

Is the Number of Citations Related to the Study Methodology in Shoulder Arthroplasty Literature? A Bibliometric and Statistical Analysis of Current Evidence

Journal of Shoulder and Elbow
Arthroplasty
Volume 8: 1–11
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DOI: 10.1177/24715492231223346
journals.sagepub.com/home/sea



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Abstract

Background: We reviewed the shoulder arthroplasty (SA) literature to correlate citations, methodological characteristics and quality of most-cited articles in this field. We hypothesized that a greater number of citations would be found for high-quality clinical studies.

Methods: We searched the Web of Knowledge database for the 50 most-cited articles about SA and collected author name, publication year, country of origin, journal, article type, level of evidence (LoE), subject of paper, type of arthroplasty and metrics (number of citations and citation rate). Coleman Methodology Score (CMS) was computed for clinical articles. Statistical analysis of variance and correlation coefficients were used to investigate the relationship between different variables.

Results: Out of the selected 50 studies on SA, 26% were nonclinical. There were 15,393 citations overall (mean 307.8), with a mean 19.5 citations per year (range 48.3–6.7). Thirty or 60% of all articles were LoE IV. All studies were published between 1984 and 2011 in 8 journals. Reverse SA (RSA) was the most common subject (36% of studies). The United States was the country responsible for most contributions (50% of studies). CMS ranged from 81 to 38 (mean 59.6). RSA received the highest number of citations ($P < .001$), independently from country of origin ($P = .137$) and LoE ($P = .723$). CMS correlated with citation rate ($r = 0.397$; $P = .013$) and publication year ($\tau = 0.397$; $P = .013$), but not with LoE ($P = .204$).

Conclusion: In SA literature, citation rate positively correlates with methodological quality of a study, independently from publication country and LoE. Among most-cited papers, RSA is the most common standalone subject.

Keywords

Analysis, shoulder arthroplasty, bibliometric

Received 8 August 2023; Revised received 24 November 2023; accepted 11 December 2023

Introduction

Shoulder arthroplasty (SA) has become a commonly performed procedure over the last 2 decades,¹ mainly due to the advancements in implant designs and to the increased number of indications. However, there is still an open debate about surgical indications and techniques.² This may be a direct consequence of the paucity of high level of evidence (LoE) studies in the SA literature. In 2020, a Cochrane review, focused on SA for osteoarthritis, concluded stating that: “no high-quality randomized trials have been conducted to determine whether shoulder replacement might be more effective than other treatments for osteoarthritis or rotator cuff tear arthropathy of the shoulder.” Moreover, the use of shoulder prosthesis for the treatment of proximal humerus fractures has been questioned by prospective

randomized controlled trials comparing conservative and surgical treatment.³ On a general note, the number of peer-reviewed citations has broadly been considered as a proxy of the intellectual influence of an article, and it has become one of most important bibliometric instruments to assess the performance of academics,⁴ institutes and journals.⁵ However, it should be emphasized that a few studies have demonstrated that the number of citations is

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often not correlated to the quality of studies.^{6,7} This means that there is a risk that opinion leadership from a few influential professionals might guide physicians in their decision-making more than high-level studies. What is more, a “citation bias,” recently defined by Higgins et al⁸ as a citation (or noncitation) which is related to the nature and direction of the results rather than the scientific quality of a manuscript, might strongly influence the number of citations of a study with chances that even articles of poor methodology could be highly cited.

To the best of our knowledge, the assessment of the quality of the most cited studies about SA has never been performed so far. In this context, our aim was to review the literature about SA in order to correlate the number of citations, the methodological characteristics, and the quality of most-cited articles in this field. We hypothesized that a greater number of citations would be found for high-quality clinical studies.

Materials and Methods

Study Selection

For this study, the Clarivate Analytics Web of Knowledge database was used to gather data and metrics. The literature search took place in December 2021. Journals from the portal “Journal Citations Report” were sorted by the number of total citations possessed by each journal under the category “Orthopedics.” Each single journal was then screened.

Search Strategy

The final Boolean search phrase was: [(shoulder) AND (prosthesis OR arthroplasty OR replacement) AND (shoulder prosthesis OR shoulder arthroplasty OR shoulder replacement)]. There were no date, language, journal, or country of origin restrictions. This resulted in a total of 15,462 articles. Articles that had SA as the focus of the study after a 2-step screening including title and abstract evaluation were included in the analysis, regardless of preoperative diagnosis or prosthetic type. If a study was unclear or if there was a question as to whether it should be excluded, the full article was obtained and reviewed by 2 independent authors (V.R. and A.G.) to ultimately decide on inclusion or exclusion.

Study Assessment and Data Extraction

The 50 studies with the highest number of citations that met the inclusion criteria were included in the analysis. These 50 studies were reviewed to obtain the following information: Author name, publication year, country of origin, journal name, subject of the article (basic science, therapeutic, prognostic, diagnostic, economic, nonclinical), study type (expert opinion, epidemiology prevalence study, review article, descriptive study, case report, case series, case-control

study, cohort study, randomized controlled trial), and the LoE for clinical articles based on the guidelines of first-quartile journals.⁹

We included Clinical and Nonclinical studies, such as reviews and metaanalysis of literature, basic science studies and expert opinions. Reviews with no systematic approach were classified as “Expert opinion.” Meta-analyses and systematic reviews were classified as “Review.” The type of procedure was recorded as hemiarthroplasty, total SA (TSA), reverse SA (RSA), whether being the only surgical procedure described or combined (Es. TSA, TSA + RSA ecc). The citation density, calculated as the number of citations per year since publication, was computed for each of the 50 studies and recorded. The Coleman Methodology Score (CMS, Figure 1) was calculated for clinical studies to assess methodological quality of such articles included in our analysis: that applied to 37 papers out of the 50.¹⁰⁻⁴⁶ The authors are not aware of any validated methodological quality score that could be used for nonclinical papers, given the extremely heterogeneous variables and outcomes included in those 13 studies, so they were not considered in quality assessment.

Statistical Analysis

The association between article metrics (Citation Density index and CMS) and the country of origin of the study, the LoE and the type of implant was based on the Kruskal–Wallis nonparametric analysis of variance followed by pairwise Mann–Whitney *U*-test for independent samples, without correction for multiplicity. Correlation between article metrics was based on the Spearman coefficient while the relationship between citation density and year of publication was assessed using the nonparametric Kendall’s tau correlation coefficient. A *P* value of .05 was set to define significance. The statistical analysis was performed using Xsoftware.

Results

Results of the Search

The 50 most-cited articles on SA are shown in Table 1 and were published in 8 journals.

The “*Journal of Bone and Joint Surgery—American Volume*” published 20 (40%) papers, followed by the “*Journal of Shoulder and Elbow Surgery*” which published 19 (38%) articles. The “*Clinical Orthopaedics and Related Research* (CORR)” and the “*Journal of Bone and Joint Surgery—British Volume*” each featured 4 and 3 papers, respectively, while “*Clinical Biomechanics*”, the “*Journal of the American Academy of Orthopaedic Surgeons*,” “*Orthopaedics & Traumatology—Surgery & Research*” and “*Orthopedics*” each released 1 article of the list. All papers were published between 1984 to 2011, but only 4 articles were found between 1990 and 2000. Conversely, the decade with the highest number of publications was 2001

Criterion	Category	
Part A: Only one score to be given for each of the seven sections		
1. Study size number of hip (N)	<20	0
	20–40	4
	41–60	7
	>60	10
2. Mean follow-up (months)	<6	0
	6–12	2
	>12	5
3. Number of different surgical procedures	Not stated, unclear, or <90% of subjects receiving same procedure	0
	More than one surgical procedure, but >90% of subjects receiving the one procedure	7
4. Type of study	One surgical procedure used	10
	Retrospective cohort study	0
	Prospective cohort study	10
5. Description of indications/diagnosis	Randomized, controlled trial	15
	No	0
6. Descriptions of surgical technique	Yes	5
	Inadequate (not stated, unclear)	0
	Fair (technique only stated)	5
7. Descriptions of postoperative rehabilitation	Adequate (technique stated, details of surgical procedure given)	10
	Inadequate (not stated, unclear)	0
	Fair (technique only stated)	3
	Adequate (technique stated, details of rehabilitation process)	5
Part B: Scores may be given for each option in each of the three sections if applicable		
1. Outcome criteria	Outcome measures clearly defined	2
	Timing of outcome assessment clearly stated	2
	Use of outcome criteria that has reported reliability	3
	General health measure included	3
2. Procedure of assessing outcomes	Subjects recruited	5
	Investigator independent of surgeon	4
	Written assessment	3
	Completion of assessment by patients themselves with minimal investigator assistance	3
3. Description of subject selection process	Selection criteria reported and unbiased	5
	Recruitment rate reported: >80%	5
	Recruitment rate reported: <80%	3
	Eligible subjects not included in the study satisfactorily accounted for or 100% recruitment	5

Figure 1. The Coleman Methodology Score sheet used to evaluate clinical papers.

to 2010 with 37 papers being published. As for the decade 2010 to 2020, 5 articles were published in the year 2011 and represent the totality of the papers published this range of years. In total, 6 papers were written before the year 2000, in the 2 decades between 1980 and 2000. The authors most frequently involved in these papers were Pascal Boileau (6 times as first author and 3 times as co-author) and Gilles Walch (author or co-author in 8 papers), both from France. The most investigated procedure was RSA by itself (18 studies), TSA (Anatomic) 9 times

and hemiarthroplasty alone 4 times. All 3 types of procedures were mentioned in the same article 3 times, Anatomic and Hemiarthroplasty were the subject of analysis together 12 times. We conducted an analysis of the indication for which arthroplasty—whether hemi, total or reverse—had been used as therapeutic mean. The indications for surgery have been depicted in Figure 2.

In total, 23 times the operation had been performed as elective surgery. Trauma was the only etiology in 7 papers, while both elective and trauma surgery were considered in 18 articles.

Bibliometric Analysis

The number of citations ranged from 788 to 181 (mean 307.8) for a total of 15,393 citations.

The Citation Density calculated for each article ranged from 48.3¹ to 6.7 citations per year,²⁶ with a mean of 19.5 citations per year. Articles originated from 8 countries, with the United States of America having the most contributions (25), followed by France (14), Switzerland (4), Netherlands (2), Austria, Canada, England and Germany (1) (Table 2.).

The mean number of citations for Level I articles (6) was 281.5 (range, 445-186), while it was 302.8 (range, 577-200) for Level II articles (5), 271.3 (range, 306-239) for Level III articles (3) times and 308.9 (range, 788-181) for Level IV articles (30). The only paper with an LoE of V⁴⁷ was cited 559 times.

The mean CMS score for clinical studies (37 articles) was 59.60 values,⁵⁹ ranging from 81 to 38.

A significant difference was observed in Citation Density when stratifying articles with respect to the type of implant ($P < .001$) (Figure 3.).

In particular, articles describing RSA showed a significantly higher CD than those describing ASA ($P < .001$) or both Anatomic and Hemi arthroplasty ($P = .003$). No difference was observed based on the country of origin and the LoE ($P = .137$ and $.723$, respectively) (Figures 4 and 5).

The CMS did not show any significant association with the LoE ($P = .204$) (Figure 6).

The Citation Density showed a significant moderate correlation with the CMS (Pearson $r = 0.397$; $P = .013$) and with the year of publication (Kendall's tau = 0.397; $P = .013$) (Figure 7a & b.), indicating that more recent articles tend to be cited more in a shorter amount of time after the publication date.

Discussion

Compared with similar topics in other specialties, SA has fewer mean citations in scientific publications. Holzer and Hozler⁵⁸ published a list of the 50 highest cited papers on hip and knee arthroplasty with a mean citation number of 550 citations (ranging from 2495 to 347), even though

Table 1. The List of the Resulting 50 Articles From our Search that met Inclusion Criteria, Their Authors, Journals and the Respective Number of Citations.¹⁰⁻⁵⁷.

Rank	Authors (First/last)	Article	Journal	No. of citations
1	Sirveaux F/Mole D.	Grammont inverted total shoulder arthroplasty in the treatment of glenohumeral osteoarthritis with massive rupture of the cuff—Results of a multicentre study of 80 shoulders	<i>JBJS -BRITISH VOLUME (2004)</i>	788
2	Werner C.M.L./ Gerber, C	Treatment of painful pseudoparesis due to irreparable rotator cuff dysfunction with the delta III reverse-ball-and-socket total shoulder prosthesis	<i>JBJS—AMERICAN VOLUME (2005)</i>	592
3	Wall B./Walsh G.	Reverse total shoulder arthroplasty: A review of results according to etiology	<i>JBJS—AMERICAN VOLUME (2007)</i>	577
4	Boileau P./Hovorka I.	Neer Award 2005: The Grammont reverse shoulder prosthesis: Results in cuff tear arthritis, fracture sequelae, and revision arthroplasty	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2006)</i>	572
5	Boileau P./Balg F.	Grammont reverse prosthesis: Design, rationale, and biomechanics	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2005)</i>	559
6	Frankle M./Vasey M.	The reverse shoulder prosthesis for glenohumeral arthritis associated with severe rotator cuff deficiency —A minimum 2-year follow-up study of 60 patients	<i>JBJS—AMERICAN VOLUME (2005)</i>	514
7	Kim S.H./Szabo R.M.	Increasing incidence of shoulder arthroplasty in the United States	<i>JBJS—AMERICAN VOLUME (2011)</i>	483
8	Bohsali K. I./ Rockwood Jr C. A.	Complications of total shoulder arthroplasty	<i>JBJS—AMERICAN VOLUME (2006)</i>	445
9	Guery, J./Walch G.	Reverse total shoulder arthroplasty—survivorship analysis of 80 replacements followed for 5 to 10 years	<i>JBJS—AMERICAN VOLUME (2006)</i>	430
10	Torchia, M.E./ Settergren, C.R.	Total shoulder arthroplasty with the Neer prosthesis: Long-term results	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (1997)</i>	427
11	Nagels, J./Roizing PM	Stress shielding and bone resorption in shoulder arthroplasty	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2003)</i>	422
12	Cofield, R. H.	Total shoulder arthroplasty with the Neer prosthesis.	<i>JBJS—AMERICAN VOLUME (1984)</i>	415
13	Boileau P./Mole D.	Tuberosity malposition and migration: Reasons for poor outcomes after hemiarthroplasty for displaced fractures of the proximal humerus	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2002)</i>	391
14	Zumstein, M.A./ Boileau P.	Problems, complications, reoperations, and revisions in reverse total shoulder arthroplasty: A systematic review	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2011)</i>	359
15	Day, J. S./Kurtz S. M.	Prevalence and projections of total shoulder and elbow arthroplasty in the United States to 2015	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2010)</i>	357
16	Wirth M.A./ Rockwood C.A.	Complications of total shoulder-replacement arthroplasty	<i>JBJS—AMERICAN VOLUME (1996)</i>	332
17	Cuff D./Frankle M.	Reverse shoulder arthroplasty for the treatment of rotator cuff deficiency	<i>JBJS—AMERICAN VOLUME (2008)</i>	311
18	Sperling J.W./ Rowland C.M.	Neer hemiarthroplasty and neer total shoulder arthroplasty in patients fifty years old or less— Long-term results	<i>JBJS—AMERICAN VOLUME (1998)</i>	306
19	Barrett W.P./ Matsen F.A.	Total shoulder arthroplasty	<i>JBJS—AMERICAN VOLUME (1987)</i>	297
20	Bufoquin T./Massin, P.	Reverse shoulder arthroplasty for the treatment of 3- and 4-part fractures of the proximal humerus in the elderly —A prospective review of 43 cases with a short-term follow-up	<i>JBJS—BRITISH VOLUME (2007)</i>	288
21	Simovitch, R. W./ Gerber C.	Predictors of scapular notching in patients managed with the Delta III reverse total shoulder replacement	<i>JBJS—AMERICAN VOLUME (2007)</i>	279
22	Sperling, J.W./ Rowland C.M.	Minimum fifteen-year follow-up of Neer hemiarthroplasty and total shoulder arthroplasty in patients aged fifty years or younger	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2004)</i>	269

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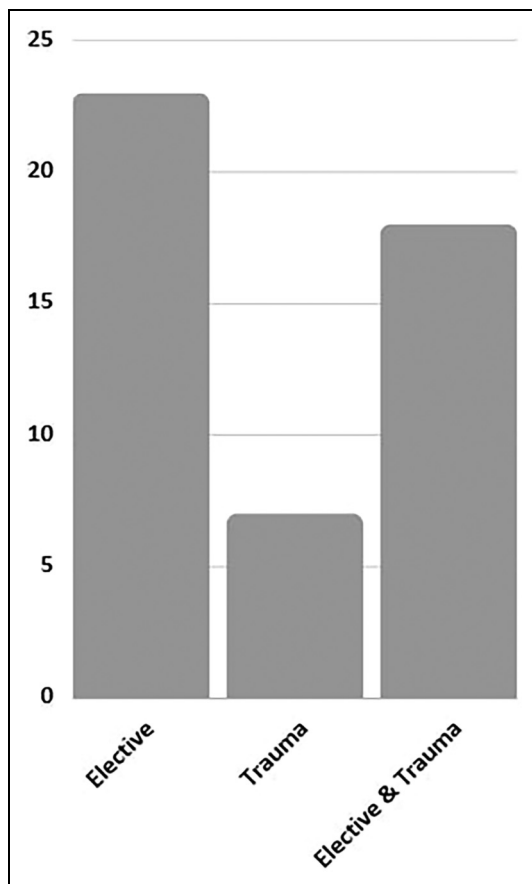
Table 1. Continued.

Rank	Authors (First/last)	Article	Journal	No. of citations
23	Amstutz H.C./ Clarke I.C.	UCLA anatomic total shoulder arthroplasty.	<i>CORR (1981)</i>	266
24	Robinson C.M./ Wakefield A.E.	Primary hemiarthroplasty for treatment of proximal humeral fractures	<i>JBJS—AMERICAN VOLUME (2003)</i>	256
25	Levigne C./Walch G.	Scapular notching in reverse shoulder arthroplasty	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2008)</i>	255
26	Gartsman G.M./ Hammerman S.M.	Shoulder arthroplasty with or without resurfacing of the glenoid in patients who have osteoarthritis	<i>JBJS—AMERICAN VOLUME (2000)</i>	249
27	Norris T.R./ Iannotti J.P.	Functional outcome after shoulder arthroplasty for primary osteoarthritis: A multicenter study	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2002)</i>	249
28	Mulieri P./Frankle M.	Reverse shoulder arthroplasty for the treatment of irreparable rotator cuff tear without glenohumeral arthritis	<i>JBJS—AMERICAN VOLUME (2010)</i>	243
29	Iannotti, JP/Norris T.R.	Influence of preoperative factors on outcome of shoulder arthroplasty for glenohumeral osteoarthritis	<i>JBJS—AMERICAN VOLUME (2003)</i>	241
30	Sperling J.W./ Cofield R.H.	Infection after shoulder arthroplasty	<i>CORR (2001)</i>	239
31	Lazarus M.D./ Matsen, F.A.	The radiographic evaluation of keeled and pegged glenoid component insertion	<i>JBJS—AMERICAN VOLUME (2002)</i>	228
32	Rittmeister M./ Kerschbaumer F.	Grammont reverse total shoulder arthroplasty in patients with rheumatoid arthritis and nonreconstructible rotator cuff lesions	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2001)</i>	225
33	Deshmukh A.V./ Thornhill T.S.	Total shoulder arthroplasty: Long-term survivorship, functional outcome, and quality of life	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2005)</i>	215
34	Bryant D./Kirkley A.	A comparison of pain, strength, range of motion, and functional outcomes after hemiarthroplasty and total shoulder arthroplasty in patients with osteoarthritis of the shoulder—A systematic review and meta-analysis	<i>JBJS—AMERICAN VOLUME (2005)</i>	209
35	Edwards T.B./ Walch G.	A comparison of hemiarthroplasty and total shoulder arthroplasty in the treatment of primary glenohumeral osteoarthritis: Results of a multicenter study	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2003)</i>	209
36	Levy J./Pupello D.	The use of the reverse shoulder prosthesis for the treatment of failed hemiarthroplasty for proximal humeral fracture	<i>JBJS—AMERICAN VOLUME (2007)</i>	207
37	Kralinger F./Resch H.	Outcome after primary hemiarthroplasty for fracture of the head of the humerus—A retrospective multicentre study of 167 patients	<i>JBJS—BRITISH VOLUME (2004)</i>	205
38	Magermans D.J./ van der Helm	Requirements for upper extremity motions during activities of daily living	<i>CLINICAL BIOMECHANICS (2005)</i>	202
39	Sperling J.W./ Rowland C.M.	Radiographic assessment of ingrowth total shoulder arthroplasty	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2000)</i>	201
40	Bell J.E./Tosteson A.N.A.	Trends and variation in incidence, surgical treatment, and repeat surgery of proximal humeral fractures in the elderly	<i>JBJS—AMERICAN VOLUME (2011)</i>	200
41	Gerber C./Richard W.	Reverse total shoulder arthroplasty	<i>JAAOS (2009)</i>	192
42	Boileau P./O'Shea K.	Bony increased-offset reversed shoulder arthroplasty: minimizing scapular impingement while maximizing glenoid fixation	<i>CORR (2011)</i>	191
43	Gallinet, D./Obert, L.	Three or 4 parts complex proximal humerus fractures: Hemiarthroplasty versus reverse prosthesis: A comparative study of 40 cases	<i>ORTHOPAEDICS & TRAUMATOLOGY-SURGERY & RESEARCH (2009)</i>	191
44	Dodson C.C./ Warren F.	Propionibacterium acnes infection after shoulder arthroplasty: A diagnostic challenge	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2010)</i>	190

(continued)

Table 1. Continued.

Rank	Authors (First/last)	Article	Journal	No. of citations
45	Hasan SS/Matsen F.A.	Characteristics of unsatisfactory shoulder arthroplasties	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2002)</i>	189
46	Favard L./Mole D.	Reverse prostheses in arthropathies with cuff tear: are survivorship and function maintained over time?	<i>CORR (2011)</i>	188
47	Farron A./Buechler P.	Risks of loosening of a prosthetic glenoid implanted in retroversion	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2006)</i>	187
48	Boileau P./Mole D.	Cemented polyethylene versus uncemented metal-backed glenoid components in total shoulder arthroplasty: A prospective, double-blind, randomized study	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2002)</i>	186
49	Boileau P./Sinnerton R.	Shoulder arthroplasty for the treatment of the sequelae of fractures of the proximal humerus	<i>JOURNAL OF SHOULDER AND ELBOW SURGERY (2001)</i>	186
50	Boulahia A./ Baratta R.V.	Early results of a reverse design prosthesis in the treatment of arthritis of the shoulder in elderly patients with a large rotator cuff tear	<i>ORTHOPEDICS (2002)</i>	181

**Figure 2.** Indication for arthroplasty in the selected articles and the respective number of papers.

from the date of publication of this paper the sheer number of published articles on the subject greatly increased.⁵⁹ For instance, on hip arthroplasty alone Zhang et al⁶⁰ found in a

Table 2. Number of Most Cited Articles in the List Published per Country of Origin.

Country of origin	No. of top-cited journals
USA	25
France	15
Switzerland	4
Netherlands	2
Austria	1
Canada	1
England	1
Germany	1

similar bibliometric analysis a mean of 312 citations overall (ranging from 994 to 191) in a selection of the 100 most cited papers, recently in 2019.

Noticeably, most papers on the list came from the journal with the highest impact factor to date among the 8 journals involved, the *JBJS American Volume* (5.284 in 2020), while the second on the list for most papers included, the *JSES*, with just 1 less article, is not the second-ranked based on impact factor. We think this may be due to the highly specialized themes of this journal. Overall, 39 papers on 50 came from these 2 journals. *CORR*, second-highest journal based on impact factor to date, came in third for the number of articles: this may be due to the fact that most articles are dated in the years between 2001 and 2010, and at that time this same journal had an Impact factor of max 2.5 points, steadily increasing during the following years.

Also, to correlate the dates of publishing of articles regarding certain prosthesis models may give us an idea of the trends in SA literature: anatomic prosthesis and hemiarthroplasty tend to concentrate in early 2000s, while reverse arthroplasty with and without other types of implants seems to be a main theme in late 2000s.

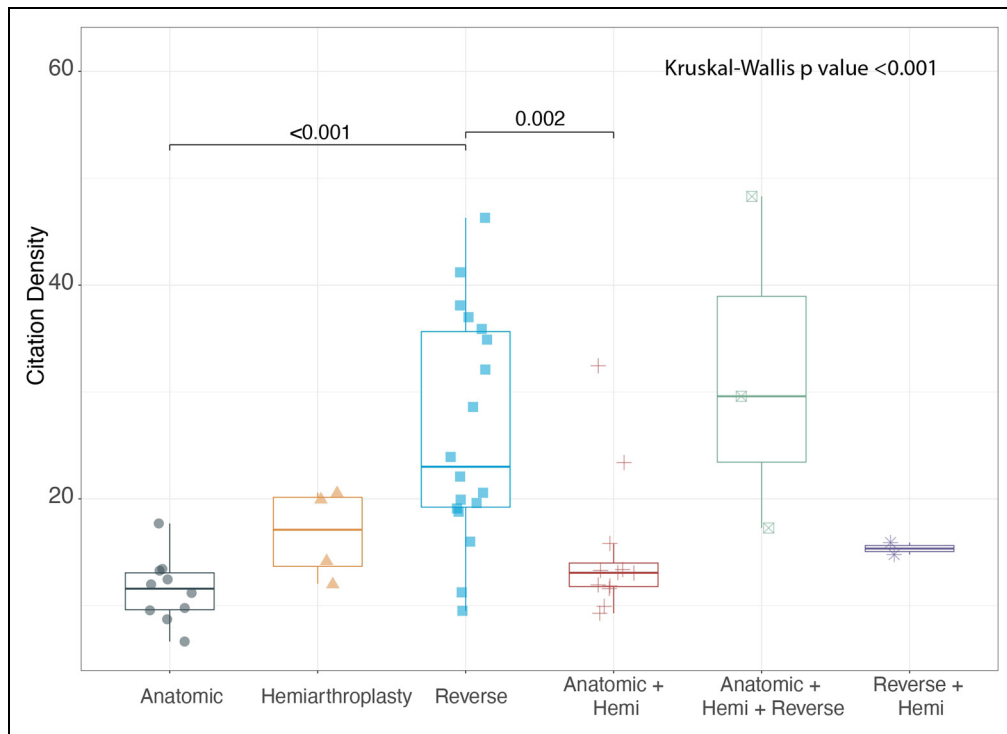


Figure 3. Correlation between type of prosthesis object of the paper and citation density showing significance toward reverse shoulder arthroplasty (RSA)-only papers ($P < .001$).

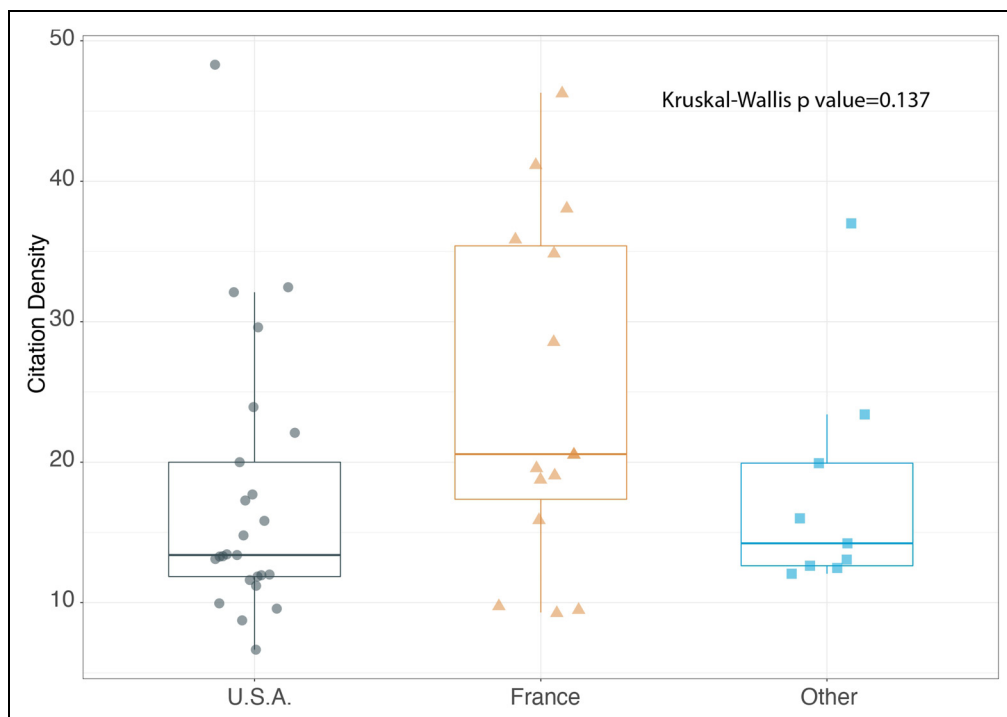


Figure 4. Correlation between country of origin of the article and citation density is nonsignificant ($P = .137$).

Moreover, looking into the evidence levels in light of the quality assessment using the CMS can give us interesting informations on the fact that level 4 papers, in addition to

being the vast majority, tend to have low mean methodological quality, and with the rising of the evidence level the mean methodological quality tends to rise, even though this data

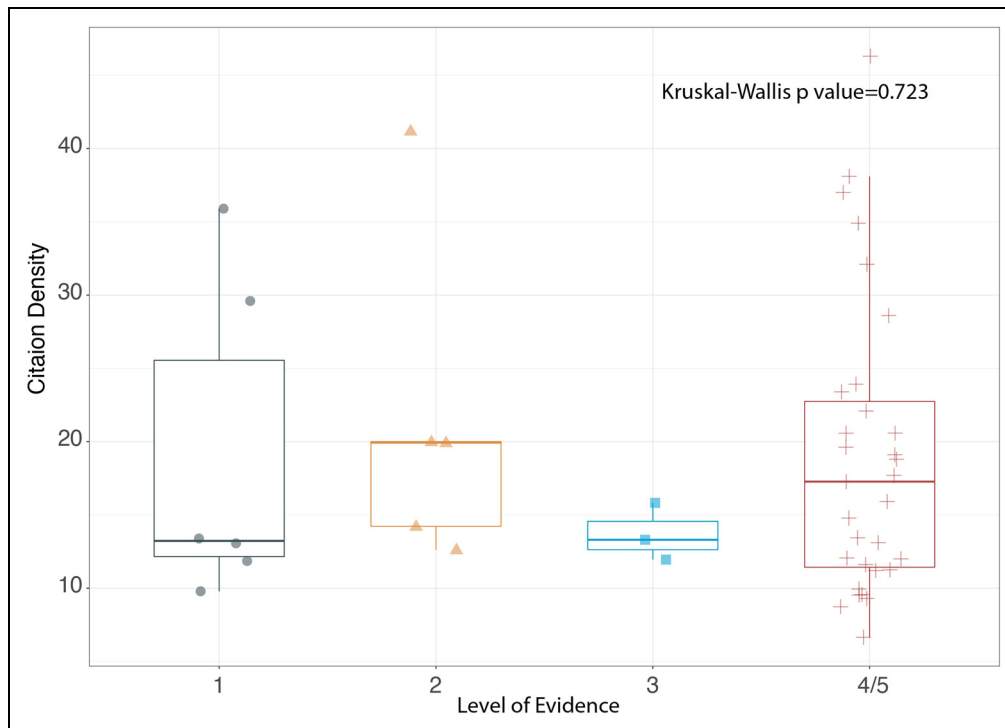


Figure 5. Correlation between level of evidence (LoE) and citation density is nonsignificant ($P = .723$).

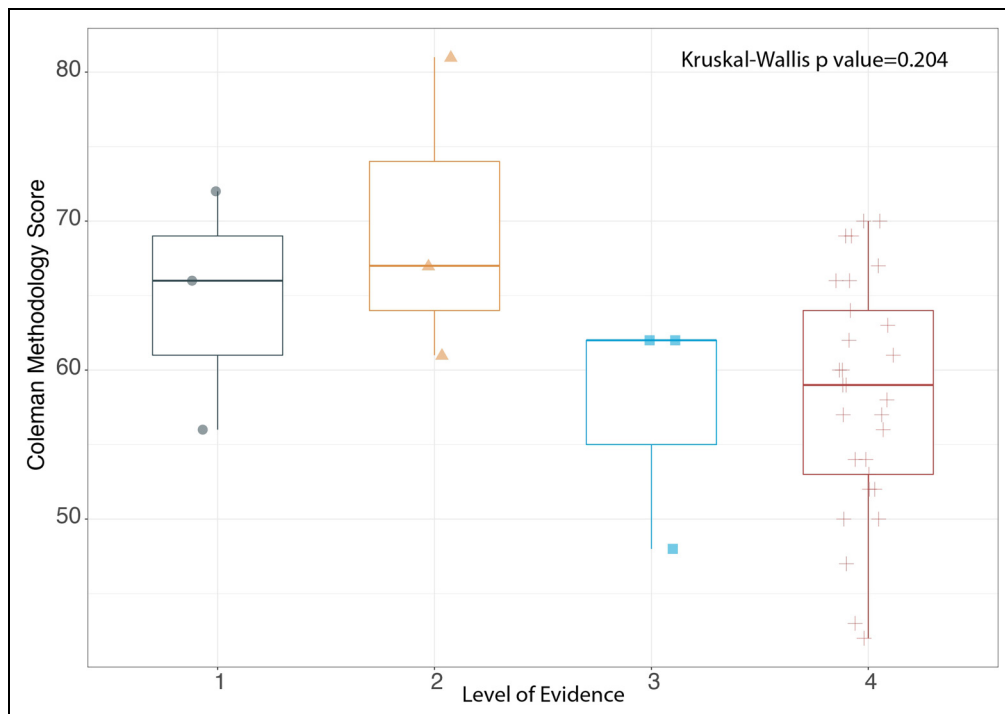


Figure 6. Correlation between LoE and CMS of the articles in the selection is nonsignificant ($P = .204$). Abbreviations: LoE, level of evidence; CMS, Coleman Methodology Score.

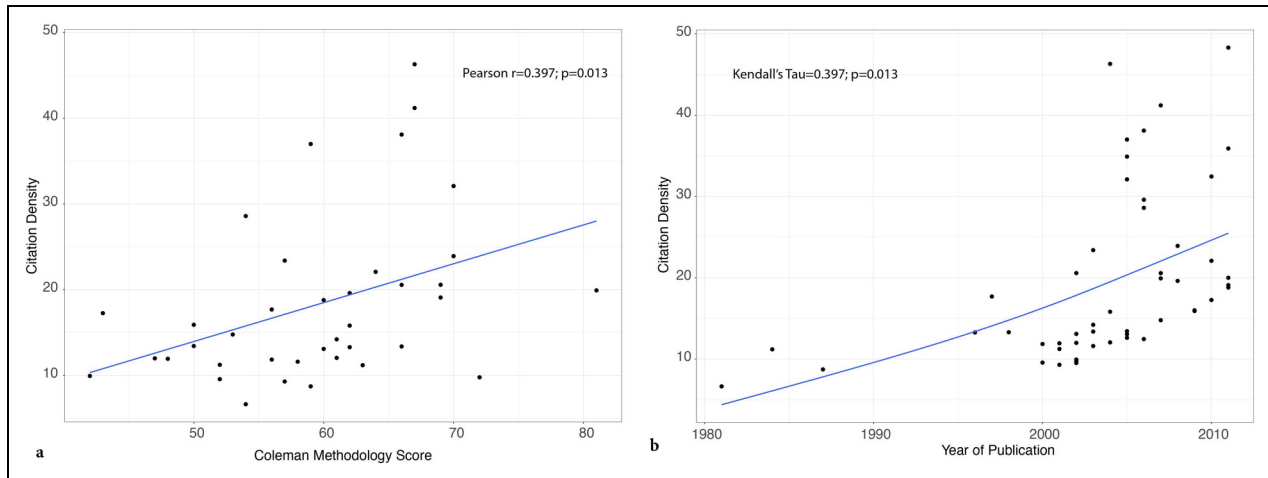


Figure 7. Correlation between the citation density and the Coleman Methodology Score (CMS) (a) and year of publication (b) of the articles in the selection has been proven significant, suggesting that most recent articles and better methodology present a higher number of citations.

didn't show statistical significance due to the quantitative difference in favor of LoE IV articles.

Nonetheless, papers on the upper-side of the methodological value-curve also tend to get more citations, but with numerous exceptions: probably because of a widespread tendency to quote “opinion leaders” in shoulder-surgery-themed scientific literature, with a less rigorous look at the actual scientific accuracy of said papers. For instance, when cross-checked with the renown Cochrane library selection on 2 recent reviews and meta-analyses on elective SA² and the treatment of proximal humerus fracture,⁶¹ we were able to find only 2 papers^{29,46} that were included both in our citations-guided list and in the elective arthroplasty review. And, even though included as highly relevant from a clinical perspective, both were judged as heavily biased for several reasons (unclear how well and how long participants were blinded; high risk of bias for physician-evaluated outcomes; incomplete outcome data; unclear risk of bias due to selective reporting; major baseline imbalance for patients included). Lastly, the fact that up to 26% of the articles in the 50 most cited about SA explore nonclinical aspects of the matter at hand, should highlight how some papers defining core concepts keep being cited even in most recent years, despite not putting the spotlight on the clinical outcome.

Limitations

This study has several limitations. The identification of the 50 most cited papers, even if based on well-defined criteria, remains a challenging selection. Therefore, important and influential papers with lower citation frequencies may have been overlooked. In some cases, the value of the contribution to the subject cannot be quantified by the number of citations. The number of citations of articles may be influenced by

various factors and does not necessarily reflect the importance of the research performed or published, nor does it directly translate into changes in clinical practice. The methodological assessment by CMS couldn't be applied to all the papers included, given the nonclinical nature of some of them. The search was conducted on the Thomson ISI Web of Science®, therefore citations of articles from other sources such as textbooks, lectures, or digital media, could not be included.

To conduct a statistical analysis given these nonordinal variables is challenging and different testing may lead to different conclusions.

Conclusions

Statistical evidence demonstrates a positive association between the methodological quality of an article addressing SA and the amount of citations that the study receives over time, regardless of the publication country or the LoE. Intriguingly, many nonclinical studies continue to be cited, whereas the vast majority of clinically influential articles are level IV papers. The high ratio of basic science to clinical data and the low evidence level of those clinical studies indicate the need for additional randomized clinical trials to be conducted in the field of SA research, or should at least suggest that level I and II papers have a difficult time garnering attention in this field.


Declaration of Conflicting Interests


The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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