A Bibliometric Analysis of the Top Cited Articles in Sports and Exercise Medicine

Omeet Khatra,*† BSc, Armita Shadgan,‡ BSc, Jack Taunton,§ BSc, MSc, MD, Amir Pakravan,‖ MD, FFSEM (UK), DipSEM (UK/I), and Babak Shadgan,*,# MSc, PhD, MD

Investigation performed at the University of British Columbia, Vancouver, Canada

Background: Although citation analysis is common in many areas of medicine, there is a lack of similar research in sports and exercise medicine.

Purpose: To identify and examine the characteristics of the 100 top cited articles in the field of sports and exercise medicine in an effort to determine what components make an article highly influential.

Study Design: Cross-sectional study.

Methods: The Web of Science, Scopus, and PubMed databases were used to determine the 100 top cited articles from 46 journals in the field of sports and exercise medicine. Each of the 100 articles was then analyzed by 2 independent reviewers, and results were compared. Basic information was collected, including journal title, country of origin, and study type. Different categories were compared using descriptive statistics of counts or percentages.

Results: The 100 top cited articles were published in 15 of the 46 identified sports and exercise medicine journals, with the most prolific being *Medicine and Science in Sports and Exercise* (n = 49), American Journal of Sports Medicine (n = 18), and Sports Medicine (n = 7). In terms of country of origin, the top 3 contributors were the United States (n = 65), Canada (n = 9), and Sweden (n = 8). The most commonly researched anatomic areas were the knee (n = 15) and the brain (n = 3). Narrative reviews were the most common study type (n = 38), and only a single study on the top 100 cited articles list used a randomized controlled trial design. The most prevalent fields of study were exercise science (55% of articles) and well-being (16% of articles).

Conclusion: Narrative reviews from the United States and published in English-language journals were the most likely to be highly cited. In addition, the knee was a common anatomic area of study on the top cited list of research in sports and exercise medicine.

Keywords: citation analysis; citation counts; top cited articles; sports medicine; exercise medicine

Citation analysis is a bibliometric method to evaluate research performance in a specific field by examining the frequency and patterns of citations in scientific literature.3-6 It is one effective method of determining an article’s effect on a particular site of study.12,19,20,29,31 It is also commonly used by academic institutions and government bodies to recognize scholarly excellence for the purposes of allocation of funding and determination of awards, as well as for tenure decisions. Within medicine, there are numerous examples of the use of citation analysis to identify scholarly work of particular significance in a specialty of interest.3,5,6,26,28,34,36,41 Sports and exercise medicine is a broad and rapidly growing discipline involving the following: (1) management of sports injuries and medical conditions in exercising individuals; (2) the biomechanics and optimization of athletic performance; and (3) the use of exercise as a medical intervention in the treatment, rehabilitation, and prevention of illness at the individual and population level.30 This breadth and growth is evidenced in part by the increasing number of articles published by researchers in a variety of journals related to this topic. At the time of this study, there were 46 journals related to sports and exercise medicine in the combined databases of Web of Science, Scopus, and PubMed. One area of sports and exercise medicine is orthopaedic sports medicine, which mainly involves prevention and treatment of musculoskeletal conditions in sports.

Web of Science is a subscription-based platform that provides access to 15 citation indexes.15 This encompasses >34,385 journals, books, proceedings, patents, and data sets, which extend from 1800 to present day. Web of Science was originally produced by the Institute for Scientific Information and is currently maintained by Clarivate Analytics. Scopus is a subscription-based abstract and indexing database that was produced by Elsevier.10 It indexes >14,000 titles from 4000 publishers. Scopus contains 27 million abstracts with citations dating back to 1966. PubMed is a free database administered by the National Center for
Biotechnology Information at the US National Library of Medicine that contains >30 million citations and abstracts of peer-reviewed biomedical literature. It does not include full-text journal articles; however, links to full-text articles from other sources are provided when available.

Although citation analysis is common in many areas of medicine, there is a lack of similar research in sports and exercise medicine. The only previous effort of a citation analysis of the literature in its entirety was by Garfield, who looked at data between 1981 and 1996 and presented his findings at the 44th Annual Meeting of the American College of Sports Medicine on May 13, 1997. However, his findings remained unpublished. Nayar et al. also performed a citation analysis, but it focused on the subspecialty of orthopaedic sports medicine. The purpose of this study was therefore to fill this void by identifying the 100 top cited articles published in journals related to sports and exercise medicine and analyzing key characteristics, such as year of publication, country of origin, source journal, and level of evidence. We hypothesized that factors, such as language, topic, level of evidence, and country of origin, would be among the key determinants of scientific effect.

We believe that this study will provide valuable information about the evidence basis for specific aspects of current clinical practice in sports and exercise medicine and help inform practitioners, researchers, and policy makers about potential research and funding priorities. The analysis can also assist researchers in finding appropriate strategies for achieving the highest scientific effect.

METHODS

The first step in our analysis was to identify and create a list of journals with a focus on sports and exercise medicine. Citation analyses in the past used a single database to create this list of journals. To create a more comprehensive list, we used the combined databases of Web of Science, Scopus, and PubMed. In May 2019, we searched the Web of Science category “sport sciences,” which yielded 316,740 publications. The source journals of these publications were determined and comprised a list of 100 journals. From this list, we removed those that were not closely related to sports and exercise medicine, leaving us with 35 journals. Next, we searched Scopus using the subject category “orthopaedics and sports medicine.” This provided us a citation rank list of 334 journals, which was reduced to 44 journals after removal of those not closely related to sports and exercise medicine. Next, we searched PubMed using the term “sports medicine.” This search yielded 10,578 articles. We identified the journals of origin and selected those that were related to sports and exercise medicine, yielding a total of 27 journals. Finally, we combined the selected journals from the 3 sources and removed any duplicate entries, thus creating a master list of 46 sports and exercise medicine–related journals (Appendix Table A1).

The second step in our analysis was to determine the 100 top cited articles from our comprehensive list of journals. We performed a complete search of all the journals on Web of Science, which generated 154,492 publications. These publications were then ranked by number of times cited, and the 100 top cited articles were recorded. Each of these 100 articles was then analyzed by 2 independent reviewers (O.K. and B.S.) using a standardized questionnaire, and the results were compared. Basic information was collected, including source journal, publication year, H-index, Altmetric score, language of publication, study participants, research design, research methods, study design, level of evidence, authors, age group, field of study, and study conclusions. The H-index, proposed by J.E. Hirsch in 2005, is an author-specific value that captures output based on the total number of publications and the total number of citations. It provides a focused assessment of an individual’s research performance. The Altmetric score is a weighted count of all the online attention that a research output has received. This includes mentions in public policy documents and references in Wikipedia, the mainstream news, social networks, and blogs.

The different categories of information were compared using descriptive statistics of counts or percentages. Statistical analysis was performed using jamovi Version 1.0.8.0 (The jamovi project). A chi-square test of association and linear regression test were used to compare groups. P ≤ .05 was considered significant.

RESULTS

The 100 top cited articles are listed in Appendix Table A2. The top 28 articles were cited >1000 times, and the range in the top 100 was from 7228 to 534 citations. They were published in 15 of the 46 identified sports and exercise medicine–related journals; the 3 journals with the majority of articles in the top 100 were the American Journal of Sports Medicine, The American Journal of Sports Medicine, and The American Journal of Sports Medicine.
TABLE 1

| Journal                                                   | No. of Articles |
|-----------------------------------------------------------|----------------|
| Medicine and Science in Sports and Exercise (n = 49)      |                |
| American Journal of Sports Medicine (n = 18)              |                |
| Sports Medicine                                           | 7              |
| Research Quarterly for Exercise and Sport (n = 4)         |                |
| British Journal of Sports Medicine (n = 3)                |                |
| Journal of Athletic Training (n = 3)                      |                |
| Journal of Sports Sciences (n = 3)                        |                |
| Canadian Journal of Sports Sciences (n = 3)               |                |
| Exercise and Sport Sciences Review (n = 2)                |                |
| International Journal of Sports Medicine (n = 2)          |                |
| Journal of Strength and Conditioning Research (n = 2)     |                |
| Clinical Journal of Sport Medicine (n = 1)                |                |
| International Journal of Sports Physiology and Performance| 1              |
| Journal of Orthopaedic and Sports Physical Therapy        | 1              |
| The Physician and Sportsmedicine                          | 1              |

Medicine (n = 18), Medicine and Science in Sports and Exercise (n = 49), and Sports Medicine (n = 7), as seen in Table 1.

The publication dates of the 100 top cited articles spanned between 1973 and 2013. The 5 top cited articles were published in the years 1982, 2000, 2003, 2007, and 2011. The decade with the greatest number of articles in the top 100 was the 2000-2009 period (n = 51), and only 1 article was published in the 1970s (Figure 1A). There was less variation in the mean number of citations in each decade, as seen in Figure 1B.

Although all of the top 100 articles were published in English, there was some diversity in terms of the country of origin. The top 3 contributors were the United States (n = 65), Canada (n = 9), and Sweden (n = 8). The most prominent institution was the University of South Carolina, with 4 articles in the top 100. In terms of contributions from outside the United States, the University of Copenhagen and the University of Queensland also had substantial influence, with 3 articles each. The most frequent author was S.G. Trost, with 5 lead authorships. The number of authors per article ranged from 1 to 10, with 10 articles being published by a single author.

Of the 100 top cited articles, 22 focused on a specific anatomic zone, such as the knee (n = 15), brain (n = 3), or ankle (n = 2) (Figure 2), with the remainder being more general in scope.

Many of the articles studying the knee were related to the biomechanics, consequences, and prevention of ACL injury. All articles focusing on the brain discussed sports-related concussion. In terms of the age demographic evaluated, the largest proportion of articles were general and not focused on any specific population (n = 44). However, a significant number investigated a pediatric (n = 16) or an adult (n = 31) population. Similar age groups were studied regardless of decade of publication (P = .64; χ² = 23.3; χ² test of association). In terms of field of study, 69 articles had a single focus, and 31 were multifocus (Figure 3A). The most common field of study was exercise science, with 55% of articles featuring it as at least a partial focus (Figure 3B).

Well-being and clinical injury studies were also quite common, as they were areas of interest in 16% and 13% of articles, respectively. Of the 100 top cited articles, 10 were sport-specific studies, with soccer being the most common sport of interest (n = 6).

The 3 most common study types from the 100 top cited articles were narrative review (n = 38), cohort (n = 20), and methodological (n = 16). Case series accounted for only 10% of the top 100 top cited articles. Only 1 article in the top 100 was a randomized controlled trial. The most common level of evidence was level 4 (n = 68), which is consistent with

![Figure 1](https://example.com/figure1.png)

**Figure 1.** (A) Number of articles on the 100 top cited articles by decade of publication. (B) Mean number of citations by decade of publication for articles on the 100 top cited articles list.

![Figure 2](https://example.com/figure2.png)

**Figure 2.** Breakdown of the 100 top cited articles based on anatomic area of focus.
with the most frequent study design types. There was no significant difference in level of evidence based on decade of publication ($P = .85; \chi^2 = 10.1; \chi^2$ test of association).

We found no correlation between an article's Altmetric score and the number of times that it was cited ($r = 0.08$; linear regression test; $P > .05$). We also found no correlation between the H-index of the lead author of an article and the number of times that it was cited ($r = 0.05$; linear regression test; $\leq .05$).

**DISCUSSION**

The purpose of this article was to identify the 100 top cited articles in the field of sports and exercise medicine and examine their characteristics in an effort to determine what elements of an article make it highly influential.

The top cited article in our list had 7228 citations (Appendix Table A2). Comparatively, this is much greater than that of the top cited article in similar reviews of other subspecialties, such as orthopaedic surgery (1748 citations), rehabilitation (1109 citations), and emergency medicine (335 citations). In terms of the temporal distribution of citations, the 2000-2009 period had by far the greatest number of citations on our 100 top cited articles list ($n = 51$); this appears in line with a similar study on spinal deformity. The earliest article was published in 1973 and was the only article on the list from the 1970s (Figure 1A). In a similar citation analysis in orthopaedic

---

**Figure 3.** Breakdown of articles on the 100 top cited articles list based on (A) singular or multiple fields of study and (B) field of study by percentage of all articles.
surgery, a substantial number of top cited articles were published in the 1940s to 1970s. This unique citation pattern in sports and exercise medicine is likely secondary to several key assertions. First, as shown in previous studies, it generally requires 10 to 20 years for prominent articles to receive their maximal recognition and reach their peak in terms of number of citations. Second, sports and exercise medicine is a relatively novel medical discipline, especially in comparison with orthopaedic surgery. Third, there has been a rapid growth in the field of sports and exercise medicine, with increased formal fellowship training opportunities over the past 2 decades, which has in turn vastly increased the amount of research output from the specialty.

Nearly two-thirds of the 100 top cited sports and exercise medicine–related articles were from the United States. Although this makes up the majority, it is actually a smaller proportion when compared with other medical subspecialties, such as general surgery (78%), orthopaedic surgery (76%), and otolaryngology (85%). This preponderance of US-based publications is secondary to several factors: (1) the American scientific community is sizably larger than that of anywhere else in the world; (2) the United States has the most available funding for research; and (3) American authors tend to preferentially cite American articles and publish their articles in American journals. As a result, US authors have an inherent advantage when attempting to publish highly cited and influential articles, although it seems that this advantage is slightly mitigated in sports and exercise medicine.

We found that 68% of the top cited articles were classified as level 4 evidence, which is reflected in the most common study type of narrative review. Case series, which were very common in previous citation analyses in orthopaedic surgery and rehabilitation, accounted for only 10% of the 100 top cited articles. This difference may partially be attributable to the multitude of institutional reviews, especially by the American College of Sports Medicine, which have been highly influential in sports and exercise medicine literature and are found throughout our 100 top cited articles list.

The knee was by far the most common anatomic site of study, accounting for 15 articles on the 100 top cited articles list (Figure 2). A majority of these articles focused on the anterior cruciate ligament. Areas of focus included injury prevention, short- and long-term consequences of injury, epidemiology, rehabilitation, and biomechanics. There was also a preponderance of female athlete studies in the ACL-related publications. These articles were published across a broad time span, extending from 1988 to 2005, and may serve as a possible area of focus for future researchers who hope to publish articles that affect the field of sports and exercise medicine.

Overall, 10% of the articles on the 100 top cited articles list were sport-specific studies, with the majority focusing on soccer. This was somewhat of a surprise because the United States was responsible for the majority of articles and soccer is of relatively lower popularity in this country in comparison with other major sports, such as football, baseball, and basketball. It may point to alternative explanations for this predisposition to soccer, such as ease of research, interest from highly influential or highly cited authors, increased acceptance of research groups into professional and semiprofessional soccer teams, sport-specific injury patterns, or possibly the popularity of the sport worldwide.

We found no correlation between the number of times that an article was cited and its Altmetric score. This may highlight a discrepancy between an article’s effect within the scientific community, which can be gauged by the number of times that it is cited, and its influence on the community at large, which is what the Altmetric score aims to capture.

As is the case with other citation analyses, several limitations to this study should be acknowledged. First and possibly the most significant is that, although westrived to create the most comprehensive list of journals possible using the combined databases of Web of Science, Scopus, and PubMed, articles published in general medical and basic science journals were not considered in this study, possibly leaving out influential works. A second limitation relates to the time of publication, with more recently published articles having an inherent disadvantage in terms of citation count. Given this disadvantage, potentially more relevant and highly influential articles published more recently may not have made the 100 top cited articles list because they have not had enough time to accumulate the necessary number of citations. This type of citation analysis also does not account for self-citation, citation in textbooks or lectures, and the predilection of authors to cite articles that are published in the journals in which they hope to publish their own work. There may also be confounding attributed to biases related to the tendency to cite articles generated by prolific researchers or colleagues, as well as a tendency to cite an article because it has previously been highly cited, in a type of “snowball effect.”

CONCLUSION

To our knowledge, this is the first comprehensive published citation analysis in sports and exercise medicine. Our findings indicated that narrative reviews focused on exercise science that were from the United States and were published in English-language, US-based journals were the most likely to be highly cited. We also found that the knee was a common anatomic site of study in these highly cited articles.

REFERENCES

1. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32(9):498-504.
2. Albert DM. Analysis of the Archives’ most frequently cited articles. Arch Ophthalmol. 1988;106:465-470.
3. Asif IM. Celebrating the advancement of science in sports medicine: a 10-year collaboration between sports health and the AMSSM. Sports Health. 2018;10(2):110-112.
4. Badhiwala JH, Nassiri F, Witv CD, et al. Highly cited works in spinal disorders: the top 100 most cited papers published in spine journals. Spine. 2018;43(24):1746-1755.

5. Baltussen A, Kindler CH. Citation classics in anesthetic journals. Anesth Analg. 2004;98:443-451.

6. Baltussen A, Kindler CH. Citation classics in critical care medicine. Intensive Care Med. 2004;30:902-910.

7. Bangsbo J, Norregaard L, Thorso F. Activity profile of competition soccer. Can J Sports Sci. 1991;16(2):110-116.

8. Borg GA. Perceived exertion: a note on “history” and methods. Med Sci Sports. 1973;5(2):90-93.

9. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982;14(5):377-381.

10. Burnham HM. Leading 20 at 20: top-cited articles and authors in the journal of orthopaedic trauma, 1987-2007. J Orthop Trauma. 2007;21(4):275-283.

11. Campbell FM. National bias: a comparison of citation practices by health professionals. Bull Med Libr Assoc. 1990;78:376-382.

12. Cheek J, Garnham B, Quan J. What’s in a number? Issues in providing evidence of impact and quality of research. Qual Health Res. 2006;16:423-435.

13. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381-1385.

14. Cullen M, Batt M. Sport and exercise medicine in the United Kingdom comes of age. Br J Sports Med. 2005;39(6):250-253.

15. Duffy JC. Web of Science. 2003;35(9):250-253.

16. Fenton JE, Roy D, Hughes JP. A century of citation classic in otolaryngology–head and neck surgery journals. J Laryngol Otol. 2002;116:494-498.

17. Football still Americans’ favorite sport to watch. Gallup Poll. Accessed May 8, 2020. https://news.gallup.com/poll/224864/football-americans-favorite-sport-watch.aspx

18. Garfield E, Batt M. Sport and exercise medicine in the United Kingdom comes of age. Br J Sports Med. 2005;39(6):250-253.

19. Garfield E. Citation classics from the Journal of the American Medical Association. JAMA. 1987;257:52-59.

20. Garfield E. Citation analysis as a tool in journal evaluation. Science. 1972;178:471-479.

21. Garfield E. Citation analysis of sports medicine research, 1981-1996 productivity, impact and influence of nations, institutions and researchers. Paper presented at: Proceedings of the 44th Annual Meeting of the American College of Sports Medicine; May 13, 1997; Denver, CO.

22. Hall GM. BJA citation classics 1945-1992. Br J Anaesth. 1998;80:4-6.

23. Hennessey K, Afshear K, MacNeil AE. The top 100 cited articles in urology. Can Urol Assoc J. 2009;3(4):293-302.

24. Krustrup P, Mohr M, Amstrup T, et al. The yo-yo intermittent recovery test: physiological response, reliability and validity. Med Sci Sports Exerc. 2003;35(4):697-705.

25. Lefaivre KA, Guy P, O’Brien PJ, Blachut PA, Shadgan B, Broekhuysse HM. Leading 20 at 20: top-cited articles and authors in the journal of orthopaedic trauma, 1987-2007. J Orthop Trauma. 2010;24(1):53-58.

26. Lefaivre KA, Shadgan B, O’Brien PJ. 100 Most cited articles in orthopaedic surgery. Clin Orthop Relat Res. 2011;469(5):1487-1497.

27. Liu L, Liu S, Alastra AJ, et al. The 100 most cited vs most relevant articles in the Journal of Neurosurgery: a bibliometric analysis. Curr. 2019;11(4):e4498.

28. Lefaivre KA, Shadgan B, O’Brien PJ, Blachut PA, Shadgan B, Broekhuysse HM. Leading 20 at 20: top-cited articles and authors in the journal of orthopaedic trauma, 1987-2007. J Orthop Trauma. 2010;24(1):53-58.

29. Loonen MP, Hage JJ, Kon M. Plastic surgery classics: characteristics of 50 top-cited articles in four plastic surgery journals since 1946. Plast Reconstr Surg. 2008;121:320e-320e.

30. Moed HF. New development in the use of citation analysis in research evaluation. Arch Immunol Ther Exp. 2009;57:13-18.

31. Mohr M, Krustop P, Bangsbo J. Match performance of high standard soccer players with special reference to development of fatigue. J Sports Sci. 2003;21(7):519-528.

32. Nayyar SK, Dein EJ, Spiker AM, Bernard JA, Zikria BA. The top 100 cited articles in clinical orthopaedic sports medicine. Am J Orthop. 2015;44(8):252-261.

33. Paladuga R, Schein M, Gardezi S. One hundred citation classics in general surgical journals. World J Surg. 2002;26:1099-1105.

34. Pate RR, O’Neill JR, Lobelo F. The evolving definition of “sedentary.” Exerc Sport Sci Rev. 2008;36(4):173-178.

35. Shadgan B, Roig M, Hajighanbari B, Reid WD. Top-cited articles in rehabilitation. Arch Phys Med Rehabil. 2010;91(5):806-815.

36. Shelbourne KD, Nitz P. Accelerated rehabilitation after anterior cruciate ligament reconstruction. Am J Sports Med. 1990;18(3):292-299.

37. Troiano RP, Berrigan D, Dodd KW, Massie LC, Tiltor T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2007;40(1):181-188.

38. Trost SG, Pate RR, Freedson PS, Salis JF, Taylor WC. Using objective physical activity measures with youth: how many days of monitoring are needed. Med Sci Sports Exerc. 1999;32(2):426-431.

39. Trout SG, Ward DS, Moorehead SM, Watson PD, Riner W, Burke JR. Validity of the computer science and applications (CSA) activity monitor in children. Med Sci Sports Exerc. 1998;30(4):629-633.

40. Tsai YL, Lee CC, Chen SC, Yen ZS. Top-cited articles in emergency medicine. Am J Emerg Med. 2006;24:647-654.

41. University of Illinois at Chicago, University Library. Measuring your research impact: impact factor, citation analysis, and other metrics—other metrics/altmetrics. Published 2018. Accessed on December 1, 2019. https://researchguides.uic.edu/c.php?g=1683205

42. University of Illinois at Chicago, University Library. Measuring your impact: impact factor, citation analysis, and other metrics—citation analysis. Published 2018. Accessed on December 1, 2019. https://researchguides.uic.edu/if/altmetrics

43. US National Library of Medicine. PubMed overview. Published 2019. https://www.nlm.nih.gov/bsd/pubmed.html

44. Zhang Y, Wumaier M, He D, Xiao B, Zhang J. The 100 top-cited articles on spinal deformity: a bibliometric analysis. Spine. 2020; 45(4):275-283.
APPENDIX

TABLE A1
Sports and Exercise Medicine–Related Journals on Web of Science, Scopus, and PubMed

| Journal Name |
|--------------|
| American Journal of Sports Medicine |
| Annals of Applied Sport Science |
| Apunts Medicina de l'Esport |
| Biology of Sport |
| BMC Sports Science, Medicine and Rehabilitation |
| British Journal of Sports Medicine |
| Canadian Journal of Sports Sciences |
| Clinical Journal of Sports Medicine |
| Clinics in Sport Medicine |
| Current Sports Medicine Reports |
| Deutsche Zeitschrift fur Sportmedizin |
| European Journal of Sport Science |
| European Journal of Sports Traumatology and Related Research |
| Exercise and Sports Sciences Reviews |
| German Journal of Exercise and Sport Research |
| International Journal of Performance Analysis in Sport |
| International Journal of Sport Nutrition and Exercise Metabolism |
| International Journal of Sports Medicine |
| International Journal of Sports Physiology and Performance |
| Japanese Journal of Physical Fitness and Sports Medicine |
| Journal of Athletic Training |
| Journal of Orthopaedic and Sports Physical Therapy |
| Journal of Science and Medicine in Sport |
| Journal of Sport and Health Science |
| Journal of Sport Rehabilitation |
| Journal of Sports Medicine and Physical Fitness |
| Journal of Sports Science and Medicine |
| Journal of Sports Sciences |
| Journal of Strength and Conditioning Research |
| Knee Surgery, Sports Traumatology, Arthroscopy |
| Medicina dello Sport |
| Medicine and Science in Sports and Exercise |
| Medicine and Sport Science |
| Montenegrin Journal of Sports Science and Medicine |
| Operative Techniques in Sports Medicine |
| Orthopaedic Journal of Sports Medicine |
| Physical Therapy in Sport |
| Research in Sports Medicine |
| Research Quarterly for Exercise and Sport |
| Revista Brasileira de Medicina do Esporte |
| Sports Biomechanics |
| Sports Health: A Multidisciplinary Approach |
| Sports Medicine |
| Sports Medicine and Arthroscopy Review |
| Sportverletzung Sportschaden |
| The Physician and Sportsmedicine |
### TABLE A2
Top 100 Cited Articles Published in Sports and Exercise Medicine–Related Journals on Web of Science, Scopus, and PubMed

| Rank | Article | No. of Citations |
|------|---------|-----------------|
| 1    | Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc.* 1982;14(5):377-381. | 7228 |
| 2    | Craig CL, Marshall AL, Stysptom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc.* 2003;35(8):1381-1395. | 6193 |
| 3    | Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc.* 2000;32(9):498-504. | 4055 |
| 4    | Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 2007;40(1):181-188. | 3584 |
| 5    | Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine position stand: quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults. Guidance for prescribing exercise. *Med Sci Sports Exerc.* 2011;43(7):1334-1359. | 2803 |
| 6    | Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc.* 2007;39(8):1423-1444. | 2748 |
| 7    | Ainsworth BE, Haskell WL, Leon AS, et al. Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc.* 1992;24(1):71-80. | 2712 |
| 8    | Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc.* 1999;32(5):963-975. | 2513 |
| 9    | Hopkins WG, Marshall SW, Batterham AM, Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc.* 2008;41(1):3-13. | 2346 |
| 10   | Hopkins WG. Measures of reliability in sports medicine and science. *Sports Med.* 2000;30(1):1-15. | 2099 |
| 11   | Weir JP. Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *J Strength Cond Res.* 2005;19(1):231-240. | 1880 |
| 12   | Ainsworth BE, Haskell WL, Herrman SD, et al. 2011 Compendium of physical activities: a second update of code and MET values. *Med Sci Sports Exerc.* 2011;43(8):1575-1581. | 1793 |
| 13   | Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc accelerometer. *Med Sci Sports Exerc.* 1998;30(5):777-781. | 1700 |
| 14   | Atkinson G, Nevill AM. Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Med.* 1998;26(4):217-238. | 1675 |
| 15   | Trost SG, Pate RR, Sallis JF, et al. Age and gender differences in objectively measured physical activity in youth. *Med Sci Sports Exerc.* 2001;34(2):350-355. | 1410 |
| 16   | 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(3):150-154. | 1392 |
| 17   | 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;29(2):88-96. | 1376 |
| 18   | Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. American College of Sports Medicine position stand: exercise and physical activity for older adults. *Med Sci Sports Exerc.* 2009;41(7):1510-1530. | 1312 |
| 19   | Hewett TE, Myer GD, Ford KR, et al. 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;33(4):492-501. | 1307 |
| 20   | Pollock ML, Gaesser GA, Butcher JD, et al. American College of Sports Medicine stand: the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc.* 1998;30(6):975-991. | 1202 |
| 21   | Jacobs DR Jr, Ainsworth BE, Hartman TJ, Leon AS. A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Med Sci Sports Exerc.* 1993;25(1):81-91. | 1175 |
| 22   | Nelson ME, Rejeski WJ, Blair SN, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc.* 2007;39(8):1435-1445. | 1147 |
| 23   | Sallis JF, Saelens BE. Assessment of physical activity by self-reports: status, limitations and future directions. *Res Q Exerc Sport.* 2000;71:1-14. | 1131 |
| 24   | Jackson AS, Pollock ML, Ward A. Generalized equations for predicting body density of women. *Med Sci Sports Exerc.* 1980;12(3):175-181. | 1122 |
| 25   | Schmitz KH, Courneya KS, Mathews C, et al. American College of Sports Medicine roundtable on exercise guidelines for cancer survivors. *Med Sci Sports Exerc.* 2010;42(7):1409-1426. | 1104 |
| 26   | Leger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. *J Sports Sci.* 1988;6(2):93-110. | 1042 |
| 27   | Ratamess NA, Alvar BA, Evetoch TK, et al. American College of Sports Medicine position stand: progression models in resistance training for healthy adults. *Med Sci Sports Exerc.* 2009;41(3):687-708. | 1031 |
| 28   | McCory P, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 12. *Br J Sports Med.* 2013;47(5):250-258. | 1024 |
TABLE A2 (continued)

| Rank | Article                                                                 | No. of Citations |
|------|------------------------------------------------------------------------|------------------|
| 29   | Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, Stachenfeld NS. American College of Sports Medicine position stand: exercise and fluid replacement. *Med Sci Sports Exerc.* 2007;39(2):377-390. | 993              |
| 30   | Donnelly JE, Blair SN, Jakicic JM, Manore MM, Rankin JW, Smith BK. American College of Sports Medicine position stand: appropriate physical activity intervention strategies for weight loss and prevention of weight gain for adults. *Med Sci Sports Exerc.* 2009;41(2):459-471. | 990              |
| 31   | Lohmander LS, Enghuld PM, Dahl LL, Roos EM. The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. *Am J Sports Med.* 2007;35(10):1756-1769. | 980              |
| 32   | Batterham AM, Hopkins WG. Making meaningful inferences about magnitudes. *Int J Sports Physiol Perform.* 2006;1(1):50-57. | 966              |
| 33   | Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: the population-health science of sedentary behavior. *Exer Sport Sci Rev.* 2010;38(3):105-113. | 962              |
| 34   | Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med.* 2004;34(1):1-8. | 960              |
| 35   | Evenson KR, Catellier DJ, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. *J Sports Sci.* 2008;26(14):1557-1565. | 956              |
| 36   | Marcus BH, Selby VC, Niaura RS, Rossi JS. Self-efficacy and the stages of exercise behavior change. *Res Q Exerc Sport.* 1992;63(1):60-66. | 945              |
| 37   | Trost SG, McIver KL, Pate RR. Conducting accelerometer-based activity assessment in field-based research. *Med Sci Sports Exerc.* 2005;37(11):531-543. | 917              |
| 38   | Hootman J, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train.* 2007;42(2):311-319. | 911              |
| 39   | Howley ET, Bassett DR Jr, Welch HG. Criteria for maximal oxygen uptake: review and commentary. *Med Sci Sports Exerc.* 1995;27(9):1292-1301. | 911              |
| 40   | 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(6):694-701. | 902              |
| 41   | Pescatello LS, Franklin BA, Faggard R, Farquhar WB, Kelley GA, Ray CA. American College of Sports Medicine position stand: exercise and hypertension. *Med Sci Sports Exerc.* 2004;36(3):533-553. | 896              |
| 42   | Thomas S, Reading J, Shephard RJ. Revision of the Physical Activity Readiness Questionnaire (PAR-Q). *Can J Sport Sci.* 1992;17(4):338-345. | 881              |
| 43   | Trost SG, Owen N, Baum AE, Sallis JF, Brown W. Correlates of adults’ participation in physical activity: review and update. *Med Sci Sports Exerc.* 2002;34(1):1996-2001. | 874              |
| 44   | Hewett TE, Lidenfeld TN, Riccobene JY, Noyes FR. The effect of neuromuscular training on the incidence of knee injury in female athletes: a prospective study. *Am J Sports Med.* 1999;27(6):699-706. | 854              |
| 45   | McAuley E, Duncan T, Tammen VV. Psychometric properties of the intrinsic motivation inventory in a competitive sport setting: a confirmatory factor analysis. *Res Q Exerc Sport.* 1989;60(1):48-55. | 840              |
| 46   | Mohr M, Krustrup P, Bangsbo J. Match performance of high standard soccer players with special reference to development of fatigue. *J Sports Sci.* 2003;21(7):519-528. | 840              |
| 47   | Foster C, Florhaug JA, Franklin J, et al. A new approach to monitoring exercise training. *J Strength Cond Res.* 2001;15(1):109-115. | 835              |
| 48   | Borg GA. Perceived exertion: a note on “history” and methods. *Med Sci Sports.* 1973;5(2):90-93. | 829              |
| 49   | Irrgang JJ, Anderson AF, Maughan RJ, Montain SJ, Stachenfeld NS. American College of Sports Medicine position stand: exercise and fluid replacement. *Med Sci Sports Exerc.* 2007;39(2):377-390. | 811              |
| 50   | Stolen T, Chamari K, Castagna C, Wisloff U. Physiology of soccer: an update. *Sports Med.* 2005;35(6):501-536. | 810              |
| 51   | Bassett DR Jr, Howley ET. Limiting factors for maximum oxygen uptake and determinants of endurance performance. *Med Sci Sports Exerc.* 1999;32(1):70-84. | 809              |
| 52   | 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(5):632-644. | 805              |
| 53   | Kraemer WJ, Adams K, Cafarelli E, et al. American College of Sports Medicine position stand: progression models in resistance training for healthy adults. *Med Sci Sports Exerc.* 2002;34(2):364-380. | 798              |
| 54   | Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc.* 2008;40(7):550-566. | 797              |
| 55   | Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med.* 2002;37(3):197-206. | 794              |
| 56   | Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease and cancer. *Med Sci Sports Exerc.* 2008;41(5):998-1005. | 774              |
| 57   | Mirwald RL, Baxter-Jones AD, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. *Med Sci Sports Exerc.* 2002;34(4):689-694. | 766              |
| 58   | Van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries: a review of concepts. *Sports Med.* 1992;14(2):82-99. | 739              |
| 59   | Friden J, Sjostrom M, Ekblom B. Myofibrillar damage following intense eccentric exercise in man. *Int J Sports Med.* 1983;4(3):170-176. | 717              |

(continued)
| Rank | Article                                                                 | No. of Citations |
|------|------------------------------------------------------------------------|-----------------|
| 60   | Trost SG, Pate RR, Freedson PS, Sallis JF, Taylor WC. Using objective physical activity measures with youth: how many days of monitoring are needed. Med Sci Sports Exerc. 1999;32(2):426-431. | 704             |
| 61   | Trauton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD. A retrospective case-control analysis of 2002 running injuries. Br J Sports Med. 2001;36(2):95-101. | 702             |
| 62   | Van Der Horst K, Paw MJ, Twisk JW, Van Mechelen W. A brief review on correlates of physical fitness and sedentariness in youth. Med Sci Sports Exerc. 2007;39(8):1241-1250. | 693             |
| 63   | Jones CJ, Rikli RE, Beam WC. A 30-s chair test as a measure of lower body strength in community-residing older adults. Res Q Exerc Sport. 1998;70(2):113-119. | 687             |
| 64   | Jackson AS, Pollock ML. Practical assessment of body composition. Phys Sportsmed. 1985;13(5):76-90. | 671             |
| 65   | Trost SG, Loprinzi PD, Moore R, Pfeiffer KA. Comparison of accelerometer cut points for predicting activity intensity in youth. Med Sci Sports Exerc. 2010;42(7):1360-1368. | 668             |
| 66   | Stewart AL, Mills KM, King AC, Haskell WL, Giles D, Ritter PL. CHAMPS physical activity questionnaire for older adults: outcomes for interventions. Med Sci Sports Exerc. 2000;32(7):1126-1141. | 658             |
| 67   | Shelbourne KD, Nitz P. Accelerated rehabilitation after anterior cruciate ligament reconstruction. Am J Sports Med. 1990;18(3):292-299. | 651             |
| 68   | Fleisig GS, Andrews JR, Dillman CJ, Escamilla RF. Kinetics of baseball pitching with implications about injury mechanisms. Am J Sports Med. 1995;23(2):233-239. | 644             |
| 69   | Clarkson PM, Nosaka K, Braun B. Muscle function after exercise-induced muscle damage and rapid adaptation. Med Sci Sports Exerc. 1991;23(6):512-520. | 641             |
| 70   | Bar-O. The Wingate Anaerobic Test: an update on methodology, reliability and validity. Sports Med. 1987;4(6):381-394. | 624             |
| 71   | Giza CC, Hovda DA. The neuromatoskeletal cascade of concussion. J Athl Train. 2001;36(3):228-235. | 609             |
| 72   | Woo SL, Hollis JM, Adams DJ, Lyon RM, Takai S. Tensile properties of the human femur–anterior cruciate ligament–tibia complex: the effects of specimen age and orientation. Am J Sports Med. 1991;19(3):217-225. | 603             |
| 73   | Yagi M, Wong EK, Kanamori A, Debski RE, Fu FH, Woo SL. Biomechanical analysis of an anatomic anterior cruciate ligament reconstruction. Am J Sports Med. 2002;30(5):660-666. | 598             |
| 74   | Pate RR, O’Neill JR, Lobelo F. The evolving definition of “sedentary.” Exerc Sport Sci Rev. 2008;36(4):173-178. | 593             |
| 75   | Person F, Massicotte D. Table of nonprotein respiratory quotient: an update. Can J Sport Sci. 1991;16(1):23-29. | 592             |
| 76   | Riddoch CJ, Bo Andersen L, Wedderkopp N, et al. Physical activity levels and patterns of 9- and 15-yr-old European children. Med Sci Sports Exerc. 2003;36(1):86-92. | 590             |
| 77   | Hewett TE, Stroupe AL, Nance TA, Noyes FR. Plyometric training in female athletes: decreased impact forces and increased hamstring torques. Am J Sports Med. 1996;24(6):765-773. | 582             |
| 78   | McCrea M, Hammeke T, Olsen G, Leo P, Guszkiewicz K. Unreported concussion in high school football players: implications for prevention. Clin J Sport Med. 2004;14(1):13-17. | 577             |
| 79   | Freedson P, Pober D, Janz KF. Calibration of accelerometer output for children. Med Sci Sports Exerc. 2005;37(11):523-530. | 573             |
| 80   | Harriss DJ, Atkinson G. Update—ethical standards in sport and exercise science research. Int J Sports Med. 2011;32(11):819-821. | 571             |
| 81   | Caspersen CJ, Pereira MA, Curran KM. Changes in physical activity patterns in the United States, by sex and cross-sectional age. Med Sci Sports Exerc. 2000;32(9):1601-1609. | 569             |
| 82   | Peterson L, Brittenberg M, Kirvena I, Akerlund T, Nauhamed L. Autologous chondrocyte transplantation: biomechanics and long-term durability. Am J Sports Med. 2002;30(1):2-12. | 565             |
| 83   | Kraemer WJ, Ratamess NA. Fundamentals of resistance training: progression and exercise prescription. Med Sci Sports Exerc. 2004;36(4):674-688. | 561             |
| 84   | Voorspijs LE, Ravelli AC, Dongemans PC, Deurenberg P, Van Staveren WA. A physical activity questionnaire for the elderly. Med Sci Sports Exerc. 1991;23(8):974-979. | 560             |
| 85   | Hertel J. Functional anatomy, pathomechanics and pathophysiolog of lateral ankle instability. J Athl Train. 2002;37(4):364-374. | 559             |
| 86   | Sale DG. Neural adaption to resistance training. Med Sci Sports Exerc. 1988;20(5):135-145. | 557             |
| 87   | Blair SN, Cheng Y, Holder JS. Is physical activity or physical fitness more important in defining health benefits. Med Sci Sports Exerc. 2001;33(6):379-399. | 556             |
| 88   | Bailey RC, Olson J, Pepper SL, Porszasz J, Barstow TJ, Cooper DM. The level and tempo of children’s physical activities: an observational study. Med Sci Sports Exerc. 1995;27(7):1033-1041. | 556             |
| 89   | Mandelbaum BR, Silvers HJ, Watanabe DS, et al. Effectiveness of neuromuscular and proprioceptive training program in preventing anterior cruciate ligament injuries in female athletes: 2-year follow-up. Am J Sports Med. 2005;33(7):1003-1010. | 550             |
| 90   | Armstrong RB. Mechanisms of exercise-induced delayed onset muscular soreness: a brief review. Med Sci Sports Exerc. 1984;16(6):529-538. | 548             |
| 91   | Riddoch CJ, Bo Andersen L, Wedderkopp N, et al. Physical activity levels and patterns of 9- and 15-yr-old European children. Med Sci Sports Exerc. 2003;36(1):86-92. | 548             |

(continued)
| Rank | Article | No. of Citations |
|------|---------|-----------------|
| 92   | Crouter SE, Schneider PL, Karabulut M, Bassett DR Jr. Validity of 10 electronic pedometers for measuring steps, distance and energy cost. *Med Sci Sports Exerc.* 2003;35(8):1455-1460. | 546 |
| 93   | Kibler WB. The role of the scapula in athletic shoulder function. *Am J Sports Med.* 1998;26(2):325-337. | 546 |
| 94   | Olsen OE, Myklebust G, Engebretsen L, Bahr R. Injury mechanism for anterior cruciate ligament injuries in team handball: a systematic video analysis. *Am J Sports Med.* 2004;32(4):1002-1012. | 541 |
| 95   | Trout SG, Ward DS, Moorehead SM, Watson PD, Riner W, Burke JR. Validity of the Computer Science and Applications (CSA) activity monitor in children. *Med Sci Sports Exerc.* 1998;30(4):629-633. | 540 |
| 96   | Sallis JF, Buono MJ, Roby JJ, Micale FG, Nelson JA. Seven-day recall and other physical activity self-reports in children and adolescents. *Med Sci Sports Exerc.* 1993;25(1):99-108. | 537 |
| 97   | Kraemer WJ, Ratamess. Hormonal responses and adaptations to resistance exercise and training. *Sports Med.* 2005;35(4):339-361. | 535 |
| 98   | Alfredson H, Pietila T, Jonsson P, Lorentzon R. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. *Am J Sports Med.* 1998;26(3):360-366. | 535 |
| 99   | Bangsbo J, Norregaard L, Thorso F. Activity profile of competition soccer. *Can J Sports Sci.* 1991;16(2):110-116. | 535 |
| 100  | Baratta R, Solomonow M, Zhou BH, Letson D, Chuinard R, D’Ambrosia R. Muscular coactivation: the role of the antagonist musculature in maintaining knee stability. *Am J Sports Med.* 1988;16(2):113-122. | 534 |

*Multiple articles with the same number of citations.*