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Top 100 most cited articles in orthopaedic surgery: An update

Zachary C. Lum*, Gavin C. Pereira, Mauro Giordani, John P. Meehan

University of California, Davis Medical Center, Adult Reconstruction Divison, Department of Orthopaedic Surgery, 4860 Y Street, Suite 3800, Sacramento, CA, USA

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ABSTRACT

Introduction: As the research landscape evolves, we sought to investigate the current most cited Orthopaedic Surgery articles and compare these to previously cited articles.

Methods: Web of Science database screened orthopaedic journal articles with comparison to previous data using multivariate regression analysis.

Results: Rate of citations increased 172% within the last decade. Previous rank and citations within the last decade had a greater effect on contemporary rank ($p = 0.084$, $p = 0.002$, respectively).

Conclusion: Trends in investigative research can shift by the next decade. Previous citation rank and citations in last decade contributed most to current rank.

1. Introduction

As the field of Orthopaedic Surgery grows, so does the amount of research, published articles and indexed journals investigating a particular topic. It is only natural to develop metrics and measuring tools to categorize these research items by the amount of influence they had on the field itself. Additionally, journals with many of these influential, frequently cited articles may be ranked based upon how often these papers are published in that specific journal. These article citation rankings and journal impact factors can suggest current trends or landmark articles in the literature.

Although the number of citations an article receives may not measure the quality of the methodology nor change the practice environment of the community, it does attest to the audience the paper has captured.[1] Additionally, as sub-topics in the field develop more interest, an increase in citation count may occur. This may represent interest generated toward that niche area, which may also affect the journals impact factor.

There has been previous interest in the most cited references in orthopaedic surgery nearly a decade ago.[2,3] However, with new technological developments and solutions to previous challenges in orthopaedics, other topics in the field may be emerging. Due to these shifts in topical research developments, we sought to investigate: (1) What are the top 100 most cited articles in Orthopaedic Surgery now?, (2) How has this changed?, (3) What factors may be attributed to the change?, (4) What additional factors may result in a high citation count?

2. Methods

Web of Science database from Science Citation Index of Institute for Scientific Information (Clarivate Analytics, Philadelphia, PA) from 1900 to 2018 was utilized to identify the most frequently cited papers from 77 orthopaedic journals from the subject area ORTHOPEDICS (Appendix A). Listings were then categorized in order of number of citations from Web of Science Core Collections database, Science Citation Index Expanded, Book Citation Index Sciences, Emerging Sources Citation Index, Current Chemical Reactions Expanded and Conference Proceedings Citation Index Science.

Each article in the most cited 100 list was reviewed and information collected, including authors, year of publications, source journal, geographic origin, article subject type (trauma, spine, hand, shoulder & elbow, hip & knee reconstruction, sports medicine, oncology, pediatrics, gait & rehabilitation, basic science and foot & ankle) and number of citations. Citation counts were collected and listed by absolute total number, citations per year, citations in the last 10 years, 5 years and last 6 months. The rate of citations were also calculated according to the year of publication.

Comparison of continuous variables between the groups was performed using the multivariate linear regression analysis. Variables analyzed using multiple models with highest possible correlation coefficient. Variables included year of publication, article subject type, number of citations in the last 5 and 10 years, citation rate determined by number of citations per year in circulation, previous citation count and previous citation rank as determined by previous publications.[3]

* Corresponding author. Department of Orthopaedic Surgery, Adult Reconstruction, 4860 Y Street, Suite 3800, Sacramento, CA, 95817, USA.
E-mail addresses: zclum@ucdavis.edu (Z.C. Lum), gcpereira@ucdavis.edu (G.C. Pereira), mgiordani@ucdavis.edu (M. Giordani), jmeehan@ucdavis.edu (J.P. Meehan).

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Table 1
Top 100 most referenced articles in Orthopaedic Surgery.

Rank	Citation	# Cit	Prev Rank
1	Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am. 1969 Jun; 51(4):737–55.	3860	1
2	Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am. 2007 Apr; 89(4):780–5.	2888	
3	Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine (Phila Pa 1976). 2000 Dec 15; 25(24):3186–91.	2696	
4	Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res. 1987 Jan; (214):160–4.	2576	11
5	Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther. 1987 Feb; 67(2):206–7.	2548	9
6	Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. Clin Orthop Relat Res. 1989 Nov; (248):13–4.	2401	7
7	Caplan AI. Mesenchymal stem cells. J Orthop Res. 1991; 9:641–650.	2387	10
8	DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop Relat Res. 1976; 121:20–32.	2097	12
9	Brooker AF, Bowerman JW, Robinson RA, Riley LH Jr. Ectopic ossification following total hip replacement: incidence and a method of classification. J Bone Joint Surg Am. 1973; 55:1629–1632.	2054	2
10	Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 1994; 15:349–353.	2030	20
11	Roland M, Morris R. A study of the natural history of back pain. Part I: Development of a reliable and sensitive measure of disability in low-back pain. Spine (Phila Pa 1976). 1983; 8:141–144.	2013	6
12	Gustilo RB, Anderson JT. Prevention of infection in treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am. 1976; 58:453–458.	2005	4
13	Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. Clin Orthop Relat Res. 1985; 198:43–49.	1827	23
14	Mankin HJ, Dorfman H, Lippiello L, Zarins A. Biomechanical and metabolic abnormalities in articular cartilage from osteo-arthritic human hips: II. Correlation of morphology with biomechanical and metabolic data. J Bone Joint Surg Am. 1971; 53:523–537.	1796	3
15	Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine (Phila Pa 1976). 2000 Nov 15; 25(22):2940-52	1787	
16	Ware JE Jr. SF-36 health survey update. Spine (Phila Pa 1976). 2000 Dec 15; 25(24):3130–9.	1646	
17	Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants: requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. Acta Orthop Scand. 1981; 52:155–170.	1550	21
18	Outerbridge RE. The etiology of chondromalacia patellae. J Bone Joint Surg Br. 1961; 43:752–757.	1509	19
19	Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements. Phys Ther. 2005 Mar; 85(3):257–68.	1506	
20	Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res. 2003 Dec; (417):112–20.	1504	
21	Neer CS 2nd. Anterior acromioplasty for chronic impingement syndrome in the shoulder: a preliminary report. J Bone Joint Surg Am. 1972; 54:41–50.	1407	8
22	Kadaba MP, Ramakrishnan HK, Wootten ME. Measurement of lower-extremity kinematics during level walking. J Orthop Res. 1990; 8:383–392.	1397	71
23	Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N, Bierma-Zeinstra S, Brandt KD, Croft P, Doherty M, Dougados M, Hochberg M, Hunter DJ, Kwoh K, Lohmander LS, Tugwell P. OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. Osteoarthritis Cartilage. 2008 Feb; 16(2):137–62.	1386	
24	Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther. 2003 Aug; 83(8):713–21.	1358	
25	Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. Am J Sports Med. 1982; 10:150–154.	1354	15
26	Jarcho M. Calcium phosphate ceramics as hard tissue prosthetics. Clin Orthop Relat Res. 1981; 157:259–278.	1327	
27	Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects: a prospective investigation. J Bone Joint Surg Am. 1990; 72:403–408.	1312	16
28	Carter DR, Hayes WC. The compressive behavior of bone as a two-phase porous structure. J Bone Joint Surg Am. 1977; 59:954–962.	1306	13
29	Ilizarov GA. The tension-stress effect on the genesis and growth of tissues. Part I: The influence of stability of fixation and soft-tissue preservation. Clin Orthop Relat Res. 1989; 238:249–281.	1293	27
30	Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J, Boos N. Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine (Phila Pa 1976). 2001 Sep 1; 26(17):1873–8.	1285	
31	Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Knee Injury and Osteoarthritis Outcome Score (KOOS)–development of a self-administered outcome measure. J Orthop Sports Phys Ther. 1998 Aug; 28(2):88–96.	1280	
32	Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther. 2000 Sep; 80(9):896–903.	1227	
33	Hewett TE, Myer GD, Ford KR, Heidt RS Jr, Colosimo AJ, McLean SG, van den Bogert AJ, Paterno MV, Succop P. Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes: a prospective study. Am J Sports Med. 2005 Apr; 33(4):492–501.	1219	
34	Hunziker EB. Articular cartilage repair: basic science and clinical progress. A review of the current status and prospects. Osteoarthritis Cartilage. 2002 Jun; 10(6):432–63.	1197	
35	Gruen TA, McNeice GM, Amstutz HC. "Modes of failure" of cemented stem-type femoral components: radiographic analysis of loosening. Clin Orthop Relat Res. 1979; 141:17–27.	1188	5
36	Enneking WF, Dunham W, Gebhardt MC, Malawar M, Pritchard DJ. A system for the functional evaluation of reconstructive procedures after surgical treatment of tumors of the musculoskeletal system. Clin Orthop Relat Res. 1993; 286:241–246.	1154	39
37	Lewinnek GE, Lewis JL, Tarr R, Compere CL, Zimmerman JR. Dislocations after total hip-replacement arthroplasties. J Bone Joint Surg Am. 1978 Mar; 60(2):217–20.	1150	
38	Woollacott M, Shumway-Cook A. Attention and the control of posture and gait: a review of an emerging area of research. Gait Posture. 2002 Aug; 16(1):1–14.	1129	
39	Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine (Phila Pa 1976). 1983; 8:817–831.	1111	36
40	Farndale RW, Sayers CA, Barrett AJ. A direct spectrophotometric micro-assay for sulfated glycosaminoglycans in cartilage cultures. Connect Tissue Res. 1982; 9:247–248.	1104	14
41	van Tulder M, Furlan A, Bombardier C, Bouter L; Editorial Board of the Cochrane Collaboration Back Review Group. Updated method guidelines for systematic reviews in the cochrane collaboration back review group. Spine (Phila Pa 1976). 2003 Jun 15; 28(12):1290–9.	1102	
42	Wakitani S, Goto T, Pineda SJ, Young RG, Mansour JM, Caplan AI, Goldberg VM. Mesenchymal cell-based repair of large, full-thickness defects of articular cartilage. J Bone Joint Surg Am. 1994; 76:579–592.	1100	27
43	Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Relat Res. 1994 Jul; (304):78–83.	1077	

(*continued on next page*)

Table 1 (*continued*)

Rank	Citation	# Cit	Prev Rank
44	D'Aubigne RM, Postel M. Functional results of hip arthroplasty of hip arthroplasty with acrylic 474 prosthesis. J Bone Joint Surg Am. 1954; 36:451–475.	1072	44
45	Ewald FC. The Knee Society total knee arthroplasty roentgenographic evaluation and scoring system. 434 Clin Orthop Relat Res. 1989; 248:9–12.	1071	60
46	Neer CS 2nd. Displaced proximal humeral fractures: I. Classification and evaluation. J Bone Joint Surg Am. 1970; 52:1077–1089.	1068	38
47	Fairbank TJ. Knee joint changes after meniscectomy. J Bone Joint Surg Br. 1948; 30:664–670.	1067	24
48	Engh CA, Bobyn JD, Glassman AH. Porous-coated hip replacement: the factors governing bone ingrowth, stress shielding, and clinical results. J Bone Joint Surg Br. 1987; 69:45–55.	1061	29
49	Neer CS 2nd. Impingement lesions. Clin Orthop Relat Res. 1983; 173:70–77.	1037	56
50	Rubin CT, Lanyon LE. Regulation of bone formation by applied dynamic loads. J Bone Joint Surg Am. 1984; 66:397–402.	1032	17
51	Airaksinen O, Brox JI, Cedraschi C et al. Chapter 4. European guidelines for the management of chronic nonspecific low back pain. *Eur Spine J*. 2006; 15 Suppl 2(Suppl 2):S192-300.	1004	
52	Galatz LM, Ball CM, Teefey SA, Middleton WD, Yamaguchi K. The outcome and repair integrity of completely arthroscopically repaired large and massive rotator cuff tears. J Bone Joint Surg Am. 2004 Feb; 86-A(2):219–24.	967	
53	Beck M, Kalhor M, Leunig M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthritis of the hip. J Bone Joint Surg Br. 2005 Jul; 87(7):1012–8.	956	
54	Linton SJ. A review of psychological risk factors in back and neck pain. Spine (Phila Pa 1976). 2000 May 1; 25(9):1148–56.	955	
55	Levine DW, Simmons BP, Koris MJ, Daltroy LH, Hohl GG, Fossel AH, Katz JN. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. J Bone Joint Surg Am. 1993; 75:1585–1592.	954	83
56	Salter RB, Harris WR. Injuries involving the epiphyseal plate. J Bone Joint Surg Am. 1963; 45:587–622.	946	18
57	LeGeros RZ. Properties of osteoconductive biomaterials: calcium phosphates. Clin Orthop Relat Res. 2002 Feb; (395):81–98.	921	
58	Lohmander LS, Englund PM, Dahl LL, Roos EM. The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. Am J Sports Med. 2007 Oct; 35(10):1756–69.	919	
59	Smith GW, Robinson RA. The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. J Bone Joint Surg Am. 1958; 40:607–624.	912	64
60	Nötzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. J Bone Joint Surg Br. 2002 May; 84(4):556–60.	902	
61	Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis. Spine (Phila Pa 1976). 1996 Nov 15; 21(22):2640–50.	893	
62	Arendt E, Dick R. Knee injury patterns among men and women in collegiate basketball and soccer: NCAA data and review of literature. Am J Sports Med. 1995; 23:694–701.	886	66
63	Panjabi MM. The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and enhancement. J Spinal Disord. 1992 Dec; 5(4):383–9; discussion 397.	884	
64	Kadaba MP, Ramakrishnan HK, Wootten ME, Gainey J, Gorton G, Cochran GV. Repeatability of kinematic, kinetic, and electromyographic data in normal adult gait. J Orthop Res. 1989; 7:849–860.	877	99
65	Govender S, Csimma C, Genant HK, Valentin-Opran A, Amit Y, Arbel R, Aro H, Atar D, Bishay M, Börner MG, Chiron P, Choong P, Cinats J, Courtenay B, Feibel R, Geulette B, Gravel C, Haas N, Raschke M, Hammacher E, van der Velde D, Hardy P, Holt M, Josten C, Ketterl RL, Lindeque B, Lob G, Mathevon H, McCoy G, Marsh D, Miller R, Munting E, Oevre S, Nordsletten L, Patel A, Pohl A, Rennie W, Reynders P, Rommens PM, Rondia J, Rossouw WC, Daneel PJ, Ruff S, Rüter A, Santavirta S, Schildhauer TA, Gekle C, Schnettler R, Segal D, Seiler H, Snowdowne RB, Stapert J, Taglang G, Verdonk R, Vogels L, Weckbach A, Wentzensen A, Wisniewski T; BMP-2 Evaluation in Surgery for Tibial Trauma (BESTT) Study Group. Recombinant human bone morphogenetic protein-2 for treatment of open tibial fractures: a prospective, controlled, randomized study of four hundred and fifty patients. J Bone Joint Surg Am. 2002 Dec; 84-A(12):2123–34.	871	
66	Enneking WF, Spanier SS, Goodman MA. A system for the surgical staging of musculoskeletal sarcoma. Clin Orthop Relat Res. 1980; 153:106–120.	866	58
67	Inman VT, Saunders JB, Abbott LC. Observations of the function of the shoulder joint. J Bone Joint Surg. 1944; 26:1–30.	866	
68	Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, Prokuski L, Sirkin MS, Ziran B, Henley B, Audigé L. Fracture and dislocation classification compendium - 2007: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma. 2007 Nov–Dec; 21(10 Suppl):S1-133.	864	
69	Shapiro F, Koide S, Glimcher MJ. Cell origin and differentiation in the repair of full-thickness defects of articular cartilage. J Bone Joint Surg Am. 1993; 75:532–553.	842	74
70	Roland M, Fairbank J. The Roland-Morris Disability Questionnaire and the Oswestry Disability Questionnaire. Spine (Phila Pa 1976). 2000 Dec 15; 25(24):3115–24.	837	
71	Steffen TM, Hacker TA, Mollinger L. Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. Phys Ther. 2002 Feb; 82(2):128–37.	835	
72	Ethgen O, Bruyère O, Richy F, Dardennes C, Reginster JY. Health-related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. J Bone Joint Surg Am. 2004 May; 86-A(5):963–74.	831	
73	Hewett TE, Lindenfeld TN, Riccobene JV, Noyes FR. The effect of neuromuscular training on the incidence of knee injury in female athletes. A prospective study. Am J Sports Med. 1999 Nov–Dec; 27(6):699–706.	829	
74	Schmalzried TP, Jasty M, Harris WH. Periprosthetic bone loss in total hip arthroplasty: polyethylene wear debris and the concept of the effective joint space. J Bone Joint Surg Am. 1992; 74:849–863.	824	26
75	Dawson J, Fitzpatrick R, Murray D, Carr A. Questionnaire on the perceptions of patients about total knee replacement. J Bone Joint Surg Br. 1998 Jan; 80(1):63–9.	822	
76	Mathiowetz V, Weber K, Volland G, Kashman N. Reliability and validity of grip and pinch strength evaluations. J Hand Surg Am. 1984 Mar; 9(2):222–6.	813	
77	Noyes FR, Butler DL, Grood ES, Zernicke RF, Hefzy MS. Biomechanical analysis of human ligament grafts used in knee-ligament repairs and reconstructions. J Bone Joint Surg Am. 1984; 66:344–352.	811	35
78	Hilibrand AS, Carlson GD, Palumbo MA, Jones PK, Bohlman HH. Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis. J Bone Joint Surg Am. 1999 Apr; 81(4):519–28.	810	
79	Banwart JC, Asher MA, Hassanein RS. Iliac crest bone graft harvest donor site morbidity. A statistical evaluation. Spine (Phila Pa 1976). 1995 May 1; 20(9):1055–60.	810	
80	Rowe CR, Patel D, Southmayd WW. The Bankart procedure: a long-term end-result study. J Bone Joint 462 Surg Am. 1978; 60:1–16.	809	48
81	Waddell G. 1987 Volvo award in clinical sciences: A new clinical model for the treatment of low-back 567 pain. Spine (Phila Pa 1976). 1987; 12:632–644.	802	30
82	Giannoudis PV, Dinopoulos H, Tsiridis E. Bone substitutes: an update. Injury. 2005 Nov; 36 Suppl 3:S20-7.	829	
83	Peterson L, Minas T, Brittberg M, Nilsson A, Sjogren-Jansson E, Lindahl A. Two- to 9-year outcome after autologous chondrocyte transplantation of the knee. Clin Orthop Relat Res. 2000; 374:212–234.	801	62

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Table 1 (*continued*)

Rank	Citation	# Cit	Prev Rank
84	Deyo RA, Battie M, Beurskens A, Bombardier C, Croft P, Koes B, Malmivaara A, Roland M, Von Korff M, Waddell G. Outcome measures for low back pain research: a proposal for standardized use. Spine (Phila Pa 1976). 1998; 23:2003–2013.	799	92
85	Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. Spine J. 2008 Jan–Feb; 8(1):8–20.	796	
86	Daniel DM, Stone ML, Dobson BE, Fithian DC, Rossman DJ, Kaufman KR. Fate of the ACL-injured patient: a prospective outcome study. Am J Sports Med. 1994; 22:632–644.	793	78
87	Mankin HJ. The response of articular cartilage to mechanical injury. J Bone Joint Surg Am. 1982; 64:460–466.	785	41
88	Ostelo RW, Deyo RA, Stratford P, Waddell G, Croft P, Von Korff M, Bouter LM, de Vet HC. Interpreting change scores for pain and functional status in low back pain: towards international consensus regarding minimal important change. Spine (Phila Pa 1976). 2008 Jan 1; 33(1):90–4.	784	
89	Knutsen G, Engebretsen L, Ludvigsen TC, Drogset JO, Grøntvedt T, Solheim E, Strand T, Roberts S, Isaksen V, Johansen O. Autologous chondrocyte implantation compared with microfracture in the knee. A randomized trial. J Bone Joint Surg Am. 2004 Mar; 86-A(3):455–64.	782	
90	Harryman DT 2nd, Mack LA, Wang KY, Jackins SE, Richardson ML, Matsen FA 3rd. Repairs of the rotator cuff. Correlation of functional results with integrity of the cuff. J Bone Joint Surg Am. 1991 Aug; 73(7):982–9.	781	
91	Kurtz S, Mowat F, Ong K, Chan N, Lau E, Halpern M. Prevalence of primary and revision total hip and knee arthroplasty in the United States from 1990 through 2002. J Bone Joint Surg Am. 2005 Jul; 87(7):1487–97.	777	
92	Furlan AD, Pennick V, Bombardier C, van Tulder M; Editorial Board, Cochrane Back Review Group. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. Spine (Phila Pa 1976). 2009 Aug 15; 34(18):1929–41.	774	
93	Livermore J, Ilstrup D, Morrey B. Effect of femoral head size on wear of the polyethylene acetabular component. J Bone Joint Surg Am. 1990; 72:518–528.	773	34
94	Girgis FG, Marshall JL, Monajem A. The cruciate ligaments of the knee joint. Anatomical, functional and experimental analysis. Clin Orthop Relat Res. 1975 Jan–Feb; (106):216–31.	773	
95	Arrington ED, Smith WJ, Chambers HG, Bucknell AL, Davino NA. Complications of iliac crest bone graft harvesting. Clin Orthop Relat Res. 1996 Aug; (329):300–9.	768	
96	Irrgang JJ, Anderson AF, Boland AL, Harner CD, Kurosaka M, Neyret P, Richmond JC, Shelborne KD. Development and validation of the international knee documentation committee subjective knee form. Am J Sports Med. 2001 Sep–Oct; 29(5):600–13.	762	
97	Kannus P, Józsa L. Histopathological changes preceding spontaneous rupture of a tendon. A controlled study of 891 patients. J Bone Joint Surg Am. 1991 Dec; 73(10):1507–25.	760	
98	Ficat RP. Idiopathic bone necrosis of the femoral head: early diagnosis and treatment. J Bone Joint Surg 434 Br. 1985; 67:3–9.	759	60
99	Biering-Sorensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. Spine (Phila Pa 1976). 1984; 9:106–119.	759	59
100	McAlindon TE, Bannuru RR, Sullivan MC, Arden NK, Berenbaum F, Bierma-Zeinstra SM, Hawker GA, Henrotin Y, Hunter DJ, Kawaguchi H, Kwoh K, Lohmander S, Rannou F, Roos EM, Underwood M. OARSI guidelines for the non-surgical management of knee osteoarthritis. Osteoarthritis Cartilage. 2014 Mar; 22(3):363–88.	757	

Data analysis was performed using Stata version 13 (Stata Corp, College Station, Texas, USA).

3. Results

348,058 articles were listed with the top 100 referenced articles published between 1944 and 2014 and with numbers of citations ranging from 3860 to 757 (Table 1). Citations within the last 5 years averaged 85 (range 0–535) and in the last 6 months averaged 5 (range 0–45). Overall citations per year averaged 55 (range 12–263) and recent in the last 5 years averaged 17 (range 0–107). Previous top 100 referenced articles were compared from 2008 to 2018. Average number of citations within the last 10 years was 689 (range 155–2112) with average rate 69 citations per year (16–211). Citation amount increased on average 172% (range 51%–357%) within the last 10 years.

Publication most commonly originated in decreasing order from the United States (56), United Kingdom (9), Sweden (7), Switzerland (5) and Canada (5). Journals with the most referenced papers were Journal of Bone and Joint Surgery – American (29), Clinical Orthopaedics and Related Research (17), Spine (17), Journal of Bone and Joint Surgery – British (7), American Journal of Sports Medicine (7), and Physical Therapy (5). Location of the research originated in decrease order from Boston, MA (10), New York, NY (6), and Cleveland, OH (3) tied with Cincinnati, OH (3). Institution where the work was performed was much more heterogeneous. Massachusetts General Hospital had the most number of publications at 7. The remaining institutions had 3 or less. The most common topics in the field of orthopaedics were adult reconstruction (23), spine (22), sports medicine (17) and basic science (14) (Tables 2–4).

Of the 100 articles, half remained in the top 100 with an average ranking loss of 9 spots (range −59 to +49). The previous top 20 articles were all within the top 100 rank (range 1–56). Number of citations per year increased 172% (51%–357%) within the last 10 years. Ranking factors investigated with regards to topic, year, recent and

Table 2
Countries of origin and number of publications. Previous from Kelly JC, Glynn RW, O'Briain DE, Felle P, McCabe JP. The 100 classic papers of orthopaedic surgery: a bibliometric analysis. J Bone Joint Surg Br. 2010 Oct; 92(10):1338–43.

Country	Current	Previous
United of States of America	56	77
United Kingdom	9	10
Sweden	7	5
Switzerland	5	–
Canada	5	4

Table 3
Journals of origin and number of publications. Previous from Lefaivre KA, Shadgan B, O'Brien PJ. 100 most cited articles in orthopaedic surgery. Clin Orthop Relat Res. 2010; 469(5):1487–97.

Journal	Current	Previous
Journal of Bone and Joint Surgery - American	29	54
Clinical Orthopaedics and Related Research	17	13
Spine Journal	17	9
Journal of Bone and Joint Surgery - British	7	9
American Journal of Sports Medicine	7	5

Table 4
Topics of each article and number of publications with new top 100 topics listed to the right.

Topic	Current	New top 100
Adult reconstruction	23	10
Spine	22	15
Sports medicine	17	8
Basic science	14	4

Table 5
Multivariate regression analysis for article ranking factors.

Variable	95% CI	P value
Year	−0.45 to 1.33	0.352
Topic	−1.77 to 1.71	0.969
Citation rate	−1.23 to 0.84	0.708
Previous citations	−0.02 to 0.05	0.444
Recent citations last decade	−0.07 to 0.01	0.084
Previous rank	0.21 to 0.88	0.002

previous citations, citation rate and previous rank found that previous rank ($p = 0.02$) and number of citations within the last 10 years ($p = 0.08$) had a greater effect on rank. No other factor was found regarding citation rank (Table 5).

4. Discussion

Half of the top 100 referenced papers in Orthopaedic Surgery changed in the last 10 years. These changes may reflect growing trends and interests in the field or changes in subject focus over time periods.[4,5] Additionally, to a simpler effect, cited research may just be more easily accessible and thus longer references lists included when performing literature review. Lokker et al.[6] reported that factors such as higher listings on the journals page, newsworthiness, longer reference lists, and even last names in the first half of the alphabet may lead to higher reference. While the change may suggest a change in the field, it could be a result of large reference lists.

The top 20 articles were still within the 100 most cited papers, but their rankings dropped to range between 1 and 56. This may be consistent with some reference analyses. Fu et al. investigated factors that contributed to highest citations at 10 years by predictive modeling. They reported number of previous first author citations was a strongest factor for future citations.[7] Although some focused topics may not be considered current, their previous citations may have had a contributing effect to present ranking.

Previous article rank and number of citations within the last decade appeared to have a stronger predictor of current rank than number of previous citations. As the total number of citations increased more than 200% for nearly every reference in the last decade, and the number of citations per year has increased 172% compared with previous years, it is no surprise that the last decade has a greater effect on citation rank than the previous decade. Some studies agree that number of current citations are a strong predictor of future citation and subsequent rank.[8,9]

Rank of location of publication, journals of publication and institution with the most publications did not change much, with this journal (JBJS-American) containing the most number of cited papers. The overall number of papers in each category did change, which may be representative of collaborative global research efforts and dissemination of world-wide information. Kelly et al.[2] reported from 1945 to 2008, the country with the most publications in decreasing order was from The United States, England, Sweden and Canada. Our report in 2018 sees little change from that order with the addition of Switzerland (Table 2). Lefaivre et al.[3] reported from 1945 to 2008 the journal of origin with the most referenced articles, in decreasing order, belonged to Journal of Bone and Joint Surgery – American, Clinical Orthopaedics and Related Research, Spine Journal and Journal of Bone and Joint Surgery – British. While absolute number of articles may have decreased, the ranking has not changed in 2018. This may represent a larger volume of journals in response to a growing amount of research publications, resulting in a lower median institutional citation count, but a wider range of global institutions being listed.

Topics of each article were based upon abstract and categorized according to subject field. Adult reconstruction and spine surgery topped the list with 23 and 22, respectively. Sports medicine was 3rd at 17 articles, and basic science was 4th at 14 articles. This rank was similar to another investigation performed at our institution of the top 100 articles in orthopaedic surgery in the last decade. However, when comparing new articles to the list compared to previously ranked top 100 articles, spine surgery was ahead 15 articles compared with 10 adult reconstruction. Sports medicine was unchanged in third position at 8 articles. This may suggest a gradual increase in spine research in the recent decade.

It was interesting to find that half of the top 100 most cited articles changed in the last decade. It was also eye-opening to realize that the citation count has more than doubled with an increased rate of 172%. It speaks to the shear volume of research being produced in our field of orthopaedic surgery. Additionally, our global access to research increases ideas shared in other countries, confirms or disputes research in our country, and may also increase the references from additional areas in the world. Previous articles speculated if Kuhnian philosophy would be validated as more modern studies change and shift the paradigm of science and thinking.[3,10] Like the conundrum of comparing these incommensurable paradigms, it appears the answers are not so clear as exactly half of the previous articles remained, and half were new.

Our study was limited to articles published in the English language. We limited our search to 77 Orthopaedic Surgery journals, with knowledge that over 200 exist in 2018. Many of these newer journals do not have the citation count to contain the top 100 journals as they were created in the last 3–4 years. However, the true citation count and ranking may change between references if more journals were included. Of note, the most recent article from our archive is 2014 and published in a well-established journal. An important note in medicine is big data analysis occurs, often via machine algorithms that are not entirely known. Unknown or un-measureable variables such as internet search-algorithms, social media and alt-metrics may have contributed to the current citation rank and may affect this in the future.[11]

5. Conclusion

The most referenced papers may have resulted in additional research on that topic due to the unique results or conclusion of that particular study. We found that half of the top 100 most cited articles in Orthopaedic Surgery changed in the last decade. This may speak to the changing shift in topical interests, availability of the articles or increased accessibility of the paper by the internet. It will be interesting to discover which articles remain in the next decade.

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Appendix A. Supplementary data

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