AJSM PreView, published on April 10, 2014 as doi:10.1177/0363546514528790

# Publication and Level of Evidence Trends in *The American Journal of Sports Medicine* From 1996 to 2011

Gregory L. Cvetanovich,*† MD, Yale A. Fillingham,† MD, Joshua D. Harris,† MD, Brandon J. Erickson,† MD, Nikhil N. Verma,† MD, and Bernard R. Bach Jr,† MD
*Investigation performed at Rush Medical College of Rush University, Rush University Medical Center, Chicago, Illinois, USA*

**Background:** There has been recent increased emphasis on the publication quality and levels of evidence in orthopaedic sports medicine clinical research. *The American Journal of Sports Medicine* (*AJSM*) began publishing levels of evidence in the abstracts of clinical articles in 2005.

**Purpose:** To analyze trends in the characteristics and levels of evidence of articles published in *AJSM*.

**Study Design:** Meta-analysis.

**Methods:** All articles in *AJSM* from 1996, 2001, 2006, and 2011 were analyzed. Articles were analyzed for type: clinical original research, basic science, current concepts review, and case report. Clinical articles were assigned a level of evidence from 1 to 4 and categorized as therapeutic, prognostic, diagnostic, or economic. Descriptive information was collected regarding funding, authorship, and study characteristics. Statistics were calculated using $\chi^2$ tests.

**Results:** A total of 795 articles were analyzed. From 1996 to 2011, there has been a significant increase in the percentage of level 1 and 2 articles (9.4% to 23.0%; $P = .007$) and a significant decrease in the percentage of level 3, 4, and 5 articles (55.1% to 45.1%; $P = .037$). There was a significant increase in the percentage of therapeutic studies (46.8% to 68.6%; $P = .004$) and a decrease in prognostic studies (36.7% to 22.2%; $P = .03$). Publishing authors were from 31 countries, notable for a significant increase in the percentage of studies published by authors from outside the United States from 1996 to 2011 (20.3% to 53.0%; $P < .001$). The percentage of articles reporting a financial conflict of interest significantly increased during this time (26.1% to 42.2%; $P = .006$).

**Conclusion:** From 1996 to 2011, the proportion of level 1 and 2 evidence studies published in *AJSM* has increased significantly. There has been an increase in therapeutic studies and a decrease in prognostic studies. There has been an increase in the number of international studies published.

**Keywords:** level of evidence; sports medicine; clinical research

There has been recent increased emphasis on the publication quality and levels of evidence in orthopaedic and sports medicine research. Starting in 2003, *The Journal of Bone and Joint Surgery* (American volume) (*JBJS-A*) published a level of evidence (LOE) rating for all clinical articles based on the Oxford Centre for Evidence-based Medicine classification.[8,12] The rating system involves assigning a level of evidence (from 1 [high] to 5 [low]) as well as classifying the article as diagnostic, therapeutic, prognostic, or economic. *The American Journal of Sports Medicine* (*AJSM*) began publishing levels of evidence in the abstracts of its clinical articles in 2005, along with classifications of study design.[9] Interobserver agreement in assigning levels of evidence to orthopaedic clinical research is high.[1,7]

Several studies have compared the level of evidence between orthopaedic journals, compared the level of evidence and journal impact factor, and analyzed whether levels of evidence have improved over time.[7,13,14] To the authors' knowledge, no study has analyzed trends in the characteristics and levels of evidence of articles published in *AJSM*. Therefore, the purpose of this study was to analyze the types of studies and levels of evidence published in *AJSM* from 1996 to 2011. The study hypothesis was that the percentage of level 1 and 2 studies would increase from 1996 to 2011.

## MATERIALS AND METHODS

### Identification of Articles

An analysis of all articles published in *AJSM* during 4 time periods separated at 5-year intervals was performed: January 1, 1996 to December 31, 1996; January 1, 2001 to

The American Journal of Sports Medicine, Vol. XX, No. X
DOI: 10.1177/0363546514528790
© 2014 The Author(s)


Downloaded from ajs.sagepub.com at Univ of Illinois at Chicago Library on November 21, 2014

December 31, 2001; January 1, 2006 to December 31, 2006; and January 1, 2011 to December 31, 2011. This permitted an analysis of articles from 2 time periods before *AJSM* began publishing levels of evidence in 2005 and 2 time periods after *AJSM* began publishing levels of evidence in 2005. A manual review was performed by selecting each item from each of the tables of contents from every issue in the studied calendar years.

### Selection of Articles for Analysis and Assignment of Levels of Evidence

All clinical articles, case reports, review articles, and basic science articles (including human, animal, laboratory, and cadaveric studies) were included. Editorials, news, announcements, and letters to the editor were excluded. For clinical articles, a level of evidence from 1 to 5 was assigned and articles categorized as therapeutic, prognostic, diagnostic, or economic based on the *JBJS-A* grading system (available at http://jbjs.org/public/instructionsauthors.aspx#LevelsofEvidence).[8,12] Two reviewers independently analyzed the articles and assigned the level of evidence and type of study. Level of evidence determinations were made independent of the level of evidence assigned by *AJSM* and then compared for assurance of the same findings. Disagreements occurred in 28 cases (16 regarding type of study, 12 regarding level of evidence) and were discussed, and the authors agreed upon a consensus level of evidence. Additional descriptive information regarding funding, authorship, and study characteristics was recorded. Public funding sources included government sources and public universities. Private funding sources included private foundations, companies, and private universities.

### Statistical Analysis

Statistics were calculated using $\chi^2$ tests, with a significance level of $P = .05$. The $\chi^2$ approximation was deemed to be the appropriate test based on the rule of thumb that the expected values in the contingency tables were greater than 5.

## RESULTS

A total of 795 articles were included for analysis (Figure 1). There has been a significant increase in the percentage of level 1 and 2 articles (9.4% to 23.0%; $P = .007$) and a significant decrease in the percentage of level 3 to 5 articles (55.1% to 45.1%; $P = .037$) (Table 1). Review articles and basic science articles did not show a significant change over this time period. There was a significant increase in the percentage of therapeutic studies (46.8% to 68.6%; $P = .004$) and a significant decrease in the percentage of prognostic studies (36.7% to 22.2%; $P = .03$) (Table 2 and Figure 2). There was no significant change in the percentage of diagnostic studies. No economic studies were published in any of the years analyzed. There was no significant change in the percentage of multicenter studies or studies with a statistician author.

Articles originated from 31 countries, with the number of countries represented increasing: 14 in 1996, 18 in 2001, 25 in 2006, and 26 in 2011 (Table 3). There was a significant increase in the percentage of studies published by authors from outside the United States from 1996 to 2011 (20.3% to 53.0%; $P < .001$) (Figure 3). The percentage of articles reporting a financial conflict of interest increased significantly from 1996 to 2011 (26.1% to 42.2%; $P = .006$), with no significant change in articles with public funding but an increase in articles with private funding ($P = .004$) and in articles with both public and private funding ($P = .007$) (Table 4).

## DISCUSSION

The present study analyzed recent trends in the characteristics and levels of evidence of articles published in *AJSM*. During the period of investigation, several significant findings were identified: a greater proportion of higher evidence level studies (levels 1 and 2), an increased number of therapeutic studies, and more internationally published studies.

The current impact factor of *AJSM* is the highest (ranked 1 of 63) among orthopaedic journals at 4.439.[11] The impact factor is a numerical value reflecting the ratio of the number of citations to the number of articles published by the journal. The impact factor has been used as a proxy for the quality of a journal on the basis of the notion that a large number of citations compared with the number of published articles reflects a higher quality journal. Despite the seemingly objective nature of the impact factor calculation, it has been criticized for not always reflecting the true quality of a particular journal.[2,4] Limitations of the impact factor include the arbitrary decision to calculate based on only 2 years of data.[5] Another potential limitation is the selection of a large number of review articles that have a historically higher rate of

*Address correspondence to Gregory L. Cvetanovich, MD, Division of Sports Medicine, Department of Orthopedic Surgery, Rush Medical College of Rush University, Rush University Medical Center, 1611 West Harrison Street, Suite 300, Chicago, IL 60612, USA (e-mail: gregory.cvetanovich@gmail.com).
†Division of Sports Medicine, Department of Orthopedic Surgery, Rush Medical College of Rush University, Rush University Medical Center, Chicago, Illinois, USA.

One or more of the authors has declared the following potential conflict of interest or source of funding: J.D.H. is on the editorial or governing board for *Arthroscopy*. N.N.V. receives royalties from Smith & Nephew; is a paid speaker for Arthrosurface; is a paid consultant for Minivasive and Smith & Nephew; owns stock or stock options in Omeros; receives research support from Arthrex Inc, Smith & Nephew, Athletico, ConMed Linvatec, Miomed, Mitek, and Arthrosurface; receives royalties from Vindico Medical-Orthopedics Hyperguide and *Arthroscopy*; is on the editorial or governing board of the *Journal of Knee Surgery, Arthroscopy*, and SLACK Inc; and is on the Arthroscopy Association Learning Center Committee. B.R.B. receives research support from Arthrex Inc, ConMed Linvatec, DJ Orthopaedics, Ossur, Smith & Nephew, and Tornier; receives royalties from SLACK Inc; and is on the Board of Trustees of the American Orthopaedic Society for Sports Medicine.

Downloaded from ajs.sagepub.com at Univ of Illinois at Chicago Library on November 21, 2014

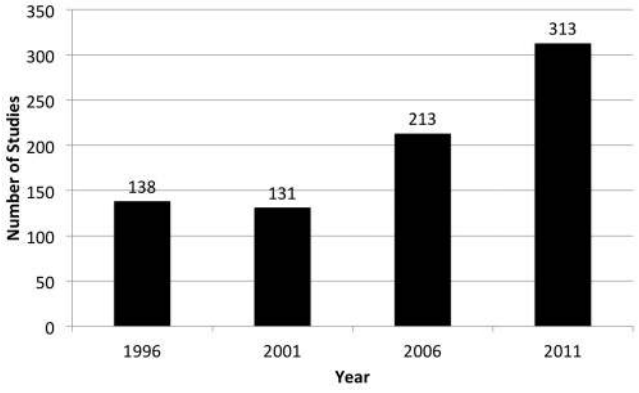


**Figure 1.** The number of articles included for each studied year increased from 1996 to 2011.

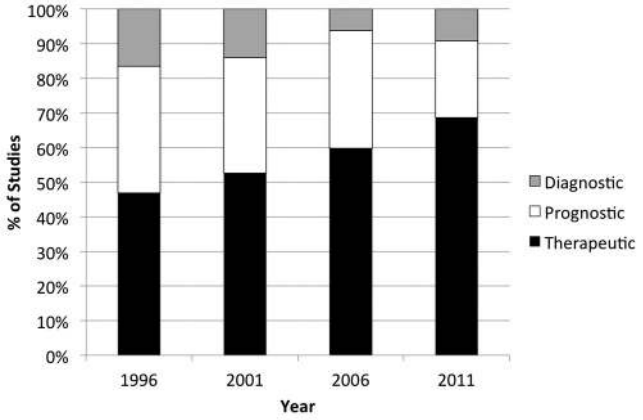


**Figure 2.** There was a significant increase in the percentage of therapeutic studies and a significant decrease in the percentage of prognostic studies published. No economic studies were identified.

TABLE 1
Significant Increase in Level of Evidence 1 and 2 Studies and Significant Decrease in Level of Evidence 3 to 5 Studies[a]

| | 1996 Articles | 2001 Articles | 2006 Articles | 2011 Articles | *P* Value |
|---|---|---|---|---|---|
| Level of evidence 1 and 2 | 13 (9.42) | 24 (18.32) | 37 (17.37) | 72 (23.00) | .007[b] |
| Level of evidence 3-5 | 76 (55.07) | 51 (38.93) | 89 (41.78) | 141 (45.05) | .037[b] |
| Review articles | 6 (4.30) | 7 (5.34) | 11 (5.16) | 16 (5.11) | .980 |
| Basic science articles | 43 (31.16) | 49 (37.40) | 76 (35.68) | 84 (26.84) | .070 |
| Total | 138 | 131 | 213 | 313 | |

[a]Values are expressed as n (%).
[b]Statistically significant difference between 1996 and 2011 ($P < .05$).

TABLE 2
Significant Increase in Percentage of Therapeutic Studies and Significant Decrease in Percentage of Prognostic Studies[a]

| | 1996 Articles | 2001 Articles | 2006 Articles | 2011 Articles | *P* Value |
|---|---|---|---|---|---|
| Therapeutic | 37 (46.84) | 30 (52.60) | 67 (59.80) | 142 (68.60) | .004[b] |
| Prognostic | 29 (36.71) | 19 (33.30) | 38 (33.90) | 46 (22.20) | .030[b] |
| Diagnostic | 13 (16.46) | 8 (14.00) | 7 (6.30) | 19 (9.20) | .100 |
| Economic | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | — |
| Total | 79 | 57 | 112 | 207 | |

[a]Values are expressed as n (%).
[b]Statistically significant difference between 1996 and 2011 ($P < .05$).

citations.[4] Regardless, the impact factor is widely used and acts as a surrogate of the journal's influence on trends within a specific field of medicine. Because *AJSM* has the highest impact factor among the orthopaedic journals, the authors wanted to investigate the quality of research that clinicians are using to guide their practice.

Obremskey et al[7] assessed the study type and level of evidence of published articles among 9 orthopaedic journals, including *AJSM*. They analyzed all clinical articles of these journals over a 6-month period in 2003 (382 articles total); *AJSM* had the highest percentage of level 1 and 2 articles (48.5%). The proportion of high levels of evidence in the current study was lower, with percentages of 9.4%, 18.3%, 17.4%, and 23.0% for the years 1996, 2001, 2006, and 2011, respectively. However, Obremskey et al[7] had excluded all level 5, review, and basic science articles from their analysis. The present study utilizes a similar concept of investigating trends in the level of evidence within the orthopaedic literature; however, the current investigation reviewed 795 articles over a period of 15 years. The expanded review of the current study provides a superior understanding of the chronological trend of the quality of research published in *AJSM*, with a statistically significant increase in level 1 and 2 studies over time.

The trend toward higher levels of evidence is not unique to *AJSM*. Zaidi et al[14] reviewed 720 articles from 3

Downloaded from ajs.sagepub.com at Univ of Illinois at Chicago Library on November 21, 2014

TABLE 3
Articles Published by Authors by Country of Origin and Year[a]

| Country | 1996 Articles | 2001 Articles | 2006 Articles | 2011 Articles |
|---|---|---|---|---|
| Australia | 6 (4.35) | 5 (3.82) | 5 (2.35) | 9 (2.88) |
| Austria | 0 (0.00) | 3 (2.29) | 0 (0.00) | 3 (0.96) |
| Belgium | 1 (0.72) | 1 (0.76) | 2 (0.94) | 4 (1.28) |
| Brazil | 0 (0.00) | 0 (0.00) | 1 (0.47) | 2 (0.64) |
| Canada | 4 (2.90) | 1 (0.76) | 6 (2.82) | 3 (0.96) |
| China | 0 (0.00) | 0 (0.00) | 1 (0.47) | 7 (2.24) |
| Croatia | 0 (0.00) | 1 (0.76) | 0 (0.00) | 0 (0.00) |
| Denmark | 1 (0.72) | 0 (0.00) | 2 (0.94) | 3 (0.96) |
| Egypt | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (0.32) |
| Finland | 0 (0.00) | 4 (3.05) | 4 (1.88) | 1 (0.32) |
| France | 0 (0.00) | 0 (0.00) | 2 (0.94) | 6 (1.92) |
| Germany | 1 (0.72) | 3 (2.29) | 10 (4.69) | 23 (7.35) |
| Greece | 0 (0.00) | 0 (0.00) | 2 (0.94) | 4 (1.28) |
| Hong Kong | 1 (0.72) | 1 (0.76) | 1 (0.47) | 0 (0.00) |
| Hungary | 0 (0.00) | 0 (0.00) | 1 (0.47) | 0 (0.00) |
| Ireland | 1 (0.72) | 0 (0.00) | 1 (0.47) | 0 (0.00) |
| Israel | 0 (0.00) | 0 (0.00) | 1 (0.47) | 1 (0.32) |
| Italy | 1 (0.72) | 1 (0.76) | 2 (0.94) | 9 (2.88) |
| Japan | 4 (2.90) | 12 (9.16) | 15 (7.04) | 17 (5.43) |
| Mexico | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (0.32) |
| Multiple countries | 0 (0.00) | 3 (2.29) | 0 (0.00) | 7 (2.24) |
| The Netherlands | 2 (1.45) | 1 (0.76) | 3 (1.41) | 8 (2.56) |
| New Zealand | 0 (0.00) | 2 (1.53) | 0 (0.00) | 0 (0.00) |
| Norway | 1 (0.72) | 2 (1.53) | 3 (1.41) | 4 (1.28) |
| Slovenia | 0 (0.00) | 1 (0.76) | 1 (0.47) | 1 (0.32) |
| South Africa | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (0.32) |
| South Korea | 1 (0.72) | 0 (0.00) | 2 (0.94) | 24 (7.67) |
| Sweden | 4 (2.90) | 5 (3.82) | 1 (0.47) | 6 (1.92) |
| Switzerland | 0 (0.00) | 1 (0.76) | 4 (1.88) | 5 (1.60) |
| Taiwan | 0 (0.00) | 0 (0.00) | 2 (0.94) | 4 (1.28) |
| United Kingdom | 0 (0.00) | 3 (2.29) | 7 (3.29) | 12 (3.83) |
| United States | 110 (79.71) | 81 (61.83) | 134 (62.91) | 147 (46.96) |
| No. of countries | 14 | 18 | 25 | 26 |

[a]Values are expressed as n (%).

TABLE 4
Significant Increase in Studies With Financial Conflict of Interest[a]

| Financial Conflict of Interest | 1996 Articles | 2001 Articles | 2006 Articles | 2011 Articles | *P* Value |
|---|---|---|---|---|---|
| Yes | 36 (26.09) | 45 (34.35) | 88 (41.31) | 132 (42.17) | .006[b] |
| No | 102 (73.91) | 86 (65.65) | 125 (58.69) | 181 (57.83) | .006[b] |
| Public | 19 (13.77) | 18 (13.74) | 37 (17.37) | 57 (18.21) | .520 |
| Private | 25 (18.12) | 37 (28.24) | 66 (30.99) | 109 (34.82) | .004[b] |
| Both public and private | 2 (1.45) | 10 (7.63) | 15 (7.04) | 34 (10.86) | .007[b] |

[a]Values are expressed as n (%).
[b]Statistically significant difference between 1996 and 2011 ($P < .05$).

journals on foot and ankle surgery in 2000, 2005, and 2010. They found a statistically significant increase in level 1 and 2 studies, with percentages of 5.2%, 4.3%, and 10.3% for each respective year. Despite presenting a similar conclusion, the present study on the published articles in *AJSM* demonstrates a higher rate of level 1 and 2 studies at 9.4%, 18.3%, 17.4%, and 23.0% for the years 1996, 2001, 2006, and 2011, respectively.

Previous reports regarding the orthopaedic literature have demonstrated that the most common levels of evidence among published studies were levels 3 to 5.[3,7,13,14] Despite the trend toward higher levels of evidence, the current investigation also demonstrates that level 3 to 5 studies are the most common. Lower level studies still have a valuable place in orthopaedic research, particularly because of the challenges in conducting level 1 and 2 studies. Many

Downloaded from ajs.sagepub.com at Univ of Illinois at Chicago Library on November 21, 2014

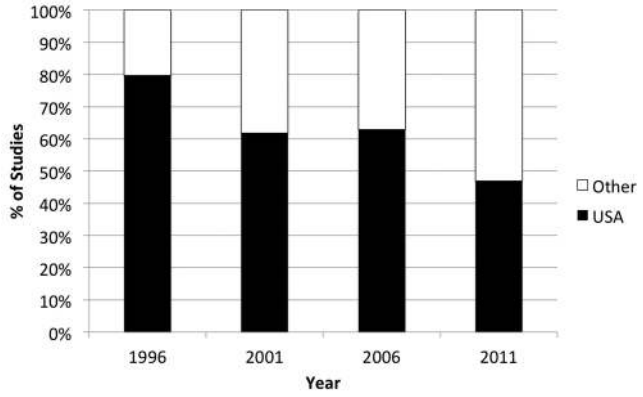


**Figure 3.** There was a significant increase in the percentage of studies published by authors from outside the United States from 1996 to 2011.

of the conditions within orthopaedics and sports medicine can occur infrequently, thereby making it unfeasible to design a higher level of evidence study. Further, there are certain orthopaedic conditions for which randomization is neither practical nor ethical. For instance, patient randomization to a surgical procedure versus a sham surgical procedure is rarely performed.[6] Another barrier to conducting randomized controlled trials in surgical research has been the potential for a negative effect on individual patient care with the application of a strict research protocol. However, a prior review of surgical research rebutted this concept by demonstrating that as much as 40% of surgical research questions were amenable to being studied as a randomized controlled trial.[10] Even though a study could be designed as a higher level of evidence, the researcher may not be incentivized to take on the length of time and financial commitment necessary for the study because of the requirement to more rapidly publish research for career advancement.[3] In addition, the combination of limited amounts of available public funding and the pressure to remove private funding from research offers a significant barrier to performing expensive randomized controlled trials. Overall, lower level studies will continue to be favored by researchers because they are significantly less resource intensive as compared with performing a randomized controlled trial. When a level 4 study is the only feasible option, the study design should include a population with 100% of the patients having the same diagnosis, use of strict inclusion and exclusion criteria, use of a standard treatment protocol, a specified time interval for follow-up of patients, well-defined measurements of outcome, and use of validated instruments for functional assessment.

Consistent with prior analyses of the orthopaedic and sports medicine literature, therapeutic studies are the most frequently published.[7,13,14] Given the emphasis of surgical specialties of identifying and validating treatment options, the results are as expected. In addition, the current investigation has demonstrated that therapeutic studies have become more popular, with a statistically significant increase over the past 15 years. However, during the same period of time, no economic studies were identified. Economic studies are important because of the large-scale effect on decision making that they can have on the health care system. Currently, one of the prevailing pressures on the health care system is cost containment and the efficient use of health care expenditures.

Over the period of the study, an increased "internationality" of *AJSM* was observed, with a greater proportion of studies published from outside the United States. The increase in authorship to include 31 countries represents the international expansion of sports medicine–related research. The broader base of authors also reflects the greater circulation of *AJSM* and the increased influence of research published by *AJSM*.

One limitation of the current study is that it only analyzed all studies per year for 4 different yearlong time periods over the past 15 years, without an analysis of the studies in the intervening years. A more detailed study could have selected every publication in every year for the time frame in question. For purposes of the current study, it was thought that analyzing every study for the past 15 years would be excessively time consuming and unnecessary to discern the trends in levels of evidence in *AJSM* over this time period. A second limitation is that this study analyzed only a single journal, which implies that the results may not extrapolate to all of sports medicine or all of orthopaedic surgery. Future studies could analyze similar trends in other journals and compare between journals. In addition, this study utilized the level of evidence but did not use detailed study methodological quality scores (eg, Coleman methodology). This limitation implies that this study's results address the trends in high and low levels of evidence but do not address high and low methodological quality. Future studies could address the trends in the methodological quality in *AJSM* or other journals using these more detailed metrics in addition to the level of evidence.

## CONCLUSION

From 1996 to 2011, the proportion of level of evidence 1 and 2 studies published in *AJSM* has increased significantly. There has been an increase in therapeutic studies and a decrease in prognostic studies. There has been an increase in the number of international studies published.

## REFERENCES

1. Bhandari M, Swiontkowski MF, Einhorn TA, et al. Interobserver agreement in the application of levels of evidence to scientific papers in the American volume of the *Journal of Bone and Joint Surgery*. *J Bone Joint Surg Am*. 2004;86(8):1717-1720.
2. Hansson S. Impact factor as a misleading tool in evaluation of medical journals. *Lancet*. 1995;346(8979):906.
3. Hanzlik S, Mahabir RC, Baynosa RC, et al. Levels of evidence in research published in *The Journal of Bone and Joint Surgery* (American volume) over the last thirty years. *J Bone Joint Surg Am*. 2009;91(2):425-428.

Downloaded from ajs.sagepub.com at Univ of Illinois at Chicago Library on November 21, 2014

4. Kurmis AP. Understanding the limitations of the journal impact factor. *J Bone Joint Surg Am*. 2003;85(12):2449-2454.
5. Manske PR. The impact of the impact factor. *J Hand Surg Am*. 2004;29(6):983-986.
6. Moseley JB, O'Malley K, Petersen NJ, et al. A controlled trial of arthroscopic surgery for osteoarthritis of the knee. *N Engl J Med*. 2002;347(2):81-88.
7. Obremskey WT, Pappas N, Attallah-Wasif E, et al. Level of evidence in orthopaedic journals. *J Bone Joint Surg Am*. 2005;87(12):2632-2638.
8. Oxford Centre for Evidence-based Medicine. Levels of evidence. 2009;2013(7/21). Available at: http://www.cebm.net/index.aspx?o=4590. Accessed July 21, 2013.
9. Reider B. Read early and often. *Am J Sports Med*. 2005;33(1):21-22.
10. Solomon MJ, McLeod RS. Should we be performing more randomized controlled trials evaluating surgical operations? *Surgery*. 1995;118(3):459-467.
11. Thomson Reuters. Journal citation reports. Available at: http://thomsonreuters.com/journal-citation-reports/. Accessed September 1, 2013.
12. Wright JG, Swiontkowski MF, Heckman JD. Introducing levels of evidence to the journal. *J Bone Joint Surg Am*. 2003;85(1):1-3.
13. Wupperman R, Davis R, Obremskey WT. Level of evidence in *Spine* compared to other orthopedic journals. *Spine (Phila Pa 1976)*. 2007;32(3):388-393.
14. Zaidi R, Abbassian A, Cro S, et al. Levels of evidence in foot and ankle surgery literature: progress from 2000 to 2010? *J Bone Joint Surg Am*. 2012;94(15):e112.1-e112.10.

For reprints and permission queries, please visit SAGE's Web site at http://www.sagepub.com/journalsPermissions.nav

Downloaded from ajs.sagepub.com at Univ of Illinois at Chicago Library on November 21, 2014