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Risk factors for full-thickness rotator cuff tears: a systematic review and meta-analysis

Jinlong Zhao[1,3]
Jianke Pan[2,3]
Ling-feng Zeng[2,3]
Ming Wu[1,3]
Weiyi Yang[2,3]
Jun Liu[2,3]

- Rotator cuff tears are a common condition of the shoulder, and 20.7% of people with the condition have a full-thickness rotator cuff tear. The purpose of this study was to explore the risk factors for full-thickness rotator cuff tears and to provide evidence to support the accurate diagnosis of full-thickness rotator cuff tears.
- Studies from PubMed, Embase and Web of Science published before 30 January 2021 were retrieved. All cohort studies and cross-sectional studies on risk factors for full-thickness rotator cuff tears were included. A meta-analysis was performed in RevMan 5.3 to calculate the relative risks (RRs) or weighted mean differences (WMDs) of related risk factors. Stata 15.1 was used for the quantitative analysis of publication bias.
- In total, 11 articles from six countries, including 4047 cases, with 1518 cases and 2529 controls, were included. The meta-analysis showed that age (MD = 0.76, 95% CI: 0.24 to 1.28, P = 0.004), hypertension (RR = 1.46, 95% CI: 1.17 to 1.81, P = 0.0007) and critical shoulder angle (CSA) (MD = 2.02, 95% CI: 1.55 to 2.48, P < 0.00001) were risk factors for full-thickness rotator cuff tears.
- Our results also suggested that body mass index, sex, dominant hand, smoking, diabetes mellitus and thyroid disease were not risk factors for full-thickness rotator cuff tears. Early identification of risk factors for full-thickness rotator cuff tears is helpful in identifying high-risk patients and choosing the appropriate treatment.

Keywords: full thickness; meta-analysis; risk factors; rotator cuff tear

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Introduction

The rotator cuff is composed of the supraspinatus muscle, infraspinatus muscle, teres minor muscle and subscapularis muscle, and forms a tendon sleeve-like structure wrapping the humeral head.[1] Epidemiological studies have shown that rotator cuff tears are one of the most common causes of shoulder pain and movement limitation, accounting for 30–70%.[2,3] Rotator cuff tears are a common condition of the shoulder; 20.7% of people with the condition have a full-thickness rotator cuff tear, and with increasing age, the incidence also increases.[4] Among asymptomatic patients over 50 years old, 40% had full-thickness rotator cuff tears.[5] Pathologically, rotator cuff tears are divided into full-thickness tears and partial tears.[6] Cadaver studies showed that the incidence of full-thickness rotator cuff tears ranged from 7% to 19%.[7] Rotator cuff tears, whether full-thickness tears or partial-thickness tears, are one of the most common shoulder diseases, causing pain, weakness and joint dysfunction.[8] The area affected by a full-thickness rotator cuff tear is generally large, so surgical treatment may be more complicated than that required for a partial tear. Some studies suggest that the rate of rotator cuff tear recurrence is 30% to 50% at 3–5 years after full-thickness rotator cuff repair.[9]

Rotator cuff tears account for approximately 60% of shoulder joint lesions, and the self-healing rate is close to zero.[10] Rotator cuff tears easily progress without intervention, and secondary steatosis, muscle atrophy and traumatic arthritis often develop with a prolonged course of disease, at which point the opportunity for operation has passed.[11] Because of the relatively large tear range of a full-thickness rotator cuff tear, the difficulty of operation and the burden on patients are theoretically greater than those associated with partial tears. Therefore, it is very important to explore the risk factors for full-thickness rotator cuff tears to aid in early diagnosis. Currently, some studies suggest that age, smoking, family genetics, hypercholesterolemia, overload, microtrauma and impaction are associated with rotator cuff injury.[12–15] However, research on the risk factors for full-thickness rotator cuff tears still lacks high-quality evidence, which makes it very difficult for clinicians and patients to identify tears early and initiate timely treatment measures. To accurately identify full-thickness rotator cuff tears in the early stage, this study used a meta-analysis to quantitatively analyse potential risk factors for full-thickness rotator cuff tears to provide a theoretical basis for clinical treatment and prognosis.

Methods

This meta-analysis was performed in strict accordance with the relevant requirements of the Meta-analysis of Observational Studies in Epidemiology (MOOSE) statement and was registered with the PROSPERO International Prospective Register of Systematic Reviews (registration number: CRD42021237835).

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) the case group comprised patients with full-thickness rotator cuff tears, while the control group comprised patients without rotator cuff tears; (2) the study included at least one evaluation index; (3) there must be at least two studies to provide data for the combined indicators; (4) cases and controls were confirmed by imaging examinations, such as magnetic resonance imaging (MRI); and (5) the study was a cohort study, case-control study or cross-sectional study. The literature was not limited by language.

The exclusion criteria were as follows: (1) the study was a duplicate study, and (2) the data could not be converted and merged.

Retrieval strategy

The PubMed, Embase and Web of Science databases were searched. The retrieval strategy employed the combination of MeSH terms and titles/abstracts. The retrieval time was from the establishment of each database to 30 January 2021. The search included the following terms: (Risk Factors OR risk factor) AND (Rotator Cuff Injury OR full thickness OR Rotator Cuff Tears OR Rotator Cuff Tears OR Rotator Cuff Tendinitis). The search strategy for each database is shown in the Supplemental Material (Appendix I).

Literature screening and data extraction

Two researchers independently screened the literature, extracted data and cross-checked the data. Disagreements were settled through discussion or negotiation with a third party. After duplicate data were removed from the data retrieved, the abstracts and full texts were read to determine whether the study should be included. If necessary, the original study author was contacted by email or telephone to obtain information that was important for this study. The extracted information included: (1) basic study information, including the first author, publication time and study design; (2) baseline characteristics of the subjects, including the sampling and imaging methods; (3) key elements of the risk of bias assessment; and (4) relevant outcome indicators and measurement data.

Assessment of study quality

The types of studies that were included in this article were cohort studies, case-control studies and cross-sectional studies. The Newcastle-Ottawa Scale (NOS) was used to evaluate the risk of bias of the case-control studies and cohort studies.[16] The following three aspects were assessed: the research subject selection process, level of intergroup comparability and data measurement process. The total possible score was 9 points. The higher the score was, the better the quality of the study. The cross-sectional studies were evaluated using the risk of bias evaluation standards recommended by the American Agency for Healthcare Research and Quality (AHRQ),[17] with 11 items in total. The response options for each item were 'yes', 'no' or 'not clear'. The higher the score was, the higher the quality of the study.

Quantitative analysis

RevMan 5.3 software (Cochrane Collaboration, UK) was used for the meta-analysis. The weighted mean difference (WMD) was used to quantify the effects of measurement data, and the risk ratio (RR) was used to analyse the effects of categorical variables. The 95% confidence interval (CI) of each WMD is provided. The heterogeneity test was used to evaluate the heterogeneity of the included studies. If there was no heterogeneity ($I^2 \leq 50\%$), the fixed-effect model was used to merge the effect values; if heterogeneity was present ($I^2 > 50\%$), the random-effects model was used to merge the effect values. For the outcome indicators with the combined data greater than five articles, Stata 15.1 (Stata Corporation, Lakeway, TX, USA) software was used to perform Egger's test to evaluate whether there was bias in the literature.

Results

Literature search results

A total of 987 studies were initially identified. A total of 269 papers remained after removing duplicates. After reading the titles and abstracts, 56 articles were included. After reading the full texts, 45 articles were excluded, and

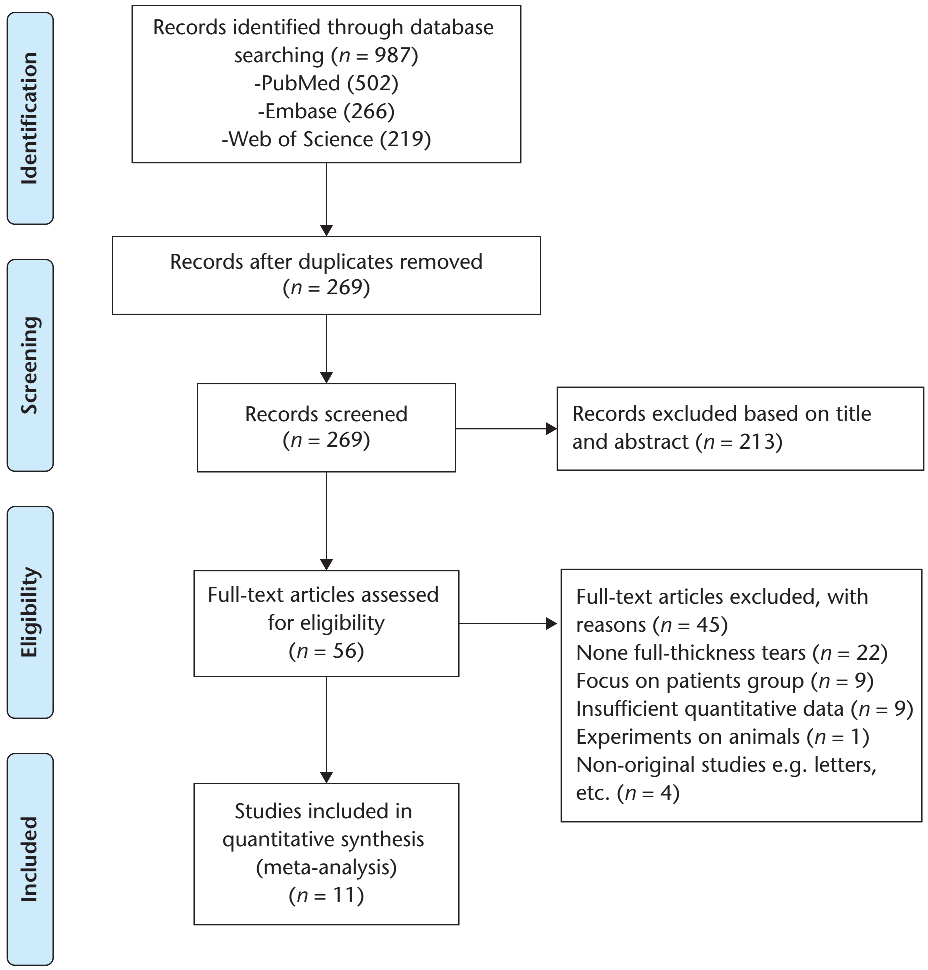

Fig. 1 PRISMA (Preferred Reporting Items for Systematic Meta-Analyses) flow chart.

11 articles were included. The literature screening process is shown in Fig. 1.

Basic characteristics of included studies

A total of 11 articles from six countries were included, all of which passed ethical review. A total of 4047 subjects were included in the studies, including 1518 cases and 2529 controls. Ten risk factors were identified. The basic characteristics of the included studies are shown in Table 1.

Literature quality evaluation

Eleven articles, including nine cohort studies and two cross-sectional studies, were included in the analysis. The scores of the quality evaluations of the included studies are shown in Table 1. The specific literature quality evaluation of each study is shown in the Supplemental Material (Appendix II). Nine cohort studies scored 4–8 points. The quality scores of the two cross-sectional studies were 6 and 7. These results suggest that the included studies had a relatively low risk of bias and relatively high methodological quality.

Meta-analysis results

Age

A total of 3064 patients were included in nine studies, with 1246 patients in the case group and 1818 people in the control group. The heterogeneity among the studies was low (P = 0.11, I^2 = 39%), and the fixed-effect model was used in the meta-analysis. The results showed that older age was a risk factor for full-thickness rotator cuff tears, and the difference was statistically significant (MD = 0.76, 95% CI: 0.24 to 1.28, P = 0.004) (Fig. 2).

Body mass index (BMI)

Two studies involving 883 patients were analysed. There was no heterogeneity between the studies (P = 1.00, I^2 = 0%), so a fixed-effect model was used in the meta-analysis. The results showed that a higher BMI was a protective

Table 1. Characteristics of included trials in the review

First author	Publication year	Country	Design	No. of patients (M/F)		Age, years		Imaging modality	NOS or AHRQ
				F-RCT	Non-RCT	F-RCT	Non-RCT		
Abate M[18]	2014	Italy	Prospective cohort study	27 (–/–)	205 (–/–)	50.9±4.1	49.7±4.0	Ultrasound	7
Atala NA[19]	2021	Argentina	Prospective cohort study	52 (15/37)	53 (14/39)	72±5	71±5	MRI	8
Blonna D[20]	2016	Italy	Prospective cohort study	40 (10/30)	80 (22/58)	63±11	70±16	MRI	8
Figueiredo EA[21]	2020	Brazil	Prospective cohort study	211 (81/130)	567 (250/317)	58.9±10.0	57.2±10.7	MRI	6
Gumina S[22]	2013	Italy	Retrospective cohort study	215 (106/109)	201 (99/102)	64.8±7.9	63.9±8.9	MRI	5
İncesoy MA[23]	2021	Turkey	Retrospective cohort study	437 (156/281)	433 (157/276)	51.2±5.8	50.7±5.3	MRI	8
Jeong J[24]	2017	Korea	Cross-sectional study	23 (11/12)	356 (94/262)	–	–	Ultrasound	6
Jeong HJ[25]	2021	Korea	Retrospective cohort study	40 (16/24)	160 (60/100)	60.1±7.5	60±8.4	MRI	7
Kim JH[26]	2019	Korea	Cross-sectional study	214 (106/108)	109 (50/59)	57.4±7.4	55.6±9.3	MRI	7
Passaretti D[27]	2016	Italy	Prospective cohort study	249 (139/110)	356 (186/170)	64±6	66±6	MRI	6
Spiegl UJ[28]	2016	USA	Retrospective cohort study	10 (6/4)	10 (8/2)	53.5±4.7	52.7±5.5	MRI	4

Note. F-RCT, full-thickness rotator cuff tear; RCT, rotator cuff tear; M, male; F, Female; NOS, Newcastle-Ottawa Scale; AHRQ, American Agency for Healthcare Research and Quality; MRI, magnetic resonance imaging.

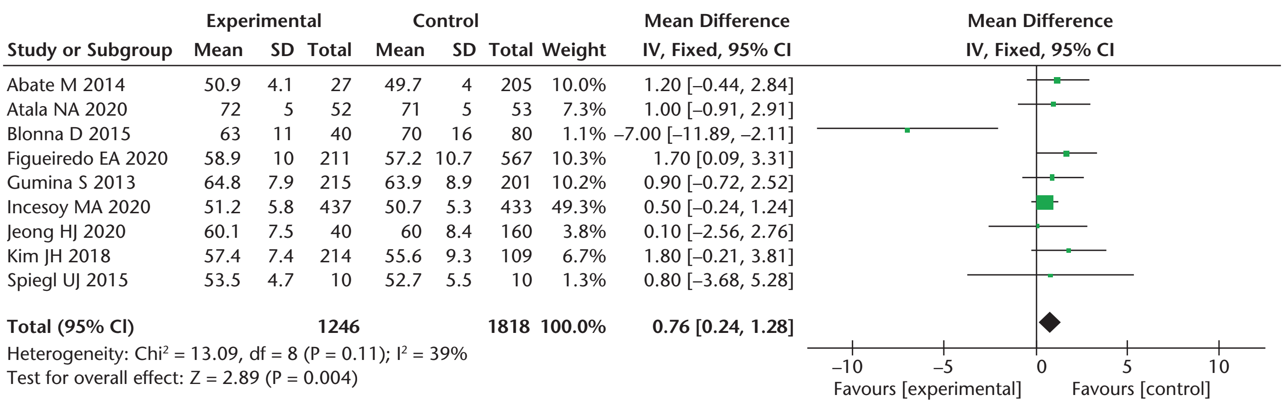

Fig. 2 Forest plot for the association between older age and F-RCT risk.

Note. F-RCT, full-thickness rotator cuff tear.

factor against full-thickness rotator cuff tears, and the difference was statistically significant (MD = –0.70, 95% CI: –1.27 to –0.13, P = 0.02) (Fig. 3).

Male sex

A total of 10 studies were analysed, and the heterogeneity among the studies was low (P = 0.43, I^2 = 14%). The fixed-effect model was used in the meta-analysis (RR = 1.01, 95% CI: 0.93 to 1.09) (Fig. 4). Meta-analysis showed that male sex was not a direct risk factor for full-thickness rotator cuff tears. The difference was not statistically significant (P = 0.87).

Female sex

A total of 10 studies were analysed, and there was no heterogeneity among the studies (P = 0.60, I^2 = 0%). The fixed-effect model was used in the meta-analysis (RR = 0.99, 95% CI: 0.94 to 1.06, P = 0.87) (Fig. 5). Female sex was not a risk factor for full-thickness rotator cuff tears, and there was no significant difference between the two groups.

Dominant arm

A total of three studies were analysed, and there was no heterogeneity among the studies (P = 0.51, I^2 = 0%). The fixed-effect model was used for the meta-analysis

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Atala NA 2020	29.2	4.6	52	29.9	5.1	53	9.5%	–0.70 [–2.56, 1.16]
Figueiredo EA 2020	26.3	3.3	211	27	4.9	567	90.5%	–0.70 [–1.30, –0.10]
Total (95% CI)			**263**			**620**	**100.0%**	**–0.70 [–1.27, –0.13]**

Heterogeneity: Chi² = 0.00, df = 1 (P = 1.00); I² = 0%
Test for overall effect: Z = 2.40 (P = 0.02)

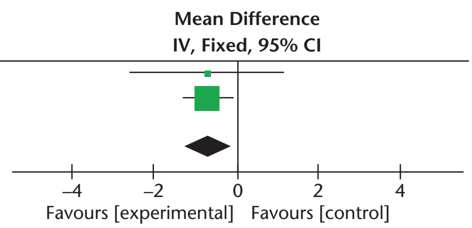

Fig. 3 Forest plot for the association between BMI and F-RCT risk.
Note. BMI, body mass index; F-RCT, full-thickness rotator cuff tear.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Atala NA 2020	15	52	14	53	2.0%	1.09 [0.59, 2.03]
Blonna D 2015	10	40	22	80	2.1%	0.91 [0.48, 1.73]
Figueiredo EA 2020	81	211	250	567	19.7%	0.87 [0.72, 1.06]
Gumina S 2013	106	215	99	201	14.9%	1.00 [0.82, 1.22]
Incesoy MA 2020	156	437	157	433	23.0%	0.98 [0.82, 1.18]
Jeong HJ 2016	11	23	94	355	1.7%	1.81 [1.14, 2.86]
Jeong HJ 2020	16	40	60	160	3.5%	1.07 [0.69, 1.64]
Kim JH 2018	106	214	50	109	9.6%	1.08 [0.85, 1.38]
Passaretti D 2016	139	249	186	356	22.3%	1.07 [0.92, 1.24]
Spiegl UJ 2015	6	10	8	10	1.2%	0.75 [0.41, 1.36]
Total (95% CI)		**1491**		**2324**	**100.0%**	**1.01 [0.93, 1.09]**
Total events	646		940			

Heterogeneity: Chi² = 10.50, df = 9 (P = 0.31); I² = 14%
Test for overall effect: Z = 0.17 (P = 0.87)

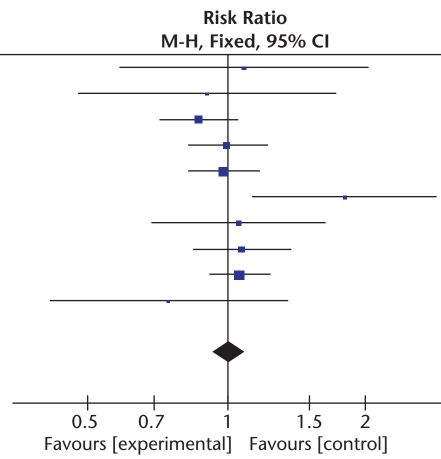

Fig. 4 Forest plot for the association between male sex and F-RCT risk.
Note. F-RCT, full-thickness rotator cuff tear.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Atala NA 2020	37	52	39	53	4.2%	0.97 [0.76, 1.23]
Blonna D 2015	30	40	58	80	4.2%	1.03 [0.83, 1.29]
Figueiredo EA 2020	130	211	317	567	18.6%	1.10 [0.97, 1.25]
Gumina S 2013	109	215	102	201	11.4%	1.00 [0.83, 1.21]
Incesoy MA 2020	281	437	276	433	30.0%	1.01 [0.91, 1.11]
Jeong HJ 2016	12	23	261	355	3.4%	0.71 [0.48, 1.05]
Jeong HJ 2020	24	40	100	160	4.3%	0.96 [0.73, 1.27]
Kim JH 2018	108	214	59	109	8.5%	0.93 [0.75, 1.16]
Passaretti D 2016	110	249	170	356	15.1%	0.93 [0.78, 1.10]
Spiegl UJ 2015	4	10	2	10	0.2%	2.00 [0.47, 8.56]
Total (95% CI)		**1491**		**2324**	**100.0%**	**0.99 [0.94, 1.06]**
Total events	845		1384			

Heterogeneity: Chi² = 7.39, df = 9 (P = 0.60); I² = 0%
Test for overall effect: Z = 0.17 (P = 0.87)

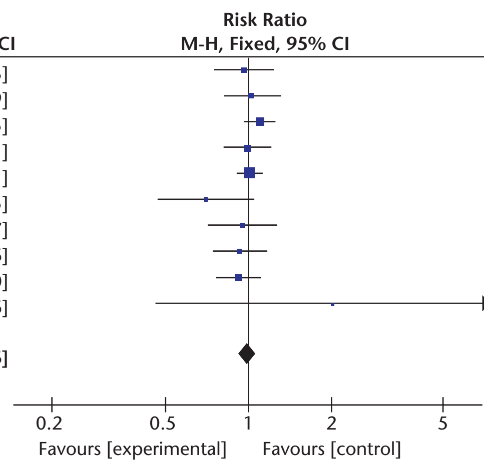

Fig. 5 Forest plot for the association between female sex and F-RCT risk.
Note. F-RCT, full-thickness rotator cuff tear.

(RR = 1.07, 95% CI: 0.93 to 1.25, P = 0.35) (Fig. 6). The results show that the dominant arm is not a risk factor for full-thickness rotator cuff tears. .

Smoking

A total of five studies were analysed, and there was heterogeneity among them (P = 0.002, I^2 = 77%). Meta-analysis was performed with the random-effects model (RR = 1.49, 95% CI: 0.94 to 2.35, P = 0.09) (Fig. 7). The results showed that smoking did not increase the risk of full-thickness rotator cuff tears. However, due to the large heterogeneity of the included data, the interpretation of the research results should be performed with caution.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Atala NA 2020	41	52	36	53	32.9%	1.16 [0.92, 1.46]
Blonna D 2015	24	40	42	80	25.8%	1.14 [0.82, 1.59]
Jeong HJ 2020	27	40	112	160	41.3%	0.96 [0.76, 1.22]
Total (95% CI)		**132**		**293**	**100.0%**	**1.07 [0.93, 1.25]**
Total events	92		190			

Heterogeneity: Chi^2 = 1.36, df = 2 (P = 0.51); I^2 = 0%
Test for overall effect: Z = 0.94 (P = 0.35)

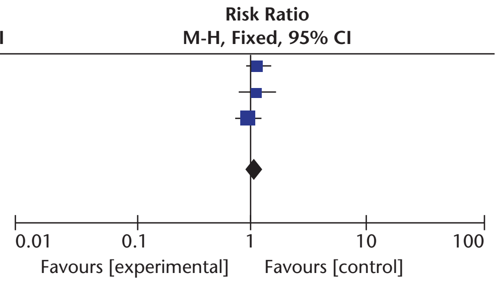

Fig. 6 Forest plot for the association between dominant arm and F-RCT risk.
Note. F-RCT, full-thickness rotator cuff tear.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Atala NA 2020	18	52	8	53	16.1%	2.29 [1.09, 4.81]
Blonna D 2015	18	40	15	80	19.4%	2.40 [1.36, 4.25]
Figueiredo EA 2020	14	211	62	567	19.6%	0.61 [0.35, 1.06]
Jeong HJ 2016	8	23	57	355	18.6%	2.17 [1.18, 3.98]
Passaretti D 2016	108	249	129	356	26.3%	1.20 [0.98, 1.46]
Total (95% CI)		**575**		**1411**	**100.0%**	**1.49 [0.94, 2.35]**
Total events	166		271			

Heterogeneity: Tau^2 = 0.20; Chi^2 = 17.43, df = 4 (P = 0.002); I^2 = 77%
Test for overall effect: Z = 1.69 (P = 0.09)

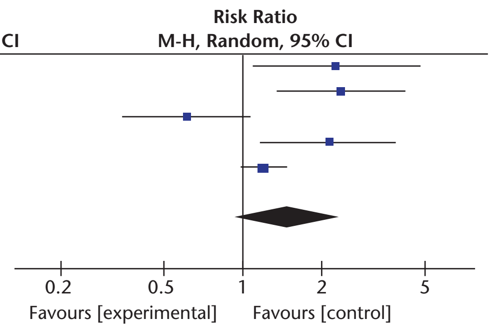

Fig. 7 Forest plot for the association between smoking and F-RCT risk.
Note. F-RCT, full-thickness rotator cuff tear.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Atala NA 2020	5	52	4	53	3.7%	1.27 [0.36, 4.48]
Jeong HJ 2016	3	23	21	355	2.4%	2.20 [0.71, 6.85]
Passaretti D 2016	93	249	122	356	93.9%	1.09 [0.88, 1.35]
Total (95% CI)		**324**		**764**	**100.0%**	**1.12 [0.91, 1.38]**
Total events	101		147			

Heterogeneity: Chi^2 = 1.47, df = 2 (P = 0.48); I^2 = 0%
Test for overall effect: Z = 1.09 (P = 0.28)

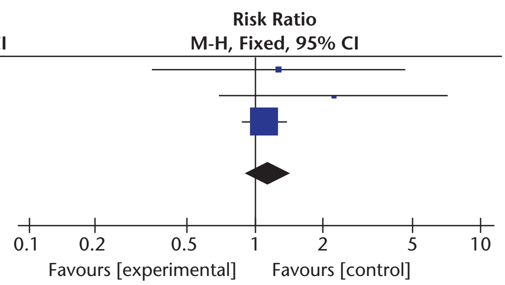

Fig. 8 Forest plot for the association between diabetes mellitus and F-RCT risk.
Note. F-RCT, full-thickness rotator cuff tear.

Diabetes mellitus (DM)

A total of three studies were analysed, and there was no heterogeneity among the studies (P = 0.48, I^2 = 0%). The fixed-effect model was used in the meta-analysis (RR = 1.12, 95% CI: 0.91 to 1.38, P = 0.28) (Fig. 8). DM is not a risk factor for full-thickness rotator cuff tears. There was no significant difference between the two groups.

Hypertension

Two studies were analysed, and the heterogeneity between the studies was low (P = 0.25, I^2 = 24%). The fixed-effect model was used for the meta-analysis (RR = 1.46, 95% CI: 1.17 to 1.81, P = 0.0007) (Fig. 9). Meta-analysis showed that people with hypertension were more likely to have full-thickness rotator cuff tears. The difference was statistically significant.

Thyroid disease

A total of two studies were analysed, and there was no heterogeneity between the studies (P = 0.75, I^2 = 0%). The fixed-effect model was used in the meta-analysis (RR = 0.77, 95% CI: 0.34 to 1.74) (Fig. 10). Thyroid disease was not a risk factor for full-thickness rotator cuff tears. The difference was not statistically significant (P = 0.53).

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Blonna D 2015	13	40	24	80	19.0%	1.08 [0.62, 1.89]
Gumina S 2013	109	215	66	201	81.0%	1.54 [1.22, 1.96]
Total (95% CI)		**255**		**281**	**100.0%**	**1.46 [1.17, 1.81]**
Total events	122		90			

Heterogeneity: Chi² = 1.31, df = 1 (P = 0.25); I² = 24%
Test for overall effect: Z = 3.38 (P = 0.0007)

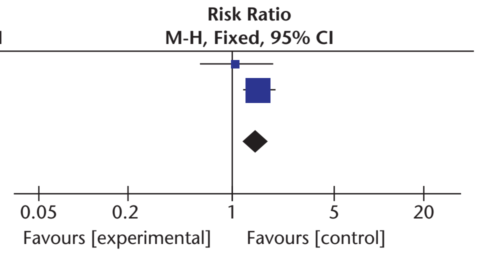

Fig. 9 Forest plot for the association between hypertension and F-RCT risk.
Note. F-RCT, full-thickness rotator cuff tear.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Atala NA 2020	8	52	10	53	84.4%	0.82 [0.35, 1.90]
Jeong HJ 2016	0	23	14	355	15.6%	0.51 [0.03, 8.32]
Total (95% CI)		**75**		**408**	**100.0%**	**0.77 [0.34, 1.74]**
Total events	8		24			

Heterogeneity: Chi² = 0.10, df = 1 (P = 0.75); I² = 0%
Test for overall effect: Z = 0.63 (P = 0.53)

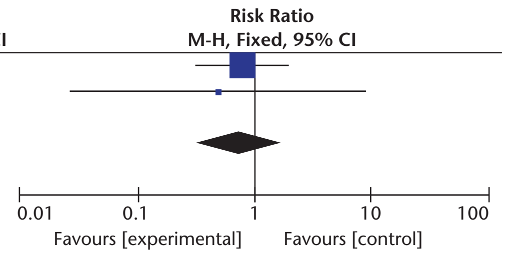

Fig. 10 Forest plot for the association between thyroid disease and F-RCT risk.
Note. F-RCT, full-thickness rotator cuff tear.

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Blonna D 2015	36	3	40	34	3	80	16.6%	2.00 [0.86, 3.14]
Incesoy MA 2020	33.6	3.9	437	31.5	4	433	78.0%	2.10 [1.57, 2.63]
Spiegl UJ 2015	37.3	2.6	10	36.4	1.9	10	5.4%	0.90 [–1.10, 2.90]
Total (95% CI)			**487**			**523**	**100.0%**	**2.02 [1.55, 2.48]**

Heterogeneity: Chi² = 1.30, df = 2 (P = 0.52); I² = 0%
Test for overall effect: Z = 8.53 (P < 0.00001)

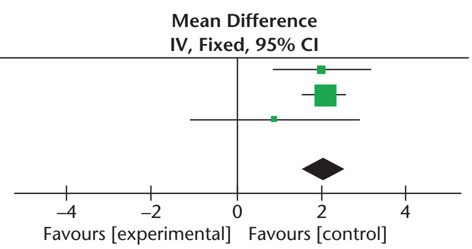

Fig. 11 Forest plot for the association between CSA and F-RCT risk.
Note. CSA, critical shoulder angle; F-RCT, full-thickness rotator cuff tear.

Critical shoulder angle (CSA)

A total of three studies were analysed, and there was no heterogeneity between the studies (P = 0.52, I^2 = 0%). The fixed-effect model was used for the meta-analysis (MD = 2.02, 95% CI: 1.55 to 2.48) (Fig. 11). The results showed that the larger the CSA was, the higher the risk factor for full-thickness rotator cuff tears. The difference was statistically significant (P < 0.00001).

Assessment of publication bias

No evidence of publication bias was found for the WMD of age (Egger's test, P = 0.058) or the RR of males and females (Egger's test, P = 0.651 and P = 0.463, respectively). The statistical results of publication bias associated with the above three outcome indicators are shown in the Supplemental Material (Appendix III).

Discussion

To our knowledge, this is the first meta-analysis of risk factors for full-thickness rotator cuff tears. In this study, we analysed the influence of 10 potential risk factors on full-thickness rotator cuff tears. Our results showed that age, hypertension and CSA were risk factors for full-thickness rotator cuff tears. A higher BMI had a weaker association with full-thickness rotator cuff tears than the abovementioned factors, and sex, dominant hand, smoking, DM and thyroid disease had no direct relationship with full-thickness rotator cuff tears.

Age

The results of this meta-analysis showed that the risk of full-thickness rotator cuff tears increased with age (MD = 0.76, 95% CI: 0.24 to 1.28). The incidence rate of rotator cuff tears increases with age, and the size of rotator cuff tears is significantly positively correlated with age.[29] Increasing age results in a decline in muscle strength, the degeneration of shoulder muscles and tendons and long-term strain, which can lead to rotator cuff tear.[30] In elderly individuals, the number of microvessels in the tendon is significantly reduced, which makes the rotator cuff tissue more prone to fibrovascular hyperplasia, fatty acid infiltration, atrophy and calcification, potentially inducing rotator cuff tear.[31,32] However, the underlying pathological mechanisms associated with ageing and full-thickness rotator cuff tears need further study.

Hypertension

Our results showed that people with hypertension were more likely to develop full-thickness rotator cuff tears than non-rotator cuff tears (RR = 1.46, 95% CI: 1.17 to 1.81). To confirm whether hypertension increased the risk of rotator cuff tears and affected the size of the tears, Gumina et al. divided 408 patients into a hypertension group and a non-hypertension group in a case-control study.[22] A logistic regression model was used to evaluate the risk of rotator cuff tears caused by hypertension. They found that high blood pressure was associated with a high risk of tears, with a twofold increase in the risk of large tears and a fourfold increase in the risk of massive tears.[22] Their research showed that the risk of rotator cuff tears was increased in people with high blood pressure. Our research supports this conclusion. However, further study is needed to determine how hypertension increases the risk of full-thickness rotator cuff tears.

CSA

Studies have shown that the CSA is related to rotator cuff tears, and the CSA of rotator cuff tear patients is much higher than that of non-rotator cuff tear patients.[33,34] Our results showed that CSA was a risk factor for full-thickness rotator cuff tears (MD = 2.02, 95% CI: 1.55 to 2.48). The compression force and shear force of the joint depend on the CSA. With an increasing CSA, the shear force of the joint increases, resulting in instability of the shoulder joint, and the rotator cuff needs additional force to balance and maintain the stability of the joint.[35] In the case of low active abduction, a high CSA can increase the supraspinatus tendon load, which also confirms that a high CSA can lead to rotator cuff tear.[34] Relevant biomechanical studies combined with our results confirm that CSA is a risk factor for full-thickness rotator cuff tears.

In this study, we found that full-thickness rotator cuff tears were less likely to occur in patients with a higher BMI (MD = –0.70, 95% CI: –1.27 to –0.13), which is an interesting phenomenon. However, there is still no research on the mechanism of association, which may be an area of future research. In contrast, lower BMI is theoretically a risk factor for full-thickness rotator cuff tears. However, whether it is higher BMI or lower BMI (protective factor or risk factor), its value should have a relative range, which is an area that needs further research and discussion. In addition, according to the results of this study, we believe that sex, dominant hand, smoking, DM and thyroid disease are not associated with full-thickness rotator cuff tears.

Limitations

Despite the notable findings mentioned above, there are some limitations of this study. First, the included studies were from different countries, and their socioeconomic environments and medical systems were different, which may be the source of heterogeneity among individual outcome indicators, such as smoking. Second, this study considered only full-thickness rotator cuff tears and did not consider the size of tears and specific muscle tears. Third, some outcomes (such as DM and thyroid disease) were analysed based on only two studies (with one study weighing much more than the other), which may affect the reliability of the statistical results, and the high heterogeneity for smoking leads to some limitations. Fourth, some risk factors, such as DM, had a strong correlation with the occurrence of rotator cuff tears in previous studies. However, the results of this study do not support this hypothesis, so additional relevant studies are needed. Finally, some risk factors (such as trauma, hypercholesterolemia, and genetic factors) were not analysed due to the lack of corresponding data in the included literature. The shortcomings of this study will be an important direction of future research.

Conclusion

This meta-analysis showed that older age, hypertension and larger CSA were risk factors for full-thickness rotator cuff tears, which has important guiding significance in accurately identifying rotator cuff disease in the early stage and formulating treatment plans. Further research is needed to better understand the complex relationships between the identified risk factors and full-thickness rotator cuff tears. In addition, due to the small sample size for some risk factors, additional multicentre and large-sample data are needed for further validation.

AUTHOR INFORMATION

[1]The Second School of Clinical Medical Sciences, Guangzhou University of Chinese Medicine, Guangzhou, China.

[2]The Second Affiliated Hospital, Guangzhou University of Chinese Medicine (Guangdong Province Hospital of Traditional Chinese Medicine), Guangzhou, China.

[3]Guangdong Academy of Traditional Chinese Medicine, Research Team on Bone and Joint Degeneration and Injury, Guangzhou, China.

Correspondence should be sent to: Jun Liu, No. 12, Ji Chang Road, Bai Yun District, Guangzhou City, Guangdong Province, China.
Email: gzucmliujun@foxmail.com

ICMJE CONFLICT OF INTEREST STATEMENT

All the authors declare no conflict of interest relevant to this work.

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SUPPLEMENTAL MATERIAL

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