




Top 100 most cited journal articles in anatomy

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Abstract

The number of citations a journal article receives can be used to represent its impact on its field. The aim of the current study was to identify and characterize the top 100 cited articles in journals related to anatomy. The Journal Citation Report database was searched to identify journals categorized as anatomy and morphology. The top 15 most highly cited journals were selected for review. The articles from these journals were then sorted by “Times Cited”. The timeline used was 1976–2001. The top 100 most cited articles were extracted for analysis. Articles were excluded if they focused on basic scientific research or animal studies. Fifteen journals were identified based on our criteria using the Journal Citation Report database and the articles were sorted by most cited; 916 anatomy articles were screened to select the top 100 cited since 1976. Among the selected articles, 46 were published in *Journal of Anatomy*, 13 in *Clinical Anatomy*, 12 in *Microscopy Research and Technique*, 11 in *Surgical and Radiologic Anatomy*, seven in *Brain Structure & Function*, five in *Annals of Anatomy - Anatomischer Anzeiger*, three in *Anatomical Record - Advances in Integrative Anatomy and Evolutionary Biology*, two in *Cells Tissues Organs*, and one in *Developmental Dynamics*. Our study identified the top 100 journal articles in anatomy with a clinical and surgical focus. This compilation of articles could help anatomists and clinicians familiarize themselves with impactful research included in terms of study type and field of anatomy, journal of publication, and recurring authors.

KEYWORDS

anatomy, bibliometric analysis, citation, web of science

1 | INTRODUCTION

Bibliometric analyses offer a way to quantify and analyze the immense number of publications objectively, enabling us to use the number of citations that a journal article receives to represent its impact on its field. The Institute for Science Information developed the first database for citation tracking in 1962. It was later combined with the Social Sciences Index and the Arts and Humanities Citation Index in 1973 and 1978, respectively. In 1997, Web of Science was developed online and later rebranded under the name Web of Science Core Collection. It was supplemented by many more citation

indexes to maintain continual systematic updating of citation counts for journal articles (Ponce & Lozano, 2010). Recently, there has been an influx of articles to establish the most impactful research within their respective fields or foci, including neurosurgery (Ponce & Lozano, 2010), cardiovascular magnetic resonance (Khan et al., 2016), urethral reconstruction (Lee et al., 2020), diabetes research (Shuaib & Costa, 2015), and epilepsy and status epilepticus (Park et al., 2017). The objective of our study was to identify and characterize the 100 most highly cited journal articles in clinical, surgical, and educational anatomy selected from 15 journals using bibliometric analysis.

2 | MATERIALS AND METHODS

The focus of this study was to identify journal articles specifically dedicated to clinical, surgical, and educational anatomy. We searched the Journal Citation Report database for journals categorized as anatomy and morphology. The journals in this category were then sorted by total numbers of citations, and the top 15 most highly cited were selected for review in this study. The chosen journals were: *Acta Zoologica*, *Anatomical Record - Advances in Integrative Anatomy and Evolutionary Biology*, *Annals of Anatomy - AnatomischerAnzeiger*, *Applied Immunohistochemistry & Molecular Morphology*, *Brain Structure & Function*, *Cells Tissues Organs*, *Clinical Anatomy*, *Developmental Dynamics*, *Frontiers in Neuroanatomy*, *International Journal of Morphology*, *Journal of Anatomy*, *Journal of Morphology*, *Microscopy Research and Technique*, *Surgical and Radiologic Anatomy*, and *Tissue & Cell*. The timeline used was from 1976 to 2021. The top 100 most cited articles were extracted from this list of journals for analysis. The following variables were collected from each article: publication journal, impact factor of journal, title, number of citations, year of publication, and type of article. Articles were excluded if they included basic science research, animal studies, or were not purely related to clinical, surgical, or educational anatomy (i.e., comparative human and animal embryo development studies or cellular function and differentiation). There was one exception to the journal articles selected for review: the article by Crick et al. (1998), which focused on functional anatomical differences between a pig and a human heart in the context of xenografts for human surgical cardiac transplantation.

3 | RESULTS

3.1 | Sources and citations

Fifteen journals were identified (Table 1) based on the criteria described in the methods section and the articles were sorted by most cited. We screened 916 anatomical articles to select the most relevant 100 cited since 1976. Among these 100 selected articles (Table 2), 46 were published in *Journal of Anatomy*, 13 in *Clinical Anatomy*, 12 in *Microscopy Research and Technique*, 11 in *Surgical and Radiologic Anatomy*, seven in *Brain Structure & Function*, five in *Annals of Anatomy - AnatomischerAnzeiger*, three in *Anatomical Record - Advances in Integrative Anatomy and Evolutionary Biology*, two in *Cells Tissues Organs*, and one in *Developmental Dynamics*.

3.2 | Field of study

The journal articles were categorized in a similar manner to that used by Ponce and Lozano (2010), our categories being embryological, functional, imaging, morphology, structure, educational, and others (Table 3). The most published topics of study in anatomy were structural ($n = 47$), followed by functional ($n = 17$), imaging ($n = 13$), other ($n = 10$), educational ($n = 9$), and embryological

TABLE 1 2020 Journal impact factors for selected journals

Name of journal	Impact factor
Anatomical Record - Advances in Integrative Anatomy and Evolutionary Biology	2.064
Annals of Anatomy - AnatomischerAnzeiger	2.241
Applied Immunohistochemistry & Molecular Morphology	2.085
Brain Structure & Function	3.622
Cells Tissues Organs	2.481
Clinical Anatomy	2.414
Developmental Dynamics	3.780
Frontiers in Neuroanatomy	3.267
International Journal of Morphology	0.519
Journal of Anatomy	2.013
Journal of Morphology	1.588
Microscopy Research and Technique	2.117
Surgical and Radiologic Anatomy	1.246
Tissue & Cell	3.043

($n = 4$). In the field of structural anatomy, the most common category involved the nervous system ($n = 13$); muscle ($n = 4$) and joints ($n = 4$) were the other most frequently represented categories. In functional anatomy, the most frequently represented category involved tendons, ligaments, and joints ($n = 11$), muscle ($n = 4$) being the second most represented. Anatomical imaging studies were mostly focused on the nervous system ($n = 11$); pancreas ($n = 1$), skin ($n = 1$), bone ($n = 1$), breast ($n = 1$), and clinical two-photon imaging ($n = 1$) were each represented by one article. In the category of "other" articles, preservation of cadavers ($n = 3$), the lymphatic system ($n = 2$), and the spine ($n = 2$) were the most frequent. For the field of study involving anatomical education, all ($n = 9$) articles focused upon adequate education during the medical school phase of training. In the embryological category, the nervous system ($n = 2$), the epicardium ($n = 1$) and conjoined twins ($n = 1$) were mentioned in the selected articles.

3.3 | Type of study

The articles were also categorized by type of study, based on information from the article or the category assigned by PubMed (Table 3). From the 100 selected journal articles, 52 were original articles, 40 were reviews, six were comparative studies, one was a case report, and there was one meta-analysis. Among the 100 articles screened, 92% centered around clinical, surgical, or education anatomy and were either original (prospective, non-review) or review (retrospective regarding data collection and analysis). In the original papers reviewed, the main fields of studies were structural ($n = 19$), imaging ($n = 9$), and functional ($n = 7$). In the review articles analyzed, the main fields of study were structural ($n = 11$), morphological ($n = 9$), and

TABLE 2 The 100 most cited papers in clinical, surgical, and educational anatomy

Rank	Citations	Article	Journal	Year of publication
1	503	Claes S, Vereecke E, Maes M, Victor J, Verdonk P, Bellemans J. Anatomy of the anterolateral ligament of the knee. <i>J Anat.</i> 2013;223(4):321–328. doi:10.1111/joa.12087	JOURNAL OF ANATOMY	2013
2	491	Thiel W. Die Konservierung ganzer Leichen in natürlichen Farben (The preservation of the whole corpse with natural color). <i>Ann Anat.</i> 1992;174(3):185–195	ANNALS OF ANATOMY - ANATOMISCHER ANZEIGER	1992
3	461	Benjamin M, Ralphs JR. Fibrocartilage in tendons and ligaments—an adaptation to compressive load. <i>J Anat.</i> 1998;193(Pt 4):481–494. doi:10.1046/j.1469-7580.1998.19340481.x	JOURNAL OF ANATOMY	1999
4	453	Benjamin M, Toumi H, Ralphs JR, Bydder G, Best TM, Milz S. Where tendons and ligaments meet bone: attachment sites ('entheses') in relation to exercise and/or mechanical load. <i>J Anat.</i> 2006;208(4):471–490. doi:10.1111/j.1469-7580.2006.00540.x	JOURNAL OF ANATOMY	2000
5	436	Patton N, Aslam T, Macgillivray T, Pattie A, Deary IJ, Dhillon B. Retinal vascular image analysis as a potential screening tool for cerebrovascular disease: a rationale based on homology between cerebral and retinal microvasculatures. <i>J Anat.</i> 2005;206(4):319–348. doi:10.1111/j.1469-7580.2005.00395.x	JOURNAL OF ANATOMY	2001
6	368	Benjamin M, Evans EJ, Copp L. The histology of tendon attachments to bone in man. <i>J Anat.</i> 1986;149:89–100	JOURNAL OF ANATOMY	1986
7	350	Benjamin M, McGonagle D. The anatomical basis for disease localisation in seronegative spondyloarthropathy at entheses and related sites. <i>J Anat.</i> 2001;199(Pt 5):503–526. doi:10.1046/j.1469-7580.2001.19950503.x	JOURNAL OF ANATOMY	2001
8	310	Zhang ET, Inman CB, Weller RO. Interrelationships of the pia mater and the perivascular (Virchow-Robin) spaces in the human cerebrum. <i>J Anat.</i> 1990;170:111–123.	JOURNAL OF ANATOMY	1990
9	289	Morris-Kay GM, Wilkie AO. Growth of the normal skull vault and its alteration in craniosynostosis: insights from human genetics and experimental studies. <i>J Anat.</i> 2005;207(5):637–653. doi:10.1111/j.1469-7580.2005.00475.x	JOURNAL OF ANATOMY	2005
10	278	Peuker ET, Filler TJ. The nerve supply of the human auricle. <i>Clin Anat.</i> 2002;15(1):35–37. doi:10.1002/ca.1089	CLINICAL ANATOMY	2002
11	277	Messner K, Gao J. The menisci of the knee joint. Anatomical and functional characteristics, and a rationale for clinical treatment. <i>J Anat.</i> 1998;193(Pt 2):161–178. doi:10.1046/j.1469-7580.1998.19320161.x	JOURNAL OF ANATOMY	1998
12	276	Crick SJ, Sheppard MN, Ho SY, Gebstein L, Anderson RH. Anatomy of the pig heart: comparisons with normal human cardiac structure. <i>J Anat.</i> 1998;193(Pt 1):105–119. doi:10.1046/j.1469-7580.1998.19310105.x	JOURNAL OF ANATOMY	1998
13	267	Lee Y, Hwang K. Skin thickness of Korean adults. <i>Surg Radiol Anat.</i> 2002;24(3–4):183–189. doi:10.1007/s00276-002-0034-5	SURGICAL AND RADIOLOGIC ANATOMY	2002
14	264	Caspers S, Eickhoff SB, Geyer S, et al. The human inferior parietal lobule in stereotaxic space. <i>Brain Struct Funct.</i> 2008;212(6):481–495. doi:10.1007/s00429-008-0195-z	BRAIN STRUCTURE & FUNCTION	1983
15	259	Saisho Y, Butler AE, Meier JJ, et al. Pancreas volumes in humans from birth to age one hundred taking into account sex, obesity, and presence of type-2 diabetes. <i>Clin Anat.</i> 2007;20(8):933–942. doi:10.1002/ca.20543	CLINICAL ANATOMY	1994
16	255	Blazevich AJ, Gill ND, Zhou S. Intra- and intermuscular variation in human quadriceps femoris architecture assessed	JOURNAL OF ANATOMY	2003

TABLE 2 (Continued)

Rank	Citations	Article	Journal	Year of publication
		in vivo. <i>J Anat.</i> 2006;209(3):289–310. doi:10.1111/j.1469-7580.2006.00619.x		
17	255	Bogduk N, Tynan W, Wilson AS. The nerve supply to the human lumbar intervertebral discs. <i>J Anat.</i> 1981;132(Pt 1):39–56	JOURNAL OF ANATOMY	1999
18	252	Herzog W, Read LJ. Lines of action and moment arms of the major force-carrying structures crossing the human knee joint. <i>J Anat.</i> 1993;182(Pt 2):213–230	JOURNAL OF ANATOMY	1993
19	234	Bogduk N, Wilson AS, Tynan W. The human lumbar dorsal rami. <i>J Anat.</i> 1982;134(Pt 2):383–397	JOURNAL OF ANATOMY	1982
20	228	Willard FH, Vleeming A, Schuenke MD, Danneels L, Schleip R. The thoracolumbar fascia: anatomy, function and clinical considerations. <i>J Anat.</i> 2012;221(6):507–536. doi:10.1111/j.1469-7580.2012.01511.x	JOURNAL OF ANATOMY	1995
21	227	Benjamin M, Kaiser E, Milz S. Structure–function relationships in tendons: a review. <i>J Anat.</i> 2008;212(3):211–228. doi:10.1111/j.1469-7580.2008.00864.x	JOURNAL OF ANATOMY	2009
22	224	Männer J, Pérez-Pomares JM, Macías D, Muñoz-Chápuli R. The origin, formation and developmental significance of the epicardium: a review. <i>Cells Tissues Organs.</i> 2001;169(2):89–103. doi:10.1159/000047867	CELLS TISSUES ORGANS	2001
23	212	Gottschalk F, Kourosh S, Leveau B. The functional anatomy of tensor fasciae latae and gluteus medius and minimus. <i>J Anat.</i> 1989;166:179–189	JOURNAL OF ANATOMY	1989
24	207	Estai M, Bunt S. Best teaching practices in anatomy education: a critical review. <i>Ann Anat.</i> 2016;208:151–157. doi:10.1016/j.aanat.2016.02.010	ANNALS OF ANATOMY-ANATOMISCHER ANZEIGER	2007
25	206	Vleeming A, Schuenke MD, Masi AT, Carreiro JE, Danneels L, Willard FH. The sacroiliac joint: an overview of its anatomy, function and potential clinical implications. <i>J Anat.</i> 2012;221(6):537–567. doi:10.1111/j.1469-7580.2012.01564.x	JOURNAL OF ANATOMY	2001
26	202	Brooks J, Tracey I. From nociception to pain perception: imaging the spinal and supraspinal pathways. <i>J Anat.</i> 2005;207(1):19–33. doi:10.1111/j.1469-7580.2005.00428.x	JOURNAL OF ANATOMY	2001
27	199	Mikić ZD. Age changes in the triangular fibrocartilage of the wrist joint. <i>J Anat.</i> 1978;126(Pt 2):367–384	JOURNAL OF ANATOMY	2006
28	197	Birnbaum K, Prescher A, Hessler S, Heller KD. The sensory innervation of the hip joint—an anatomical study. <i>Surg Radiol Anat.</i> 1997;19(6):371–375. doi:10.1007/BF01628504	SURGICAL AND RADIOLOGIC ANATOMY	2005
29	195	Azer SA, Eizenberg N. Do we need dissection in an integrated problem-based learning medical course? Perceptions of first- and second-year students. <i>Surg Radiol Anat.</i> 2007;29(2):173–180. doi:10.1007/s00276-007-0180-x	SURGICAL AND RADIOLOGIC ANATOMY	2007
30	191	Cheng WT, Liu MT, Liu HN, Lin SY. Micro-Raman spectroscopy used to identify and grade human skin pilomatixoma. <i>Microsc Res Tech.</i> 2005;68(2):75–79. doi:10.1002/jemt.20229	MICROSCOPY RESEARCH AND TECHNIQUE	2005
31	189	Nakanuma Y, Hosono M, Sanzen T, Sasaki M. Microstructure and development of the normal and pathologic biliary tract in humans, including blood supply. <i>Microsc Res Tech.</i> 1997;38(6):552–570. doi:10.1002/(SICI)1097-0029(19970915)38:6<552::AID-JEMT2>3.0.CO;2-H	MICROSCOPY RESEARCH AND TECHNIQUE	1997

(Continues)

TABLE 2 (Continued)

Rank	Citations	Article	Journal	Year of publication
32	187	Cottam WW. Adequacy of medical school gross anatomy education as perceived by certain postgraduate residency programs and anatomy course directors. <i>Clin Anat.</i> 1999;12(1):55–65. doi:10.1002/(SICI)1098-2353(1999)12:1<55::AID-CA8>3.0.CO;2-O	CLINICAL ANATOMY	1999
33	185	Rozen WM, Tran TM, Ashton MW, Barrington MJ, Ivanusic JJ, Taylor GI. Refining the course of the thoracolumbar nerves: a new understanding of the innervation of the anterior abdominal wall. <i>Clin Anat.</i> 2008;21(4):325–333. doi:10.1002/ca.20621	CLINICAL ANATOMY	1993
34	184	Sarubbo S, De Benedictis A, Maldonado IL, Basso G, Duffau H. Frontal terminations for the inferior fronto-occipital fascicle: anatomical dissection, DTI study and functional considerations on a multi-component bundle. <i>Brain Struct Funct.</i> 2013;218(1):21–37. doi:10.1007/s00429-011-0372-3	BRAIN STRUCTURE & FUNCTION	2004
35	183	Williams PE, Goldspink G. Connective tissue changes in immobilised muscle. <i>J Anat.</i> 1984;138(Pt 2):343–350	JOURNAL OF ANATOMY	2003
36	182	Satyapal KS, Haffejee AA, Singh B, Ramsaroop L, Robbs JV, Kalideen JM. Additional renal arteries: incidence and morphometry. <i>Surg Radiol Anat.</i> 2001;23(1):33–38. doi:10.1007/s00276-001-0033-y	SURGICAL AND RADIOLOGIC ANATOMY	2006
37	173	Bastir M, Rosas A, O'Higgins P. Craniofacial levels and the morphological maturation of the human skull. <i>J Anat.</i> 2006;209(5):637–654. doi:10.1111/j.1469-7580.2006.00644.x	JOURNAL OF ANATOMY	2006
38	171	Rojkova K, Volle E, Urbanski M, Humbert F, Dell'Acqua F, Thiebaut de Schotten M. Atlasing the frontal lobe connections and their variability due to age and education: a spherical deconvolution tractography study. <i>Brain Struct Funct.</i> 2016;221(3):1751–1766. doi:10.1007/s00429-015-1001-3	BRAIN STRUCTURE & FUNCTION	2012
39	171	Nieder GL, Parmelee DX, Stolfi A, Hudes PD. Team-based learning in a medical gross anatomy and embryology course. <i>Clin Anat.</i> 2005;18(1):56–63. doi:10.1002/ca.20040	CLINICAL ANATOMY	2002
40	171	Rodríguez-Niedenführ M, Vázquez T, Nearn L, Ferreira B, Parkin I, Sañudo JR. Variations of the arterial pattern in the upper limb revisited: a morphological and statistical study, with a review of the literature. <i>J Anat.</i> 2001;199(Pt 5):547–566. doi:10.1046/j.1469-7580.2001.19950547.x	JOURNAL OF ANATOMY	1996
41	170	Korf HW, Wicht H, Snipes RL, et al. The dissection course—necessary and indispensable for teaching anatomy to medical students. <i>Ann Anat.</i> 2008;190(1):16–22. doi:10.1016/j.aanat.2007.10.001	ANNALS OF ANATOMY - ANATOMISCHER ANZEIGER	1999
42	166	Ilio KY, Hess RA. Structure and function of the ductuli efferentes: a review. <i>Microsc Res Tech.</i> 1994;29(6):432–467. doi:10.1002/jemt.1070290604	MICROSCOPY RESEARCH AND TECHNIQUE	1987
43	165	Robert R, Prat-Pradal D, Labat JJ, et al. Anatomic basis of chronic perineal pain: role of the pudendal nerve. <i>Surg Radiol Anat.</i> 1998;20(2):93–98. doi:10.1007/BF01628908	SURGICAL AND RADIOLOGIC ANATOMY	1995
44	164	Martino J, De Witt Hamer PC, Berger MS, et al. Analysis of the subcomponents and cortical terminations of the perisylvian superior longitudinal fasciculus: a fiber dissection and DTI tractography study. <i>Brain Struct Funct.</i> 2013;218(1):105–121. doi:10.1007/s00429-012-0386-5	BRAIN STRUCTURE & FUNCTION	2000
45	162		ANATOMICAL RECORD -ADVANCES IN	2008

TABLE 2 (Continued)

Rank	Citations	Article	Journal	Year of publication
		Farrell GC, Teoh NC, McCuskey RS. Hepatic microcirculation in fatty liver disease. <i>Anat Rec (Hoboken)</i> . 2008;291(6):684–692. doi:10.1002/ar.20715	INTEGRATIVE ANATOMY AND EVOLUTIONARY BIOLOGY	
46	161	Zarei M, Johansen-Berg H, Smith S, Ciccarelli O, Thompson AJ, Matthews PM. Functional anatomy of interhemispheric cortical connections in the human brain. <i>J Anat</i> . 2006;209(3):311–320. doi:10.1111/j.1469-7580.2006.00615.x	JOURNAL OF ANATOMY	2002
47	161	Koops A, Wojciechowski B, Broering DC, Adam G, Krupski-Berdien G. Anatomic variations of the hepatic arteries in 604 selective celiac and superior mesenteric angiographies. <i>Surg Radiol Anat</i> . 2004;26(3):239–244. doi:10.1007/s00276-004-0229-z	SURGICAL AND RADIOLOGIC ANATOMY	1999
48	161	Vanderwinden JM, Rumessen JJ. Interstitial cells of Cajal in human gut and gastrointestinal disease. <i>Microsc Res Tech</i> . 1999;47(5):344–360. doi:10.1002/(SICI)1097-0029(19991201)47:5<344::AID-JEMT6>3.0.CO;2-1	MICROSCOPY RESEARCH AND TECHNIQUE	1983
49	159	Eckstein F, Hudelmaier M, Putz R. The effects of exercise on human articular cartilage. <i>J Anat</i> . 2006;208(4):491–512. doi:10.1111/j.1469-7580.2006.00546.x	JOURNAL OF ANATOMY	2003
50	159	Frackowiak RS, Friston KJ. Functional neuroanatomy of the human brain: positron emission tomography—a new neuroanatomical technique. <i>J Anat</i> . 1994;184(Pt 2):211–225.	JOURNAL OF ANATOMY	1994
51	157	Engelhardt B, Wolburg-Buchholz K, Wolburg H. Involvement of the choroid plexus in central nervous system inflammation. <i>Microsc Res Tech</i> . 2001;52(1):112–129. doi:10.1002/1097-0029(20010101)52:1<112::AID-JEMT13>3.0.CO;2-5	MICROSCOPY RESEARCH AND TECHNIQUE	1997
52	157	Hansen HC, Helmke K. The subarachnoid space surrounding the optic nerves. An ultrasound study of the optic nerve sheath. <i>Surg Radiol Anat</i> . 1996;18(4):323–328. doi:10.1007/BF01627611	SURGICAL AND RADIOLOGIC ANATOMY	1981
53	153	Benjamin M. The fascia of the limbs and back—a review. <i>J Anat</i> . 2009;214(1):1–18. doi:10.1111/j.1469-7580.2008.01011.x	JOURNAL OF ANATOMY	2003
54	150	Thiel W. Ergänzung für die Konservierung ganzer Leichennach W. Thiel (supplement to the conservation of an entire cadaver according to W. Thiel). <i>Ann Anat</i> . 2002;184(3):267–269. doi:10.1016/s0940-9602(02)80121-2	ANNALS OF ANATOMY - ANATOMISCHER ANZEIGER	1999
55	147	Kerby J, Shukur ZN, Shalhoub J. The relationships between learning outcomes and methods of teaching anatomy as perceived by medical students. <i>Clin Anat</i> . 2011;24(4):489–497. doi:10.1002/ca.21059	CLINICAL ANATOMY	2011
56	146	Goycoolea MV, Lundman L. Round window membrane. Structure function and permeability: a review. <i>Microsc Res Tech</i> . 1997;36(3):201–211. doi:10.1002/(SICI)1097-0029(19970201)36:3<201::AID-JEMT8>3.0.CO;2-R	MICROSCOPY RESEARCH AND TECHNIQUE	2005
57	146	Mayhew TM, Olsen DR. Magnetic resonance imaging (MRI) and model-free estimates of brain volume determined using the Cavalieri principle. <i>J Anat</i> . 1991;178:133–144	JOURNAL OF ANATOMY	2003
58	146	Woodley SJ, Mercer SR. Hamstring muscles: architecture and innervation. <i>Cells Tissues Organs</i> . 2005;179(3):125–141. doi:10.1159/000085004	CELLS TISSUES ORGANS	2005
59	144	Maganaris CN. Force-length characteristics of the in vivo human gastrocnemius muscle. <i>Clin Anat</i> . 2003;16(3):215–223. doi:10.1002/ca.10064	CLINICAL ANATOMY	2003

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TABLE 2 (Continued)

Rank	Citations	Article	Journal	Year of publication
60	143	Waterston SW, Stewart IJ. Survey of clinicians' attitudes to the anatomical teaching and knowledge of medical students. <i>Clin Anat.</i> 2005;18(5):380–384. doi:10.1002/ca.20101	CLINICAL ANATOMY	2005
61	142	Mayoux-Benhamou MA, Revel M, Vallée C, Roudier R, Barbet JP, Bary F. Longus colli has a postural function on cervical curvature. <i>Surg Radiol Anat.</i> 1994;16(4):367–371. doi:10.1007/BF01627655	SURGICAL AND RADIOLOGIC ANATOMY	1994
62	141	Lee TC, Mohsin S, Taylor D, et al. Detecting microdamage in bone. <i>J Anat.</i> 2003;203(2):161–172. doi:10.1046/j.1469-7580.2003.00211.x	JOURNAL OF ANATOMY	2003
63	140	König K, Ehlers A, Riemann I, Schenk I, Bückle R, Kaatz M. Clinical two-photon microendoscopy. <i>Microsc Res Tech.</i> 2007;70(5):398–402. doi:10.1002/jemt.20445	MICROSCOPY RESEARCH AND TECHNIQUE	2007
64	140	Preston JE. Aging choroid plexus-cerebrospinal fluid system. <i>Microsc Res Tech.</i> 2001;52(1):31–37. doi:10.1002/1097-0029(20010101)52:1<31::AID-JEMT5>3.0.CO;2-T	MICROSCOPY RESEARCH AND TECHNIQUE	2001
65	140	Szél A, Röhlich P, Caffé AR, van Veen T. Distribution of cone photoreceptors in the mammalian retina. <i>Microsc Res Tech.</i> 1996;35(6):445–462. doi:10.1002/(SICI)1097-0029(19961215)35:6<445::AID-JEMT4>3.0.CO;2-H	MICROSCOPY RESEARCH AND TECHNIQUE	1996
66	140	Adams MA, Dolan P. Intervertebral disc degeneration: evidence for two distinct phenotypes. <i>J Anat.</i> 2012;221(6):497–506. doi:10.1111/j.1469-7580.2012.01551.x	JOURNAL OF ANATOMY	2012
67	138	Evan AP, Coe FL, Lingeman JE, et al. Mechanism of formation of human calcium oxalate renal stones on Randall's plaque. <i>Anat Rec (Hoboken).</i> 2007;290(10):1315–1323. doi:10.1002/ar.20580	ANATOMICAL RECORD - ADVANCES IN INTEGRATIVE ANATOMY AND EVOLUTIONARY BIOLOGY	2007
68	137	Fairclough J, Hayashi K, Toumi H, et al. The functional anatomy of the iliotibial band during flexion and extension of the knee: implications for understanding iliotibial band syndrome. <i>J Anat.</i> 2006;208(3):309–316. doi:10.1111/j.1469-7580.2006.00531.x	JOURNAL OF ANATOMY	2006
69	136	Fitzgerald JE, White MJ, Tang SW, Maxwell-Armstrong CA, James DK. Are we teaching sufficient anatomy at medical school? The opinions of newly qualified doctors. <i>Clin Anat.</i> 2008;21(7):718–724. doi:10.1002/ca.20662	CLINICAL ANATOMY	2008
70	133	Fox AJ, Wanivenhaus F, Burge AJ, Warren RF, Rodeo SA. The human meniscus: a review of anatomy, function, injury, and advances in treatment. <i>Clin Anat.</i> 2015;28(2):269–287. doi:10.1002/ca.22456	CLINICAL ANATOMY	2015
71	133	Abu-Hijleh MF, Habbal OA, Moqattash ST. The role of the diaphragm in lymphatic absorption from the peritoneal cavity. <i>J Anat.</i> 1995;186(Pt 3):453–467	JOURNAL OF ANATOMY	1995
72	132	Neubauer S, Gunz P, Hublin JJ. The pattern of endocranial ontogenetic shape changes in humans. <i>J Anat.</i> 2009;215(3):240–255. doi:10.1111/j.1469-7580.2009.01106.x	JOURNAL OF ANATOMY	2009
73	132	Kriz W. Podocyte is the major culprit accounting for the progression of chronic renal disease. <i>Microsc Res Tech.</i> 2002;57(4):189–195. doi:10.1002/jemt.10072	MICROSCOPY RESEARCH AND TECHNIQUE	2002
74	131	Gallay MN, Jeanmonod D, Liu J, Morel A. Human pallidothalamic and cerebellothalamic tracts: anatomical basis for functional stereotactic neurosurgery. <i>Brain Struct Funct.</i> 2008;212(6):443–463. doi:10.1007/s00429-007-0170-0	BRAIN STRUCTURE & FUNCTION	2008

TABLE 2 (Continued)

Rank	Citations	Article	Journal	Year of publication
75	131	Lexell J, Taylor CC. Variability in muscle fibre areas in whole human quadriceps muscle: effects of increasing age. <i>J Anat.</i> 1991;174:239–249	JOURNAL OF ANATOMY	1991
76	130	Shababi M, Lorson CL, Rudnik-Schöneborn SS. Spinal muscular atrophy: a motor neuron disorder or a multi-organ disease? <i>J Anat.</i> 2014;224(1):15–28. doi:10.1111/joa.12083	JOURNAL OF ANATOMY	2014
77	130	Pinar YA, Govsa F. Anatomy of the superficial temporal artery and its branches: its importance for surgery. <i>Surg Radiol Anat.</i> 2006;28(3):248–253. doi:10.1007/s00276-006-0094-z	SURGICAL AND RADIOLOGIC ANATOMY	2006
78	130	Paulsen F, Tillmann B, Christofides C, Richter W, Koebeke J. Curving and looping of the internal carotid artery in relation to the pharynx: frequency, embryology and clinical implications. <i>J Anat.</i> 2000;197(Pt 3):373–381. doi:10.1046/j.1469-7580.2000.19730373.x	JOURNAL OF ANATOMY	2000
79	130	Pelletier RM, Byers SW. The blood-testis barrier and Sertoli cell junctions: structural considerations. <i>Microsc Res Tech.</i> 1992;20(1):3–33. doi:10.1002/jemt.1070200104	MICROSCOPY RESEARCH AND TECHNIQUE	1992
80	130	Kurz B, Lemke AK, Fay J, Pufe T, Grodzinsky AJ, Schünke M. Pathomechanisms of cartilage destruction by mechanical injury. <i>Ann Anat.</i> 2005;187(5–6):473–485. doi:10.1016/j.aanat.2005.07.003	ANNALS OF ANATOMY-ANATOMISCHER ANZEIGER	2005
81	130	Lazennec JY, Charlot N, Gorin M, et al. Hip-spine relationship: a radio-anatomical study for optimization in acetabular cup positioning. <i>Surg Radiol Anat.</i> 2004;26(2):136–144. doi:10.1007/s00276-003-0195-x	SURGICAL AND RADIOLOGIC ANATOMY	2004
82	129	Ramsay DT, Kent JC, Hartmann RA, Hartmann PE. Anatomy of the lactating human breast redefined with ultrasound imaging. <i>J Anat.</i> 2005;206(6):525–534. doi:10.1111/j.1469-7580.2005.00417.x	JOURNAL OF ANATOMY	2005
83	129	Swartz MA, Skobe M. Lymphatic function, lymphangiogenesis, and cancer metastasis. <i>Microsc Res Tech.</i> 2001;55(2):92–99. doi:10.1002/jemt.1160	MICROSCOPY RESEARCH AND TECHNIQUE	2001
84	129	Pollock H, Hutchings M, Weller RO, Zhang ET. Perivascular spaces in the basal ganglia of the human brain: their relationship to lacunes. <i>J Anat.</i> 1997;191(Pt 3):337–346. doi:10.1046/j.1469-7580.1997.19130337.x	JOURNAL OF ANATOMY	1997
85	128	Benjamin M, Qin S, Ralphs JR. Fibrocartilage associated with human tendons and their pulleys. <i>J Anat.</i> 1995;187(Pt 3):625–633	JOURNAL OF ANATOMY	1995
86	127	Hermans JJ, Beumer A, de Jong TA, Kleinrensink GJ. Anatomy of the distal tibiofibular syndesmosis in adults: a pictorial essay with a multimodality approach. <i>J Anat.</i> 2010;217(6):633–645. doi:10.1111/j.1469-7580.2010.01302.x	JOURNAL OF ANATOMY	2010
87	127	Yang ZF, Poon RT. Vascular changes in hepatocellular carcinoma. <i>Anat Rec (Hoboken).</i> 2008;291(6):721–734. doi:10.1002/ar.20668	ANATOMICAL RECORD - ADVANCES IN INTEGRATIVE ANATOMY AND EVOLUTIONARY BIOLOGY	2008
88	127	Spencer R. Theoretical and analytical embryology of conjoined twins: Part I: embryogenesis. <i>Clin Anat.</i> 2000;13(1):36–53. doi:10.1002/(SICI)1098-2353(2000)13:1<36::AID-CA5>3.0.CO;2-3	CLINICAL ANATOMY	2000
89	127	van Ingen Schenau GJ, Bobbert MF, Rozendal RH. The unique action of bi-articular muscles in complex movements. <i>J Anat.</i> 1987;155:1–5.	JOURNAL OF ANATOMY	1987

(Continues)

TABLE 2 (Continued)

Rank	Citations	Article	Journal	Year of publication
90	122	Fuss FK. The ulnar collateral ligament of the human elbow joint. <i>Anatomy, function and biomechanics. J Anat.</i> 1991;175:203–212	JOURNAL OF ANATOMY	1991
91	121	Knop E, Knop N. The role of eye-associated lymphoid tissue in corneal immune protection. <i>J Anat.</i> 2005;206(3):271–285. doi:10.1111/j.1469-7580.2005.00394.x	JOURNAL OF ANATOMY	2005
92	121	Bartonicek J. Anatomy of the tibiofibular syndesmosis and its clinical relevance. <i>Surg Radiol Anat.</i> 2003;25(5–6):379–386. doi:10.1007/s00276-003-0156-4	SURGICAL AND RADIOLOGIC ANATOMY	2003
93	120	Patel KM, Moxham BJ. The relationships between learning outcomes and methods of teaching anatomy as perceived by professional anatomists. <i>Clin Anat.</i> 2008;21(2):182–189. doi:10.1002/ca.20584	CLINICAL ANATOMY	2008
94	118	Birk DE, Zycband EI, Woodruff S, Winkelmann DA, Trelstad RL. Collagen fibrillogenesis in situ: fibril segments become long fibrils as the developing tendon matures. <i>Dev Dyn.</i> 1997;208(3):291–298. doi:10.1002/(SICI)1097-0177(199703)208:3<291::AID-AJA1>3.0.CO;2-D	DEVELOPMENTAL DYNAMICS	1997
95	117	Nieuwenhuys R. The myeloarchitectonic studies on the human cerebral cortex of the Vogt-Vogt school, and their significance for the interpretation of functional neuroimaging data. <i>Brain Struct Funct.</i> 2013;218(2):303–352. doi:10.1007/s00429-012-0460-z	BRAIN STRUCTURE & FUNCTION	2013
96	117	Williams PE, Catanese T, Lucey EG, Goldspink G. The importance of stretch and contractile activity in the prevention of connective tissue accumulation in muscle. <i>J Anat.</i> 1988;158:109–114	JOURNAL OF ANATOMY	1988
97	117	Vasile F, Dossi E, Rouach N. Human astrocytes: structure and functions in the healthy brain. <i>Brain Struct Funct.</i> 2017;222(5):2017–2029. doi:10.1007/s00429-017-1383-5	BRAIN STRUCTURE & FUNCTION	2017
98	116	Brenner E. Human body preservation - old and new techniques. <i>J Anat.</i> 2014;224(3):316–344. doi:10.1111/joa.12160	JOURNAL OF ANATOMY	2014
99	110	Atherton DS, Deep NL, Mendelsohn FO. Micro-anatomy of the renal sympathetic nervous system: a human postmortem histologic study. <i>Clin Anat.</i> 2012;25(5):628–633. doi:10.1002/ca.21280	CLINICAL ANATOMY	2012
100	110	Stephan KE. On the role of general system theory for functional neuroimaging. <i>J Anat.</i> 2004;205(6):443–470. doi:10.1111/j.0021-8782.2004.00359.x	JOURNAL OF ANATOMY	2004

TABLE 3 Field and type of study

Study type	Embryological	Functional	Imaging	Morphology	Structural	Other	Educational	Total
Case Report	0	1	0	0	0	0	0	1
Comparative	0	2	0	2	0	1	1	6
Original	1	7	9	5	19	4	7	52
Review	3	7	4	9	11	5	1	40
Meta analysis	0	0	0	1	0	0	0	1
Total	4	17	13	17	30	10	9	100

functional ($n = 7$). Comparative studies were the next most frequently referenced type and focused mainly on functional ($n = 2$) and morphological ($n = 2$) anatomy. There was one case report involving the

functional anatomy of the iliotibial band and one meta-analysis that focused on lymphatic function and lymphangiogenesis during cancer metastasis.

4 | DISCUSSION

In this literature review, we present the top 100 most cited articles in clinical, surgical, or educational anatomy published since 1976. Our research was conducted similarly to other reviews of the most relevant articles within their respective fields (Khan et al., 2016; Lee et al., 2020; Park et al., 2017; Ponce & Lozano, 2010; Shuaib & Costa, 2015). In order to focus this review solely on clinical, surgical, or educational anatomy, we excluded basic science research, animal studies, and any articles that did not fit the criteria described in the methods section. This paper is an important contribution to the field of anatomy because only one other article referencing the top 100 cited papers in anatomy has been published (Petekkaya, 2019). Petekkaya (2019) also used the WoS; however, instead of searching for the highest cited journals in anatomy and morphology, the term “anatomy” was used for that search and the report was structured on the basis of that criterion. The top journals cited by Petekkaya (2019) included *Neuroimage*, *Brain*, and *Nature Reviews Neuroscience*. Publications from 20 scientific journals were included, whereas we limited our search to 15. Owing to the nature of the search, the study by Petekkaya (2019) focused more on neuroscience and neuroanatomy because of the growth in the literature concerning these fields, as discussed by the author. In the present study, we focused on the 100 most cited anatomy articles in clinical, surgical, and educational anatomy within one table, in the hope of eliminating the time burden for other physicians, residents, and others interested in the most cited research in anatomy.

5 | LIMITATIONS

There are several limitations associated with bibliometric analyses of published data. Although analyzing the literature by ranking articles on the basis of total citations permits the most impactful papers in anatomy to be identified objectively, there is an ongoing debate about correlating number of citations with contribution to the field (Moed, 2009). Older studies can seem to have a greater impact because they have had more time to accumulate citations, while newer studies that could be more relevant have fewer citations because they are recent (Gisvold, 1999). The limitations of Web of Science must also be recognized as it only includes data from 1976 to 2021, so older articles or very recent ones are not included in the present analysis.

6 | CONCLUSION

This study presented the 100 most cited journal articles in clinical and surgical anatomy from selected journals using the Journal Citation Report database and identified the most impactful papers by compiling the most cited ones using the Web of Science Core Collection.

While this is not a flawless method for determining the impact of a researcher or publication quality, it allowed us to perform a meaningful bibliometric analysis of published data and thus help anatomists and clinicians to familiarize themselves with pioneering research in anatomy.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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