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Top 50 cited journal articles on overhead throwing athletes: a bibliographic analysis

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Background: The frequency of citations for a journal article is a reflection of its academic impact. The purpose of this study was to identify and characterize the top 50 cited journal articles related to overhead throwing athletes in the published literature.

Methods: The Web of Science database was searched on January 18, 2016, using the terms "throwing athlete," "baseball," and "pitcher" to identify the top 50 cited articles related to overhead throwing athletes using the all-database function. The type of study, country of origin, publishing journal, and year published were reviewed for each article.

Results: The top 50 articles identified were cited between 95 and 471 times and were published in 13 journals between 1969 and 2011. Most of the articles were small case series or nonsystematic literature reviews. The shoulder was the most common body region studied in the top 50 articles (33 of 50 [66%]). Among original studies (n = 43), there was a good representation of surgical management of shoulder and elbow pathology in overhead athletes (9 of 43 [20.9%]); however, most of the articles reported on shoulder and elbow kinematics (19 of 43 [44.2%]) and pathoanatomy (15 of 43 [34.9%]).

Conclusion: The greater prevalence of nonsurgical articles may reflect a continued effort to better understand the different pathologies specific to overhead throwing athletes. An understanding of the variable content and quality of frequently cited articles on overhead throwing athletes may serve as a stepping stone for future studies to advance the diagnosis and management of complex elbow and shoulder injuries in these high functional individuals.

The number of times a journal article is cited serves as a measurement of the influence of that publication in a specific field. In 2002, Paladugu et al,[72] published the "One hundred citation classics in general surgical journals" to identify seminal contributions in general surgery. Inspired by Paladugu et al, multiple specialties have initiated similar publications, including the publications by Lefaivre et al[55] and Kelly et al[48] in orthopedic surgery. A number of subspecialties within orthopedics have published similar "top cited" or "classic papers" studies, including pediatrics,[8,47] hip and knee arthroplasty,[41] arthroscopy,[19] hip arthroscopy,[53] shoulder surgery,[67] elbow surgery,[43] knee research,[1] foot and ankle,[9,26] spine surgery,[64,87,90,100] sports medicine,[69] fracture surgery,[7] and hand surgery.[46,98] Specific journals have also published findings on their own top cited articles.[24,29,54,60,61] The number of times an article is cited is not the only way to determine its true importance or impact in a field, but it does help identify "classic" articles relevant to orthopedic knowledge and training and may serve as a way to gauge the focus of interest within a given specialty over a period of time.

In sports medicine, particularly in the field of shoulder and elbow surgery, the pathology and treatment associated with overhead throwing athletes is of great interest. Major advances have occurred in the diagnosis and management of shoulder and elbow pathology in throwing athletes in the past decade.[27,32,51,63,79,84,86,88] This is likely related to a combination of improvement in diagnostic and surgical technology and greater understanding of shoulder and elbow mechanics and pathoanatomy. As the niche for specialized care in high-level overhead throwing athletes continues to expand, identifying the top cited articles in the field provides a concise list of published articles that may serve as a stepping stone for ongoing and future research aimed at improving outcomes in complex pathologies common in overhead throwing athletes. The purpose of this study was to identify and characterize the top 50 cited journal articles related to overhead throwing athletes in the published literature.

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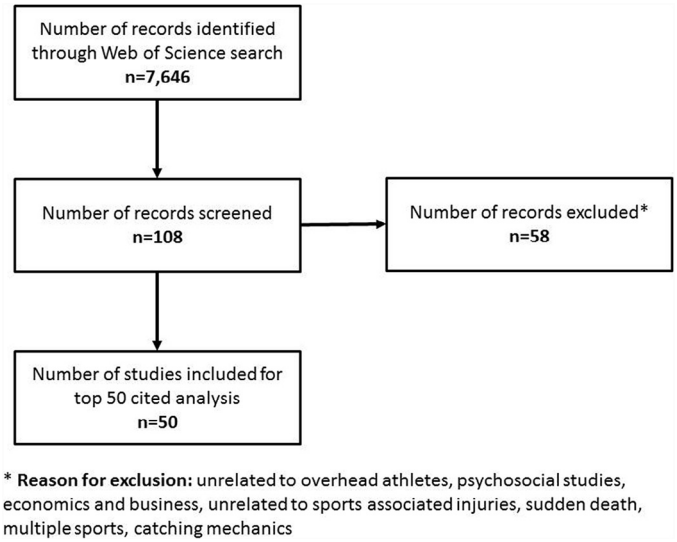

Figure 1 Flow diagram demonstrates the literature search results.

Table I
Summary of bibliographic parameters

Number of citations	95 to 471
Citation density*	2.9 to 26.9
Year of publication	1969 to 2011
Authors, No.	**Total: 142** Per study range: 1 to 11
Countries, No.	**Total: 4** USA:47 Belgium: 1 Taiwan: 1 Germany: 1
Body region	Shoulder: 33 - Specific to scapula: 4 Elbow: 12 - Specific to MCL injury: 7 Shoulder and Elbow: 5
Study topic	Biomechanics: 19 Pathoanatomy: 15 Surgical Management: 9 Non-systematic review: 7
Level of evidence of clinical studies (n = 18)	II—16.7% III—22.2% IV—61.1%
Sample size	3 to 476

MCL, medial collateral ligament of elbow.
* Number of citations/years since publication.

Materials and methods

The Web of Science (formerly Web of Knowledge) database was used to search for all studies of overhead throwing athletes using the search terms "throwing athletes," "pitchers," and "baseball." Between 1945 and 2017, 5538 journal articles from 58 countries and 13,711 authors met the search criteria without restrictions in the type or specialty or journal articles. Previous studies have demonstrated that an all-database search represents a more in-depth methodology of determining the true citation ranking of articles when using this database.[19]

Results were ranked by number of citations and screened for studies related to overhead throwing mechanics, upper extremity anatomy, and injuries and surgical interventions in overhead throwing athletes. Excluded were studies associated with nonoverhead sports (rugby, football [soccer]) or nonthrowing baseball studies (batting mechanics and catching), psychological or cognitive evaluations, economic analysis, and sudden death, among others (Fig. 1).

All selected journal articles were reviewed and analyzed according to the type of article (basic science, clinical, or review), topic (pathology/injury, surgical management, nonsurgical management, or biomechanical/kinetic study), body region (shoulder, elbow, or other), authorship, country of origin, publishing journal, and year of publication. Clinical studies were further analyzed by the level of evidence based on guidelines adapted by *The Journal of Bone and Joint Surgery* from the Oxford Center for Evidence-Based Medicine 2011 Working Group.[92] Lastly, articles in the top 50 were assessed for citation density, defined as the number of times cited divided by number of years since publication.[67]

Results

The top 50 cited articles in the present study were published between 1969 and 2006 in 13 journals, from 4 countries, and by 142 authors (Table I). The top article, by Fleisig et al,[34] was cited 475 times, and the 50th article, by Reinold et al, [79] was cited 98 times. Taken together, the top 50 articles were cited an average of 170 times and accounted for 8557 citations in the literature. The oldest article was published in 1969 by King et al, [49] and the most recent article was published in 2011 by Wilk et al. [98] Half of the articles were published on or after 2000 (Table II).

There were 43 original articles[4-6,10-13,17,18,22,23,25,28,30,34,35,37,39,42,44,45,50,57,58,65,66,70,71,73-76,78,80,82,85,95-97,99,102,103,105] and 7 review papers,[15,16,36,49,52,62,106] and 33 of 50 (66%) focused on the shoulder (Table I). Among 18 clinical studies (36%), the level of evidence ranged from II to IV, and sample size ranged from 23 to 476. The predominant type of study was case series, followed by retrospective case-control studies and no randomized prospective studies. Only 1 study reported on nonbaseball players (ie, handball).[76] When divided by topic, 19 of the original 43 studies (44.2%) reported on shoulder (15 of 19 [78.9%]) and elbow (4 of 19 [21.1%]) biomechanics and kinematics. Interestingly, 3 studies specifically examined scapular kinematic. Studies reporting on pathoanatomy (15 of 43 [34.9%]) were also prevalent, particularly on the shoulder (9 of 15 [60.0%]). Very few publications (9 of 50 [18%]) studied surgical management of a specific shoulder (3 of 50 [6%]) or elbow (6 of 50 [12%]) pathology, and there were no studies regarding nonsurgical or conservative management of injuries.

All review papers were nonsystematic narrative or current concepts reviews. Only 1 review discussed common elbow pathologies and included both surgical and nonsurgical treatment options.[16] The remaining 6 reviews reported on the shoulder, among which 4 focused on the biomechanics, pathoanatomy, and classification of shoulder injuries in throwing athletes. The top cited review, which ranked number 2 in the top 50, focused specifically on the role of scapula kinematics in shoulder pathology.[49] Only 2 reviews highlighted the management of shoulder pathology. The review by Kvitne and Jobe[52] specifically discussed surgical options for anterior shoulder instability in throwing athletes. In contrast, Wilk et al,[106] reported on the evidence of structured rehabilitation for the nonoperative management of several shoulder pathologies.

More than half of the papers (28 of 50 [56%]) were published in the *American Journal of Sports Medicine*, followed by *Journal of Bone and Joint Surgery* (4 of 50 [8%]; Table III). All but 3 articles originated from the United States. A total of 142 authors were listed; however, JR Andrews contributed to 19 of the top 50 articles (38%) in these studies.

Citation density ranged from 2.94 to 26.93. The top 3 studies with the highest citation density correlated with the top 3 most cited papers; however, the study with the fourth highest citation density ranked 49th on the total citation list.[105] Among those with citation density greater than 10 (17 of 50 [34.0%]), only 1 discussed

Table II
List of top 50 cited articles in overhead throwing athletes

Rank	Authors	Title	Journal	Year	Citations, No.	Citation density
1	Fleisig GS Andrews JR Dillman CJ	Kinetics of baseball pitching with implications about injury mechanisms	*Am J Sports Med*	1995	471	21.4
2	Kibler WB	The role of the scapula in athletic shoulder function	*Am J Sports Med*	1998	404	21.3
3	Burkhart SS Morgan CD	The Disabled Throwing Shoulder: Spectrum of Pathology Part I: Pathoanatomy and Biomechanics	*Arthroscopy*	2003	377	26.9
4	Conway JE Jobe FW Glousman RE	Medial Instability of the Elbow in Throwing Athletes: Treatment By Repair or Reconstruction of the Ulnar Collateral Ligament	*J Bone Joint Surg Am*	1992	265	10.6
5	Altchek DW Warren RF Skyhar MJ	T-plasty modification of the Bankart procedure for multidirectional instability of the anterior and inferior types.	*J Bone Joint Surg Am*	1991	252	9.7
6	Crocket HC Gross LB Wilk KE Schwartz ML Reed J O'Mara J Reilly MT Dugas JR Meister K Lyman S	Osseous adaptation and range of motion at the glenohumeral joint in professional baseball pitchers	*Am J Sports Med*	2002	238	15.9
7	Wilk KE Meister K	Current Concepts in the Rehabilitation of the Overhead Throwing Athlete	*Am J Sports Med*	2002	233	15.5
8	Townsend H Jobe FW Pink M	Electromyographic analysis of the glenohumeral muscles during a baseball rehabilitation program	*Am J Sports Med*	1991	221	8.5
9	Dillman CJ Fleisig GS	Biomechanics of Pitching with Emphasis upon Shoulder Kinematics	*J Orthop Sports Phys Ther*	1993	219	9.1
10	Fleisig GS Barrentine SW Zheng N Escamilla RF	Kinematic and kinetic comparison of baseball pitching among various levels of development	*J Biomech*	1999	216	12.0
11	Jobe FW Giangarra CE Kvitne RS	Anterior capsulolabral reconstruction of the shoulder in athletes in overhand sports	*Am J Sports Med*	1991	216	8.3
12	Pappas AM Zawacki RM	Biomechanics of baseball pitching. A preliminary report.	*Am J Sports Med*	1985	209	6.5
13	Lyman S Fleisig GS Andrews JR	Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers	*Am J Sports Med*	2002	192	12.8
14	Brown LP Niehues SL Harrah A Yavorsky P	Upper extremity range of motion and isokinetic strength of the internal and external shoulder rotators in major league baseball players	*Am J Sports Med*	1988	190	6.6
15	Jobe CM	Posterior Superior Glenoid Impingement: Expanded Spectrum	*Arthroscopy*	1995	188	8.5
16	Bigliani LU Kurzweil PR Schwartzbach CC Wolfe IN	Inferior capsular shift procedure for anterior-inferior shoulder instability in athletes	*Am J Sports Med*	1994	185	8.0
17	Myers JB Laudner KG Pasquale MR Bradley JP	Glenohumeral Range of Motion Deficits and Posterior Shoulder Tightness in Throwers With Pathologic Internal Impingement	*Am J Sports Med*	2006	182	16.5
18	Bigliani LU Codd TP Connor PM Levine WN Littlefield MA	Shoulder motion and laxity in the professional baseball player	*Am J Sports Med*	1997	179	9.0
19	Fleisig GS Barrentine SW Escamilla RF	Biomechanics of overhand throwing with implications for injuries	*Sports Med*	1996	178	8.5
20	Reagan KM Meister K Horodyski MB Werner DW Carruthers C	Humeral retroversion and its relationship to glenohumeral rotation in the shoulder of college baseball players	*Am J Sports Med*	2002	172	11.5
21	Werner SL Fleisig GS Dillman CJ	Biomechanics of the Elbow During Baseball Pitching	*J Orthop Sports Phys Ther*	1993	170	7.1

(*continued on next page*)

Table II (*continued*)

Rank	Authors	Title	Journal	Year	Citations, No.	Citation density
22	Lyman S Fleisig GS Waterbor JW Funkhouser EM Pulley L Andrews JR Osinski ED	Longitudinal study of elbow and shoulder pain in youth baseball pitchers	*Med Sci Sports Exerc*	2001	160	10.0
23	Feltner M Dapena J	Dynamics of the Shoulder and Elbow Joints of the Throwing Arm during a Baseball Pitch	*Int J Sports Biomechanics*	1986	159	5.1
24	Olsen SJ Fleisig GS Dun S Loftice J	Risk factors for shoulder and elbow injuries in adolescent baseball pitchers	*Am J Sports Med*	2006	150	13.6
25	Cools AM Witvrouw EE Declercq GA Danneels LA	Scapular Muscle Recruitment Patterns: Trapezius Muscle Latency with and without Impingement Symptoms	*Am J Sports Med*	2003	148	10.6
26	Azar FM Andrews JR Wilk KE	Operative Treatment of Ulnar Collateral Ligament Injuries of the Elbow in Athletes	*Am J Sports Med*	2000	147	8.6
27	Timmerman LA Schwartz ML	Preoperative Evaluation of the Ulnar Collateral Ligament by Magnetic-Resonance-Imaging and Computed-Tomography Arthrography—Evaluation in 25 Baseball Players with Surgical Confirmation	*Am J Sports Med*	1994	146	6.3
28	Cain EL Dugas JR Wolf RS	Elbow Injuries in Throwing Athletes: A Current Concepts Review	*Am J Sports Med*	2003	143	10.2
29	Osbahr DC Cannon DL	Retroversion of the humerus in the throwing shoulder of college baseball pitchers	*Am J Sports Med*	2002	142	9.5
30	King JW Brelsford HJ	Analysis of the pitching arm of the professional baseball pitcher	*Clin Orthop Relat Res*	1969	141	2.9
31	Callaway GH Field LD Deng XH Torzilli PA O'Brien SJ Altchek DW	Biomechanical evaluation of the medial collateral ligament of the elbow	*J Bone Joint Surg Am*	1997	137	6.9
32	Meister K	Injuries to the Shoulder in the Throwing Athlete Part One: Biomechanics/Pathophysiology/Classification of Injury	*Am J Sports Med*	2000	133	7.8
33	Rohrbough JT Altchek DW Hyman J Williams RJ III	Medial Collateral Ligament Reconstruction of the Elbow using the Docking Technique	*Am J Sports Med*	2002	127	8.5
34	Pieper HG	Humeral torsion in the throwing arm of handball players	*Am J Sports Med*	1998	126	6.6
35	Andrews JR	Outcome of elbow surgery in professional baseball players	*Am J Sports Med*	1995	122	5.5
36	Bey MJ Zauel R Brock SK	Validation of a new model-based tracking technique for measuring three-dimensional, in vivo glenohumeral joint kinematics	*J Biomech Eng*	2006	119	10.8
37	Wilk KE Andrews JR Arrigo CA Keirns MA	The Strength Characteristics of Internal and External Rotator Muscles in Professional Baseball Pitchers	*Am J Sports Med*	1993	118	4.9
38	Tirman PFJ Bost FW Steinbach LS Mall JC Peterfy CG Sampson TG Sheehan WE Forbes JR	MR arthrographic depiction of tears of the rotator cuff: benefit of abduction and external rotation of the arm	*Radiology*	1994	117	5.1
39	Kvitne RS	The diagnosis and treatment of anterior instability in the throwing athlete	*Clin Orthop Relat Res*	1993	116	4.8
40	Ellenbecker TS Roetert EP Bailie DS Davies GJ	Glenohumeral joint total rotation range of motion in elite tennis players and baseball pitchers	*Med Sci Sports Exerc*	2002	112	7.5
41	Grossman MG Tibone JE McGarry MH Schneider DJ Veneziani S	A cadaveric model of the throwing shoulder: a possible etiology of superior labrum anterior-to-posterior lesions	*J Bone Joint Surg Am*	2005	112	9.3
42	Thompson WH Jobe FW Yocum LA	Ulnar collateral ligament reconstruction in athletes: muscle-splitting approach without transposition of the ulnar nerve	*J Shoulder Elbow Surg*	2001	111	6.9

(*continued on next page*)

Table II (*continued*)

Rank	Authors	Title	Journal	Year	Citations, No.	Citation density
43	Petty DH Andrews JR Fleisig GS	Ulnar collateral ligament reconstruction in high school baseball players: clinical results and injury risk factors	*Am J Sports Med*	2004	111	8.5
44	Myers JB Laudner KG Pasquale MR Bradley JP	Scapular position and orientation in throwing athletes	*Am J Sports Med*	2005	109	9.1
45	Carson WG	Little Leaguer's shoulder—A report of 23 cases	*Am J Sports Med*	1998	107	5.6
46	Schwartz ML Al-Zahrani S Morwessel RM	Ulnar collateral ligament injury in the throwing athlete: evaluation with saline-enhanced MR arthrography	*Radiology*	1995	106	4.8
47	Paley KJ Jobe FW Pink M Kvitne RS	Arthroscopic findings in the overhand throwing athlete: evidence for posterior internal impingement of the rotator cuff	*Arthroscopy*	2000	105	6.2
48	Hsu YH Chen WY Lin HC Wang WTJ	The effects of taping on scapular kinematics and muscle performance in baseball players with shoulder impingement syndrome	*J Electromyogr Kinesiol*	2009	103	12.9
49	Wilk KE Macrina LC Fleisig GS Porterfield R Simpson CD II Harker P Paparesta N	Correlation of Glenohumeral Internal Rotation Deficit and Total Rotational Motion to Shoulder Injuries in Professional Baseball Pitchers	*Am J Sports Med*	2011	102	17.0
50	Reinold MM Wilk KE Fleisig GS Zhneg N Barrentine SW Chmielewski T Cody RC Jameson GG	Electromyographic analysis of the rotator cuff and deltoid musculature during common shoulder external rotation exercises	*J Orthop Sports Phys Ther*	2004	98	7.5

surgical management, and its focus was ulnar collateral ligament pathology. The remainder of the studies described biomechanics and pathoanatomy of the shoulder and elbow.

Discussion

Overhead throwing athletes exert strong and repetitive forces across the shoulder and elbow joints and subject the arm to range of motion extremes.[20] These highly athletic individuals are susceptible to a wide range of complex injuries to the upper extremity.[2,3,21,89] Although the findings in this study do not provide answers into the improvement of managing different pathologies among overhead throwing athletes, specifically baseball players, our study highlights the different areas of interest published in the literature for new and ongoing research. A greater understanding of shoulder and elbow anatomy and kinetics may identify opportunities for advancement in preventing and treating a number of pathologies.

Table III
List of journals

Journals (n = 13)	Citations, No.
American Journal of Sports Medicine	28
Journal of Bone and Joint Surgery	4
Arthroscopy	3
Journal of Orthop Sports Physical Therapy	3
Clinical Orthopaedics and Related Research	2
Radiology	2
Medicine and Science in Sports and Exercise	2
International Journal of Sports Biomechanics	1
Journal of Biomechanical Engineering	1
Journal of Biomechanics	1
Journal of Electromyography and Kinesiology	1
Journals of Shoulder and Elbow Surgery	1
Sports Medicine	1

Baseball has been described as the ninth toughest sport in the world.[33] In other words, only 8 sports, most of which are contact sports (ie, boxing, hockey, American football, wrestling, and martial arts), place greater physical demands on the competing athletes. It is not surprising that many of the articles in the top 50 studies focused on the biomechanics of the shoulder girdle and elbow attempting to provide information on the muscle forces and balances at these joints during the overhead throwing motion in high-level athletes. Interestingly, 4 studies discussed scapular kinematics and its role in shoulder function,[23,42,49,66] an understanding which is critical in those who care for these athletes. Although the effect of the papers that discussed scapular kinematics on the current understanding of shoulder pathology is difficult to assess, more recent studies have reported on the role of the scapula in shoulder pathology, including rotator cuff disease, glenohumeral internal rotation deficit, subacromial impingement, internal impingement, labral tears, anterior capsule laxity, and shoulder instability.[77] As a result, assessment of scapular position, mobility, and strength is a crucial part for successful rehabilitation programs in overhead throwing athletes.[104]

Only 1 review paper on shoulder pathology represented the outcomes of conservative management of throwers. Results of operative intervention of the shoulder in this population is tempered by a systematic review reporting 63% returning to the same level of play after superior labrum anteroposterior repair.[84] Effective nonoperative treatment strategies are of paramount importance to maintain high rates of return to play, but the literature lacks outcomes reporting and evidence-based treatment guidance. Only 9 of the top 50 studies (18%) in this review reported the surgical management of shoulder or elbow injuries.[4-6,12,22,45,75,82,95] These studies were all published

in the United States, in 3 different journals. All were small case series or retrospective case-control studies, 3 of which did not report outcomes. The outcome studies only reported changes in range of motion or return to play. The highest ranked surgical study (#4) reported outcomes with repair or reconstruction of the medial collateral ligament of the elbow and was published in 1992.

The indication of one technique over another may likely be associated with the type of injury, patient population, and surgeon preference; however, there is currently no consensus on the best treatment option of ulnar collateral ligament injuries.[68] These findings highlight that despite significant advances in understanding of elbow pathology and surgical instrumentation, future studies should aim to apply appropriate methodology to answer clinically relevant questions with outcomes data including not only return to play, but time to return to play.[59]

Although 142 authors contributed to this body of literature, 1 author (JR Andrews) was involved in more than one-third of the studies in the top 50 cited articles. Furthermore, all but 3 papers were published in the United States. This study identifies specific leaders in the field, underlines the importance of baseball within the sporting landscape of the United States, and highlights the need for greater diversity in the field of overhead throwing sports. Baseball is among the top 10 most popular sports in the world. Baseball is the second most popular sport in the United States[83] and is the most popular sport in Japan.[101] In 2016, Major League Baseball reported $10 billion in revenue,[14] and the New York Yankees are tied second for the most valuable sports franchise in the world, at $3.2 billion.[94] Clearly, there is great interest and tremendous value in the prevention and management of injuries in athletes at the highest level of competition. The money associated with Major League Baseball and the popularity of the sport in the United States both likely played a role in the greater prevalence of studies in the United States. Perhaps more important, the rise in the epidemic of youth and adolescent throwing arm injuries is cause for concern, with a need for more studies and additional understanding.[59]

The usefulness or appropriateness of compiling lists of top cited articles has been questioned.[31] Some authors contend that simply ranking articles according to the number of times cited does not provide readers with high-quality publications. Our study supports this viewpoint, because the level of evidence for 61% of clinical studies was IV, and all reviews were not performed to systematic review standards. There is consensus regarding the relative weakness in methodological quality of orthopedic literature; however, evidence shows that the quality of orthopedic literature is improving.[38,40] Of the publications on this list, 54% (27 of 50) were published in the *American Journal of Sports Medicine*, one of the highest-rated orthopedic journals in the world, with a 5-year impact factor of 5.501.[91] Furthermore, many orthopedic journals have encouraged authors to use reporting guidelines, such as the Consolidated Standards of Reporting Trials (CONSORT),[81] Strengthening the Reporting of Observational studies in Epidemiology (STROBE),[93] and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA),[56] to continue to improve the research quality in orthopedics.

Despite the absence of high-quality clinical studies, this top 50 list provides numerous basic science, biomechanical, and imaging studies that have served as a foundation for the understanding of complex elbow and shoulder pathology in overhead throwing athletes, particularly in baseball players. Although much has been done regarding biomechanics, fatigue, pain, and even injury, the sport still lacks scientifically sound guidelines of safety, including pitch counts and duration. The number of citations can also be influenced by the time since publication, which favors older articles. We corrected for publication duration by calculating the citation density to correct for the years since publication. The top 3 cited articles, however, demonstrated the highest number of citations and highest citation density.

Conclusion

The findings from this study highlight the contributions of investigators who have contributed significantly to the current knowledge of overhead throwing athlete pathologies. Although the list is not meant to be exhaustive, it undoubtedly provides a picture of the direction in which the literature in overhead throwing athletes is headed. Our findings also serve as a primer for the understanding of shoulder and elbow mechanics and pathoanatomy in the overhead throwing athletes and highlights the evolution in management of these complex pathologies in high demand athletes. We additionally highlight that evidence-based medicine for throwing athletes continues to evolve and that the practitioners caring for these athletes continue to make substantial contributions to the field for improved patient care and value. Lastly, this work demonstrates the paucity of high-quality clinical trials among these top cited papers, and understanding the variability in the content and quality of frequently cited articles may help improve the quality of research on overhead throwing athletes.

Disclaimer

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