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Factors Associated With Symptomatic Rotator Cuff Tears: The ROW Cohort Study

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Abstract

Objective: Although rotator cuff tear is one of the most common musculoskeletal disorders, its etiology is poorly understood. We assessed factors associated with the presence of rotator cuff tears in a cohort of patients with shoulder pain.

Design: From February 2011 to July 2016, a longitudinal cohort of patients with shoulder pain was recruited. Patients completed a detailed questionnaire in addition to a magnetic resonance imaging scan and a clinical shoulder evaluation. The association of multiple factors associated with rotator cuff tears was assessed using multivariate logistic regression.

Results: In our cohort of 266 patients, 61.3% of patients had a rotator cuff tear. Older age (per 1 year: odds ratio [OR] = 1.03, 95% confidence interval [CI] = 1.02 to 1.07), involvement of the dominant shoulder (OR = 2.02, 95% CI = 1.16 to 3.52), and a higher BMI (per 1 kg/m^2: OR = 1.06, 95% CI = 1.03 to 1.12) were independently associated with rotator cuff tears. Sex, depression, smoking status, shoulder use at work, hypertension, and diabetes were not significantly associated with rotator cuff tear.

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Conclusion: In a cohort of patients with shoulder pain, we identified older age, involvement of the dominant shoulder, and a higher BMI to be independently associated with rotator cuff tear. The mechanism of how these factors possibly lead to rotator cuff tears needs further research.

Keywords

Rotator cuff tear; risk factors; shoulder pain; cohort

INTRODUCTION

Rotator cuff tears are a common etiology of shoulder pain[1]. Particularly in the elderly population, rotator cuff tears represent one of the most common causes of disability related to shoulder issues[2]. Prevalence of rotator cuff tears in the general population has been estimated to range from 5%[3] to 39%[4]. Several studies have reported that the prevalence of rotator cuff tears increase with older age[5–7]. Over the past two decades, the number of clinical visits and the number of surgical procedures to manage rotator cuff pathology has increased in the United States[8]. With an aging and increasingly active U.S. population, it is expected that there will be a continued increase in patients with rotator cuff-related issues. Other possible factors, such as smoking and hypercholesterolemia, have been implicated in prior studies[9] but the overall evidence is limited.

Due to its enormous public health impact, it is important to understand the underlying factors that are associated with rotator cuff tears. Assessment of factors associated with rotator cuff tears can improve our understanding of the mechanisms of this disorder and encourage investigations on potential prevention strategies. Hence, in a cohort of patients with shoulder pain, we assessed factors associated with symptomatic rotator cuff tears.

MATERIALS AND METHODS

Patient Population

We used data from a multicenter longitudinal cohort study named the Rotator Cuff Outcomes Workgroup (ROW)[10–14]. Patients in this cohort were recruited from sports medicine/shoulder clinics (from three academic settings and one community setting) from February 2011 to July 2016. Recruited patients were aged 45 years or older and had been experiencing shoulder pain and/or loss of range of motion. The age cut-off was determined based on our goal to recruit patients with degenerative rotator cuff tears. Exclusion criteria for the study included: current shoulder fracture on the same side, history of shoulder surgery on the same side, and findings of cervical pain radiating to the ipsilateral shoulder/arm/hand (active cervical radiculopathy). All inclusion and exclusion criteria were applied to the symptomatic shoulder. Patients who had a shoulder magnetic resonance imaging (MRI) and those who completed a baseline questionnaire on enrollment were eligible for this analysis (n=266). Patients included in the study provided written informed consent. The study was approved by our Institutional Review Boards. This study conforms to all STROBE guidelines and reports the required information accordingly (see Supplementary Checklist).

Structured History Questionnaire and Outcome Measures

Upon enrollment in the study, patients completed a structured history questionnaire. An abridged version of this questionnaire (excluding questions on comorbidities and social history) was subsequently mailed to patients at follow-up time points. The questionnaire elicited basic demographic information, alcohol and tobacco use, medical comorbidities, level of shoulder use at work, onset and characterization of symptoms, and patient expectation for improvement.

Daily shoulder use at work was evaluated by asking patients to assess the level of manual labor at their current job. If patients were not working at the time, they were instructed to answer the question with reference to their past job. Body mass index (BMI) was calculated from the height and weight of the patient using information from the electronic medical record and self-reported data. Duration of symptoms, shoulder instability, steroid medication use, and medications per day were self-reported on the baseline questionnaire.

Patients completed a modified Fear-Avoidance Beliefs Questionnaire (FABQ)[15], assessing fear-avoidance beliefs about physical activity and work due to their shoulder pain. In addition, patients completed the Mental Health Inventory (MHI-5)[16], assessing mental health status. A score of 68 or lower on the MHI-5 indicates a possible mood disorder, such as depression[17,18]. The Shoulder Pain and Disability Index (SPADI)[19] and the American Shoulder and Elbow Surgeons Standardized Shoulder (ASES)[20] form were also used to measure shoulder pain and functional outcomes.

Diagnostic Imaging

Shoulder experts (L.D.H. and N.B.J. or J.E.K. and N.B.J.) read shoulder MRIs in a blinded fashion. The methodology of MRI reviews in this study has been described in a previous study, in which good inter-rater and intra-rater reliability was shown compared to readings by a musculoskeletal radiologist[13].

Diagnosis of Rotator Cuff Tear

The diagnosis of a rotator cuff tear in this study was based on: (1) MRI findings that indicated a rotator cuff tear, and (2) clinical diagnosis of a rotator cuff tear by an attending-level sports medicine or shoulder fellowship-trained physician[10–14]. Patients in whom there was a suspicion of a rotator cuff tear based on clinical impression (assessment made before MRI was ordered) but without evidence of a structural defect on MRI (n=33) were deemed to not have a rotator cuff tear. Similarly, patients in whom it was clinically determined that their symptoms were not attributable to a tear but had structural evidence of a tear on MRI were deemed not to have a tear in our study (n=20).

Selection of Factors

The primary objective of this analysis was to estimate the association of factors with the probability of a rotator cuff tear. Potential factors were selected a priori based on expert knowledge and the existing literature[6,21–24]. These included: patient demographics (sex, age, race, and ethnicity), social factors (smoking, alcohol use, education, marital status), shoulder related factors (dominant arm, contralateral shoulder problems, duration of symptoms, shoulder use at work, shoulder osteoarthritis, and shoulder instability), medical comorbidities (hypertension, diabetes, rheumatoid arthritis, osteoporosis, depression, body mass index (BMI), and medication use (oral steroid medication use and duration, total number of medications used per day). Variables that had low prevalence (shoulder instability, contralateral shoulder problems, osteoporosis, rheumatoid arthritis) or had very few patients in one category (race, ethnicity, oral steroid medication duration) were excluded from the analysis. ASES and SPADI were not analyzed as potential factors because these were used as outcome scores in our cohort.

Statistical Analysis

Redundancy analysis was performed and variables with a R^2 greater than 0.9 were deleted. Hierarchical clustering using the Spearman correlation metric was estimated to assess whether a set of variables provided similar information. Subsequently, clinical expertise was used to select a set of variables that were meaningful and had potential association with rotator cuff tear. The final set of variables that were assessed for potential association with rotator cuff tear from the above process included: age, depression, smoking status, BMI, shoulder use at work, hypertension, diabetes, steroid medication usage, and involvement of the dominant arm. To adjust for missing data, 20 imputation data sets were analyzed using predictive mean matching. Estimates of standard errors among these datasets were calculated using Rubin’s rules[25]. Logistic regression, with and without imputed data, was used to estimate the association between predictor variables and the probability of a rotator cuff tear. All analyses were conducted using R 3.4.1[26].

RESULTS

Among the 266 patients in this analysis, 163 patients (61.3%) had a rotator cuff tear and 103 patients (38.7%) did not have a rotator cuff tear (Table I). Patients who had rotator cuff tears were older (median age of 63 years [interquartile range (IQR) = 55–67] for those with rotator cuff tear versus 59 years [IQR = 52–67] for those without rotator cuff tear, p = 0.05). Patients with rotator cuff tears had a shorter duration of symptoms (median duration of 6 months [IQR = 4–18] for those with rotator cuff tear versus 10 months [IQR = 5–19] for those without rotator cuff tear, p = 0.04) and were more likely to have their dominant shoulder affected (71% for those with rotator cuff tear versus 56% for those without rotator cuff tear, p = 0.01).

Our multivariate logistic regression model demonstrated that the odds of having a rotator cuff tear increased with older age (per 1 year: odds ratio [OR] = 1.03, 95% confidence interval [CI] = 1.02 to 1.07), if the dominant shoulder was affected (OR = 2.02, 95% CI = 1.16 to 3.52), and with a higher BMI (per 1 kg/m^2: OR = 1.06, 95% CI = 1.03 to 1.12) (Table II). For ease of clinical interpretation, we also present odds ratios comparing the 75^{th} percentile versus the 25^{th} percentile of values for continuous variables in our dataset, including age (67 years vs. 54 years: OR = 1.57, 95% CI = 1.03 to 2.39) and BMI (32.3 kg/m^2 vs. 25 kg/m^2: OR = 1.54, 95% CI = 1.02 to 2.31) (Figure 1).

A calibration curve for our final model displayed good overlap of predicted versus actual values (Appendix A). The variables that most influenced our predictive model were age, dominant shoulder, and BMI (Figure 2).

DISCUSSION

We assessed factors associated with the presence of rotator cuff tears in a cross-sectional analysis of our cohort of patients with shoulder pain. Overall, we identified older age, involvement of the dominant shoulder, and a higher BMI as independent factors associated with an increased likelihood of rotator cuff tear.

Prior epidemiological studies have recognized older age to be associated with rotator cuff tears[9]. Yamamoto et al. studied 683 people from a mountain village in Japan and found the presence of rotator cuff tears in 20.7% of these subjects. They identified age, dominant arm, and a history of trauma as factors for rotator cuff tears in their cohort[6]. Yamaguchi et al. found that prevalence of rotator cuff tears increase with age in a group of patients presenting with shoulder pain, with an average age of 58.7 years for those with a unilateral tear compared to an average age of 48.7 years in those without a tear[7]. Tempelhof et al. used ultrasound to assess 400 patients with asymptomatic shoulders and found a significant positive correlation between age and rotator cuff tears[27].

The association of age with rotator cuff tears is likely the result of a natural degenerative process. This degeneration is mediated by several factors such as age-related compromise of the microvascular system[28], loss of cellularity and fibrocartilage mass at the rotator cuff insertion site[29], and collagen fiber disorientation[30]. It is possible that a confluence of these factors place older individuals at a higher risk of sustaining rotator cuff tears. However, the exact mechanisms associated with the natural history of rotator cuff tears and whether or not they become symptomatic are not currently known[31].

Other etiologies such as impingement, tensile overload, and repetitive stress that leads to microtrauma[6] have been implicated in the pathogenesis of non-traumatic rotator cuff tears. These mechanisms may explain the reason for dominant shoulder as a factor for rotator cuff tears. A systematic review by Sayampanathan et al. concluded that, aside from older age, shoulder dominance was the other major factor associated with a greater chance of developing a rotator cuff tear[32]. Consistent with our study, this analysis found that the dominant shoulder had more than double the odds of sustaining a rotator cuff tear compared to the non-dominant shoulder.

There is substantial evidence that obesity and BMI play a role in the pathogenesis of musculoskeletal disorders[33], particularly in osteoarthritis[34–36]. However, few studies have looked specifically at the relationship between BMI and rotator cuff tears. Wendelboe et al. performed a case-control study that showed increasing BMI to be a factor for rotator cuff tendonitis and related conditions[37]. Gumina et al. showed that obesity (measured as BMI and body fat percentage) was a significant factor for both occurrence and severity of rotator cuff tears[24]. Given that the shoulder is not a weight-bearing joint, it is possible that the association between BMI and rotator cuff tears is due to metabolic factors as opposed to increased mechanical stress caused by obesity. The pathophysiology is still poorly understood but tendon hypovascularity[38] may be a plausible explanation. The majority of rotator cuff tears occur in an area of relative hypovascularity located within the distal 10 mm of the tendon near its insertion into the greater tuberosity of the humerus[39]. Obesity, as modulated by other comorbidities such as diabetes[40], hypertension[23], and hyperlipidemia[21], may exacerbate the natural vascular deficiency in this area[24]. This is hypothesized to be due to a pathway initiating with an increase in production of adipokines, inducing oxidative stress, inflammation, and cell apoptosis[41]. This process eventually causes degeneration of the rotator cuff tendon that predisposes it to injury[42].

The association of cigarette smoking with rotator cuff tears is debated in the literature. A retrospective case-control study by Baumgarten et al. suggests a strong association between smoking and rotator cuff tears[22]. However, in our study, smoking was not associated with the presence of rotator cuff tears. It is possible that our sample size (especially of smokers) was not sufficient to detect the association between smoking and rotator cuff tears. Similarly, other factors such as shoulder use at work were not associated with rotator cuff tears in our study. It is possible that self-report of this variable does not accurately describe the micro-trauma associated with heavy labor or that our sample size was not sufficient to detect this relationship.

Limitations of our study include exclusion of patients less than 45 years old, the use of a binary definition of rotator cuff tear (present vs. absent) instead of degree or size of tears, the absence of ultrasound examination, and the recruitment of patients from specialty clinics, which may have increased the overall prevalence of rotator cuff tears and may limit the generalizability of our findings to primary care settings. All patients in our cohort (including our control population) presented with shoulder pain. Hence, our controls were patients with shoulder pain and not those in the general population. Although this is a limitation, a study that uses the general population as controls would not be feasible because a shoulder MRI would be needed in these persons to avoid inclusion of asymptomatic tears. While comprehensive information was collected on patients in our cohort, it is possible that unknown confounding variables were not accounted for in our analysis. Our study had minimal (<10% for all variables) missing data but this also represents a limitation.

CONCLUSION

In a cohort of patients with shoulder pain, we identified older age, involvement of the dominant shoulder, and a higher BMI as independent factors associated with an increased likelihood of rotator cuff tear. The mechanism of how these factors are possibly associated with rotator cuff tears needs further research.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. Meislin RJ, Sperling JW, Stitik TP. Persistent shoulder pain: epidemiology, pathophysiology, and diagnosis. Am J Orthop. 2005;34(12 Suppl):5–9. [PubMed: 16450690]
2. Chakravarty K, Webley M. Shoulder joint movement and its relationship to disability in the elderly. J Rheumatol. 1993;20(8):1359–1361. [PubMed: 8230019]
3. Neer CS. Impingement lesions. Clin Orthop Relat Res. 1983;(173):70–77. [PubMed: 6825348]
4. Matsen FA, Titelman RM, Lippitt SB Rotator cuff. In: The Shoulder. Philadelphia: WB Saunders; 2004:795–878.
5. Teunis T, Lubberts B, Reilly BT, Ring D. A systematic review and pooled analysis of the prevalence of rotator cuff disease with increasing age. J Shoulder Elbow Surg. 2014;23(12):1913–1921. doi:10.1016/j.jse.2014.08.001 [PubMed: 25441568]
6. Yamamoto A, Takagishi K, Osawa T, et al. Prevalence and risk factors of a rotator cuff tear in the general population. J Shoulder Elbow Surg. 2010;19(1):116–120. doi:10.1016/j.jse.2009.04.006 [PubMed: 19540777]
7. Yamaguchi K, Ditsios K, Middleton WD, Hildebolt CF, Galatz LM, Teefey SA. The demographic and morphological features of rotator cuff disease. A comparison of asymptomatic and symptomatic shoulders. J Bone Joint Surg Am. 2006;88(8):1699–1704. doi:10.2106/JBJS.E.00835 [PubMed: 16882890]
8. Colvin AC, Egorova N, Harrison AK, Moskowitz A, Flatow EL. National trends in rotator cuff repair. J Bone Joint Surg Am. 2012;94(3):227–233. doi:10.2106/JBJS.J.00739 [PubMed: 22298054]
9. Tashjian RZ. Epidemiology, natural history, and indications for treatment of rotator cuff tears. Clin Sports Med. 2012;31(4):589–604. doi:10.1016/j.csm.2012.07.001 [PubMed: 23040548]
10. Jain NB, Luz J, Higgins LD, et al. The Diagnostic Accuracy of Special Tests for Rotator Cuff Tear: The ROW Cohort Study. Am J Phys Med Rehabil. 2017;96(3):176–183. doi:10.1097/PHM.0000000000000566 [PubMed: 27386812]

11. Jain NB, Ayers GD, Fan R, et al. Predictors of Pain and Functional Outcomes After the Nonoperative Treatment of Rotator Cuff Tears. Orthop J Sports Med. 2018;6(8). doi:10.1177/2325967118788531
12. Dickinson RN, Ayers GD, Archer KR, et al. Physical therapy versus natural history in outcomes of rotator cuff tears: the Rotator Cuff Outcomes Workgroup (ROW) cohort study. J Shoulder Elbow Surg. 2019;28(5):833–838. doi:10.1016/j.jse.2018.10.001 [PubMed: 30553798]
13. Jain NB, Collins J, Newman JS, Katz JN, Losina E, Higgins LD. Reliability of magnetic resonance imaging assessment of rotator cuff: the ROW study. PM R. 2015;7(3):245–254.e3; quiz 254. doi:10.1016/j.pmrj.2014.08.949 [PubMed: 25180471]
14. Jain NB, Ayers GD, Fan R, et al. Predictors of pain and functional outcomes after operative treatment for rotator cuff tears. J Shoulder Elbow Surg. 2018;27(8):1393–1400. doi:10.1016/j.jse.2018.04.016 [PubMed: 30016692]
15. Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain. 1993;52(2):157–168. doi:10.1016/0304-3959(93)90127-b [PubMed: 8455963]
16. Berwick DM, Murphy JM, Goldman PA, Ware JE, Barsky AJ, Weinstein MC. Performance of a five-item mental health screening test. Med Care. 1991;29(2):169–176. doi:10.1097/00005650-199102000-00008 [PubMed: 1994148]
17. Kelly MJ, Dunstan FD, Lloyd K, Fone DL. Evaluating cutpoints for the MHI-5 and MCS using the GHQ-12: a comparison of five different methods. BMC Psychiatry. 2008;8:10. doi:10.1186/1471-244X-8-10 [PubMed: 18284689]
18. Thorsen SV, Rugulies R, Hjarsbech PU, Bjorner JB. The predictive value of mental health for long-term sickness absence: the Major Depression Inventory (MDI) and the Mental Health Inventory (MHI-5) compared. BMC Med Res Methodol. 2013;13:115. doi:10.1186/1471-2288-13-115 [PubMed: 24040899]
19. Roach KE, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a shoulder pain and disability index. Arthritis Care Res. 1991;4(4):143–149. [PubMed: 11188601]
20. Richards RR, An KN, Bigliani LU, et al. A standardized method for the assessment of shoulder function. J Shoulder Elbow Surg. 1994;3(6):347–352. doi:10.1016/S1058-2746(09)80019-0 [PubMed: 22958838]
21. Abboud JA, Kim JS. The effect of hypercholesterolemia on rotator cuff disease. Clin Orthop Relat Res. 2010;468(6):1493–1497. doi:10.1007/s11999-009-1151-9 [PubMed: 19885710]
22. Baumgarten KM, Gerlach D, Galatz LM, et al. Cigarette smoking increases the risk for rotator cuff tears. Clin Orthop Relat Res. 2010;468(6):1534–1541. doi:10.1007/s11999-009-0781-2 [PubMed: 19283436]
23. Gumina S, Arceri V, Carbone S, et al. The association between arterial hypertension and rotator cuff tear: the influence on rotator cuff tear sizes. J Shoulder Elbow Surg. 2013;22(2):229–232. doi:10.1016/j.jse.2012.05.023 [PubMed: 22748932]
24. Gumina S, Candela V, Passaretti D, et al. The association between body fat and rotator cuff tear: the influence on rotator cuff tear sizes. J Shoulder Elbow Surg. 2014;23(11):1669–1674. doi:10.1016/j.jse.2014.03.016 [PubMed: 24906904]
25. Rubin DB Multiple Imputation for Nonresponse in Surveys. John Wiley and Sons
26. R Core Team. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing; 2019. https://www.R-project.org/
27. Tempelhof S, Rupp S, Seil R. Age-related prevalence of rotator cuff tears in asymptomatic shoulders. J Shoulder Elbow Surg. 1999;8(4):296–299. doi:10.1016/s1058-2746(99)90148-9 [PubMed: 10471998]
28. Mehta S, Gimbel JA, Soslowsky LJ. Etiologic and pathogenetic factors for rotator cuff tendinopathy. Clin Sports Med. 2003;22(4):791–812. doi:10.1016/s0278-5919(03)00012-7 [PubMed: 14560548]
29. Barr KP. Rotator cuff disease. Phys Med Rehabil Clin N Am. 2004;15(2):475–491. doi:10.1016/j.pmr.2004.03.002 [PubMed: 15145426]

30. Hashimoto T, Nobuhara K, Hamada T. Pathologic evidence of degeneration as a primary cause of rotator cuff tear. Clin Orthop Relat Res. 2003;(415):111–120. doi:10.1097/01.blo.0000092974.12414.22
31. Keener JD, Steger-May K, Stobbs G, Yamaguchi K. Asymptomatic rotator cuff tears: patient demographics and baseline shoulder function. J Shoulder Elbow Surg. 2010;19(8):1191–1198. doi:10.1016/j.jse.2010.07.017 [PubMed: 21030274]
32. Sayampanathan AA, Andrew THC. Systematic review on risk factors of rotator cuff tears. J Orthop Surg (Hong Kong). 2017;25(1):2309499016684318. doi:10.1177/2309499016684318 [PubMed: 28211286]
33. Viester L, Verhagen EALM, Oude Hengel KM, Koppes LLJ, van der Beek AJ, Bongers PM. The relation between body mass index and musculoskeletal symptoms in the working population. BMC Musculoskelet Disord. 2013;14:238. doi:10.1186/1471-2474-14-238 [PubMed: 23937768]
34. Felson DT, Anderson JJ, Naimark A, Walker AM, Meenan RF. Obesity and knee osteoarthritis. The Framingham Study. Ann Intern Med. 1988;109(1):18–24. doi:10.7326/0003-4819-109-1-18 [PubMed: 3377350]
35. Coggon D, Reading I, Croft P, McLaren M, Barrett D, Cooper C. Knee osteoarthritis and obesity. Int J Obes Relat Metab Disord. 2001;25(5):622–627. doi:10.1038/sj.ijo.0801585 [PubMed: 11360143]
36. Stürmer T, Günther KP, Brenner H. Obesity, overweight and patterns of osteoarthritis: the Ulm Osteoarthritis Study. J Clin Epidemiol. 2000;53(3):307–313. doi:10.1016/s0895-4356(99)00162-6 [PubMed: 10760642]
37. Wendelboe AM, Hegmann KT, Gren LH, Alder SC, White GL, Lyon JL. Associations between body-mass index and surgery for rotator cuff tendinitis. J Bone Joint Surg Am. 2004;86(4):743–747. doi:10.2106/00004623-200404000-00011 [PubMed: 15069138]
38. Codman E The Shoulder: Rupture of the Supraspinatus Tendon and Other Lesions in or about the Subacromial Bursa. Thomas Todd; 1934.
39. Hegedus EJ, Cook C, Brennan M, Wyland D, Garrison JC, Driesner D. Vascularity and tendon pathology in the rotator cuff: a review of literature and implications for rehabilitation and surgery. Br J Sports Med. 2010;44(12):838–847. doi:10.1136/bjsm.2008.053769 [PubMed: 19293165]
40. Rechardt M, Shiri R, Karppinen J, Jula A, Heliövaara M, Viikari-Juntura E. Lifestyle and metabolic factors in relation to shoulder pain and rotator cuff tendinitis: a population-based study. BMC Musculoskelet Disord. 2010;11:165. doi:10.1186/1471-2474-11-165 [PubMed: 20646281]
41. Dandona P, Aljada A, Chaudhuri A, Mohanty P, Garg R. Metabolic syndrome: a comprehensive perspective based on interactions between obesity, diabetes, and inflammation. Circulation. 2005;111(11):1448–1454. doi:10.1161/01.CIR.0000158483.13093.9D [PubMed: 15781756]
42. Lohr JF, Uhthoff HK. The microvascular pattern of the supraspinatus tendon. Clin Orthop Relat Res. 1990;(254):35–38.

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What is Known:

Current evidence suggests older age is associated with rotator cuff tears, but other factors have not been clearly elucidated.

What is New:

In a cohort of patients with shoulder pain, we identified older age, involvement of the dominant shoulder, and a higher BMI as independent factors for rotator cuff tear.

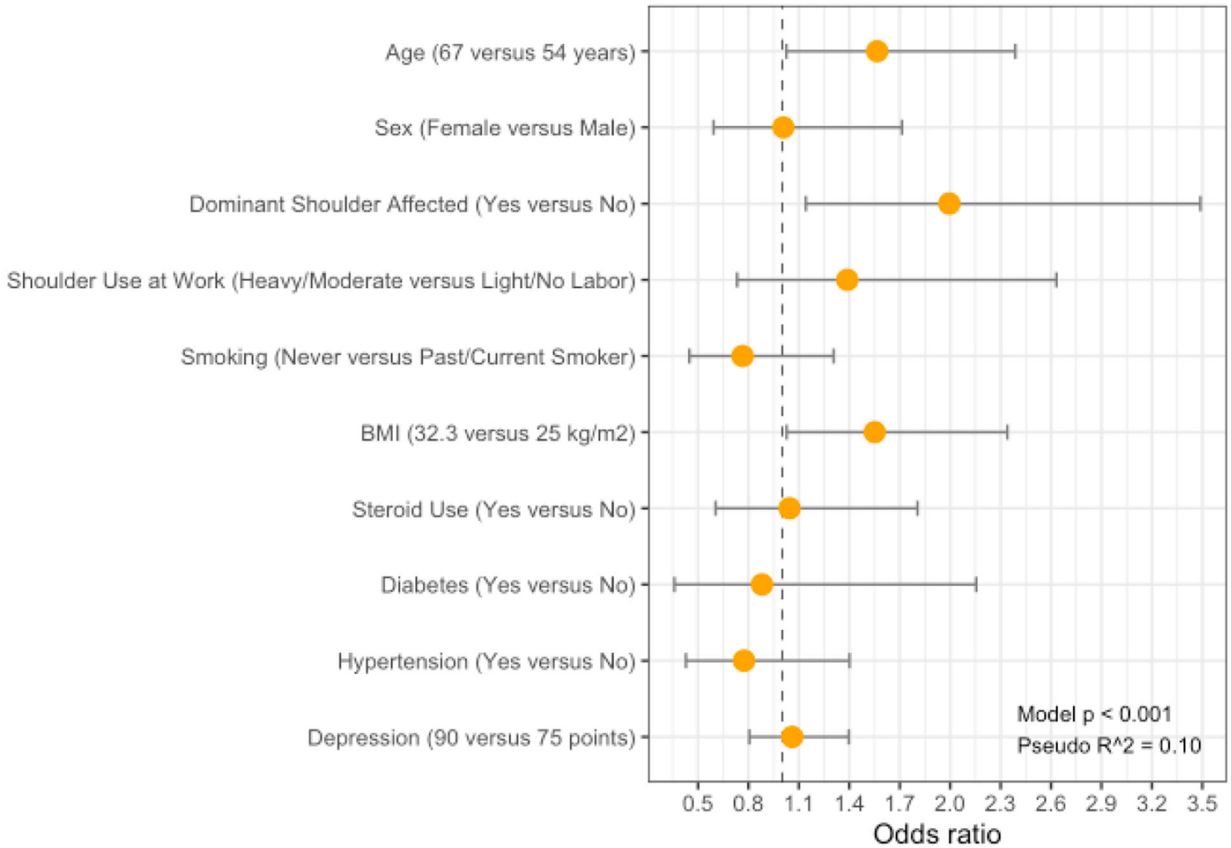

Figure 1: Selected factors associated with the diagnosis of Rotator Cuff Tears (n=266)

Strength of association is shown with odds ratios and 95% confidence intervals. A 95% confidence interval that excludes 1 denotes a statistically significant effect at $p < 0.05$.

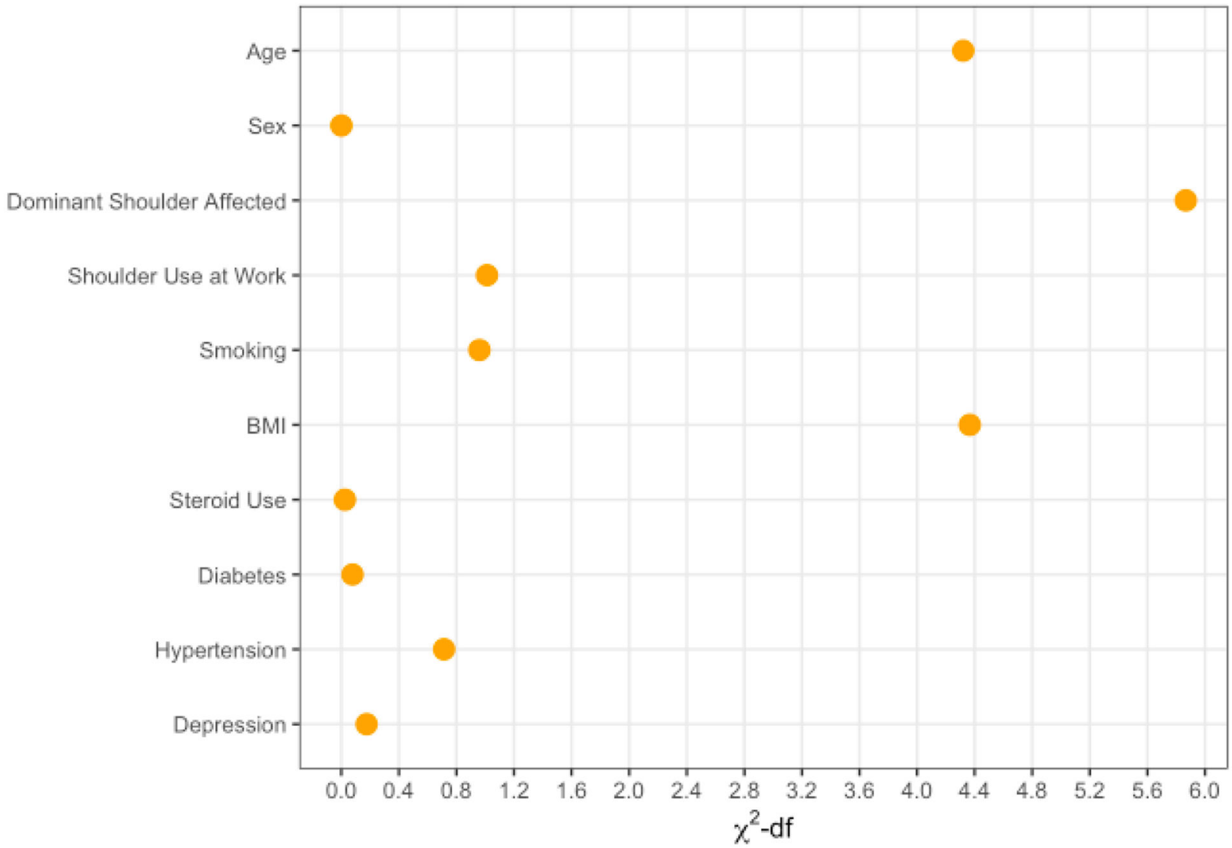

Figure 2: Relative strength of contribution of factors to the model

A higher χ^2-df represents a relatively higher contribution of the respective variable.

BMI = body mass index.

Table I:

Baseline patient characteristics

RISK FACTOR	N	Rotator Cuff Tear	
		Present N=163	Absent N=103
Age *			
Median (IQR)	266	63 (55–67)	59 (52–67)
Sex			
Male	148	93 (57%)	55 (53%)
Female	118	70 (43%)	48 (47%)
Race/Ethnicity			
Caucasian (Non-Hispanic)	226	133 (87%)	93 (92%)
Other	28	20 (13%)	8 (8%)
Level of Education			
College or above	178	107 (67%)	71 (70%)
Less than college	82	30 (30%)	52 (33%)
Marital status			
Married	184	115 (71%)	69 (68%)
Single, married, or divorced	78	32 (32%)	46 (29%)
Duration of Symptoms, mo *			
Median (IQR)	252	6 (4–18)	10 (5–19)
Body Mass Index			
Median (IQR)	245	28 (25–33)	28 (25–32)
Dominant Shoulder Affected *			
Yes	167	112 (71%)	55 (56%)
No	88	45 (29%)	43 (44%)
Daily Shoulder Use at Work			
Heavy/Moderate manual labor	63	42 (26%)	21 (21%)
Light/No manual labor	200	119 (74%)	81 (79%)
SOCIAL HISTORY			
Alcohol Use			
1–2 times per week or more	130	79 (50%)	51 (51%)
2–3 times per month or less	129	80 (50%)	49 (49%)
Smoking			
Current/Past	134	87 (53%)	47 (46%)
Never	125	72 (45%)	53 (53%)
Steroid Use	263	59 (37%)	34 (33%)
COMORBIDITIES			
Arthritis	45	28 (17%)	17 (16%)
Hypertension	95	60 (37%)	35 (34%)
Diabetes	29	19 (12%)	10 (10%)
Depression			

RISK FACTOR	N	Rotator Cuff Tear	
		Present N=163	**Absent N=103**
Median (IQR)	264	85 (75–90)	80 (75–90)

Data are shown as n (%) unless otherwise indicated.

*Significant differences between groups were seen for age (p=0.05), duration of symptoms (p = 0.04), and dominant shoulder affected (p = 0.01). IQR, interquartile range. Age units = years, Body mass index units = kg/m^2. Depression measured by points on the MHI-5 scale. Missing values: Race/Ethnicity n=12, Level of Education n=6, Marital status n=4, Duration of symptoms n=14, BMI n=21, Dominant Shoulder n=11, Daily Shoulder Use at Work n=3, Alcohol Use n=7, Smoking n=7, Steroid Use n=3.

Table II:

Odds ratios and 95% confidence interval of risk factors associated with the diagnosis of Rotator Cuff Tears

Risk Factor	OR	95% CI	
		Lower	Upper
Age (per 1-year increment)	1.03	1.02	1.07
Sex (Male)[a]	0.98	0.59	1.72
Dominant Shoulder Affected[a]	2.02	1.16	3.52
Heavy/Moderate Daily Shoulder Use at Work[a]	1.39	0.73	2.65
Smoking (Past or Current)[a]	1.31	0.44	1.29
BMI (per 1-kg/m^2 increment)	1.06	1.03	1.12
Steroid Use[a]	1.02	0.59	1.77
Diabetes	0.87	0.35	2.14
Hypertension	0.77	0.42	1.39
Depression	1.00	0.80	1.39

[a]Reference variable is sex (female), non-dominant shoulder affected, light/no daily shoulder use at work, never smoking, no steroid use. OR = odds ratio, CI = confidence interval, BMI = body mass index. Age units = years, Body mass index units = kg/m^2.