Morrey BF, Kaufman KR. The effects of anthropometric scaling parameters on normalized muscle strength in uninjured baseball pitchers. *J Sport Rehabil*. 2011;20(3):311–320.
33. Vahlensieck M. MRI of the shoulder. *Eur Radiol*. 2000;10 (2):242–249. https://doi.org/10.1007/s003300050040.
34. Mulyadi E, Harish S, O'Neill J, Rebello R. MRI of impingement syndromes of the shoulder. *Clin Radiol*. 2009;64(3):307–318. https://doi.org/10.1016/j.crad.2008.08.013.
35. Farshad-Amacker NA, Jain Palrecha S, Farshad M. The primer for sports medicine professionals on imaging: the shoulder. Sports Health. 2013;5(1):50–77. https://doi.org/10.1177/1941738112468265.
36. Sehn F, Chachamovich E, Vidor LP, et al. Cross-cultural adaptation and validation of the Brazilian Portuguese version of the pain catastrophizing scale. *Pain Med Malden Mass*. 2012;13 (11):1425–1435. https://doi.org/10.1111/j.1526-4637.2012.01492.x.
37. McClure P, Tate AR, Kareha S, Irwin D, Zlupko E. A clinical method for identifying scapular dyskinesis, part 1: reliability. *J Athl Train*. 2009;44(2):160–164. https://doi.org/10.4085/1062-6050-44.2.160.
38. Tate AR, McClure P, Kareha S, Irwin D, Barbe MF. A clinical method for identifying scapular dyskinesis, part 2: validity. *J Athl Train*. 2009;44(2):165–173. https://doi.org/10.4085/1062-6050-44.2.165.
39. Kennedy CA, Manno M, Hogg-Johnson S, et al. Prognosis in soft tissue disorders of the shoulder: predicting both change in disability and level of disability after treatment. *Phys Ther*. 2006;86(7):1013–1032. discussion 1033-1037.
40. Ginn KA, Cohen ML. Conservative treatment for shoulder pain: prognostic indicators of outcome. *Arch Phys Med Rehabil*. 2004;85(8):1231–1235. https://doi.org/10.1016/j.apmr.2003.09.013.
41. Zheng X, Simpson JA, van der Windt DA, Elliott AM. Data from a study of effectiveness suggested potential prognostic factors related to the patterns of shoulder pain. *J Clin Epidemiol*. 2005;58(8):823–830. https://doi.org/10.1016/j.jclinepi.2005.01.011.
42. Solomon DH, Bates DW, Schaffer JL, Horsky J, Burdick E, Katz JN. Referrals for musculoskeletal disorders: patterns, predictors, and outcomes. *J Rheumatol*. 2001;28 (9):2090–2095.
43. Tabachnick BG, Fidell LS. Using Multivariate Statistics. *5ª Edição*. Pearson; 2006.
44. Field A. *Discovering Statistics Using IBM SPSS Statistics*. 4th ed. Sage Publications; 2013.
45. Kleinbaum DG, Kupper LL, Nizam A, Muller KE. Applied Regression Analysis and Other Multivariable Methods. *4 Edition*. Duxbury Press; 2007.
46. Snipes M, Taylor DC. Model selection and Akaike Information Criteria: an example from wine ratings and prices. *Wine Econ Policy*. 2014;3(1):3–9. https://doi.org/10.1016/j.wep.2014.03.001.
47. Symonds MRE, Moussalli A. A brief guide to model selection, multimodel inference and model averaging in behavioural ecology using Akaike's information criterion. *Behav Ecol Sociobiol*. 2011;65(1):13–21. https://doi.org/10.1007/s00265-010-1037-6.

48. Akaike H. A new look at the statistical model identification. *IEEE Trans Autom Control*. 1974;19(6):716–723. https://doi.org/10.1109/TAC.1974.1100705.
49. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J Clin Epidemiol*. 1996;49(12):1373–1379.
50. Moons KGM, Royston P, Vergouwe Y, Grobbee DE, Altman DG. Prognosis and prognostic research: what, why, and how? *BMJ*. 2009;338:b375.
51. Wijma AJ, van Wilgen CP, Meeus M, Nijs J. Clinical biopsychosocial physiotherapy assessment of patients with chronic pain: the first step in pain neuroscience education. *Physiother Theory Pract*. 2016;32(5):368–384. https://doi.org/10.1080/09593985.2016.1194651.
52. Karel YHJM, Verhagen AP, Thoomes-de Graaf M, et al. Development of a prognostic model for patients with shoulder complaints in physical therapist practice. *Phys Ther*. 2017;97(1):72–80. https://doi.org/10.2522/ptj.20150649.
53. Lentz TA, Barabas JA, Day T, Bishop MD, George SZ. The relationship of pain intensity, physical impairment, and pain-related fear to function in patients with shoulder pathology. *J Orthop Sports Phys Ther*. 2009;39(4):270–277. https://doi.org/10.2519/jospt.2009.2879.
54. Linsell L, Dawson J, Zondervan K, et al. Prevalence and incidence of adults consulting for shoulder conditions in UK primary care; patterns of diagnosis and referral. *Rheumatol Oxf Engl*. 2006;45(2):215–221. https://doi.org/10.1093/rheumatology/kei139.
55. Naunton J, Harrison C, Britt H, Haines T, Malliaras P. General practice management of rotator cuff related shoulder pain: a reliance on ultrasound and injection guided care. PLoS ONE. 2020;15:(1) e0227688. https://doi.org/10.1371/journal.pone.0227688.
56. Chalmers PN, Ross H, Granger E, Presson AP, Zhang C, Tashjian RZ. The effect of rotator cuff repair on natural history: a systematic review of intermediate to long-term outcomes. *JBJS Open Access*. 2018;3(1):e0043. https://doi.org/10.2106/JBJS.OA.17.00043.
57. Schibany N, Zehetgruber H, Kainberger F, et al. Rotator cuff tears in asymptomatic individuals: a clinical and ultrasonographic screening study. *Eur J Radiol*. 2004;51(3):263–268. https://doi.org/10.1016/S0720-048X(03)00159-1.
58. Moosmayer S, Smith HJ, Tariq R, Larmo A. Prevalence and characteristics of asymptomatic tears of the rotator cuff: an ultrasonographic and clinical study. *J Bone Joint Surg Br*. 2009;91(2):196–200. https://doi.org/10.1302/0301-620X.91B2.21069.
59. Barreto RPG, Braman JP, Ludewig PM, Ribeiro LP, Camargo PR. Bilateral magnetic resonance imaging findings in individuals with unilateral shoulder pain. *J Shoulder Elbow Surg*. 2019;28(9):1699–1706. https://doi.org/10.1016/j.jse.2019.04.001.
60. Kibler WB, Ludewig PM, McClure PW, Michener LA, Bak K, Sciascia AD. Clinical implications of scapular dyskinesis in shoulder injury: the 2013 consensus statement from the ‘scapular summit.’. *Br J Sports Med*. 2013;47(14):877–885. https://doi.org/10.1136/bjsports-2013-092425.
61. Hickey D, Solvig V, Cavalheri V, Harrold M, Mckenna L. Scapular dyskinesis increases the risk of future shoulder pain by 43% in asymptomatic athletes: a systematic review and meta-analysis. *Br J Sports Med*. 2018;52(2):102–110. https://doi.org/10.1136/bjsports-2017-097559.
62. Hogan C, Corbett JA, Ashton S, Perraton L, Frame R, Dakic J. Scapular dyskinesis is not an isolated risk factor for shoulder injury in athletes: a systematic review and meta-analysis. *Am J Sports Med*. 2020 363546520968508. https://doi.org/10.1177/0363546520968508. Published online November 19.