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An Assessment of the Methodological Quality of Research Published in *The American Journal of Sports Medicine*

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Background: Evidence-based medicine has become a popular topic in academic medicine during the past several decades and more recently in orthopaedics and sports medicine.

Hypothesis: Articles published in *The American Journal of Sports Medicine* have shown an improvement in methodological quality in 2001-2003, compared with 1991-1993.

Study Design: Systematic review.

Methods: All articles published in *The American Journal of Sports Medicine* during the periods 1991-1993 and 2001-2003 were reviewed and classified by type of study. The use of pertinent methodologies such as prospective data collection, randomization, blinding, and controlled studies was noted for each article. The frequency of each article type and the use of evidence-based techniques were compared across study periods.

Results: Case series and descriptive studies decreased during the study period, from 27.4% to 15.3% (P = .00003) and from 11.9% to 5.6% (P = .001), respectively, of articles published. Prospective cohort studies increased from 4.7% to 14.1% (P = .000005), and randomized, prospective clinical trials increased from 2.7% to 5.9% of articles (P = .04). More studies tested an explicit hypothesis (P = .0000002), used prospective data collection (P = .000003), and used blinding (P = .02), and more studies identified a funding source (P = .004).

Conclusions: Overall, there was a shift toward more prospective and randomized research designs published in *The American Journal of Sports Medicine* during 2001-2003 compared to 1991-1993, demonstrating an improvement in the methodological quality of published research.

Keywords: evidence-based medicine; evidence-based surgery; sports medicine; research methodology

Evidence-based medicine (EBM) has become a popular topic in academic medicine during the past several decades. Although the use of decision analysis first appeared in the medical literature in 1973,[21] the concept of EBM was introduced in the 1980s in Canada,[24] and since then, it has slowly but surely established itself as an accepted approach to research.[5,17-19,22,26] Relative to other specialties, orthopaedics has embraced EBM relatively slowly,[7,12,16,23,28] but there is an established and growing interest within the field.[1,8,9,11]

Ubbink and Legemate[24] defined EBM as "the conscientious, explicit and judicious use of best available evidence in making decisions about individual patient care."[(p1091)] While this may not strike the reader as something new, it is the systematic approach using rational methods that elevates EBM beyond the traditional approach of expert opinion, pathophysiological reasoning, and established experience to guide patient care, and it starts with identifying and critically appraising the best available evidence in the literature.[20]

An editorial in the *British Journal of Sports Medicine* from 2001 discussed the need to "foster the development of a culture that embraces EBM"[13(p79)] in sports medicine. A study evaluating the quality of research in sports journals found randomized controlled trials making up less than 10% of all original research articles, although the proportion of randomized controlled trials in the *British Journal of Sports Medicine* did increase from 3% in 1991-1995 to 7% in 1996-2000.[2] Has this growing interest in EBM affected the type of study published in *The American Journal of Sports Medicine*, and if so, how? The objective of this study was to evaluate the methodological quality of research published in *The American Journal of Sports Medicine* during two 3-year periods, 10 years apart.

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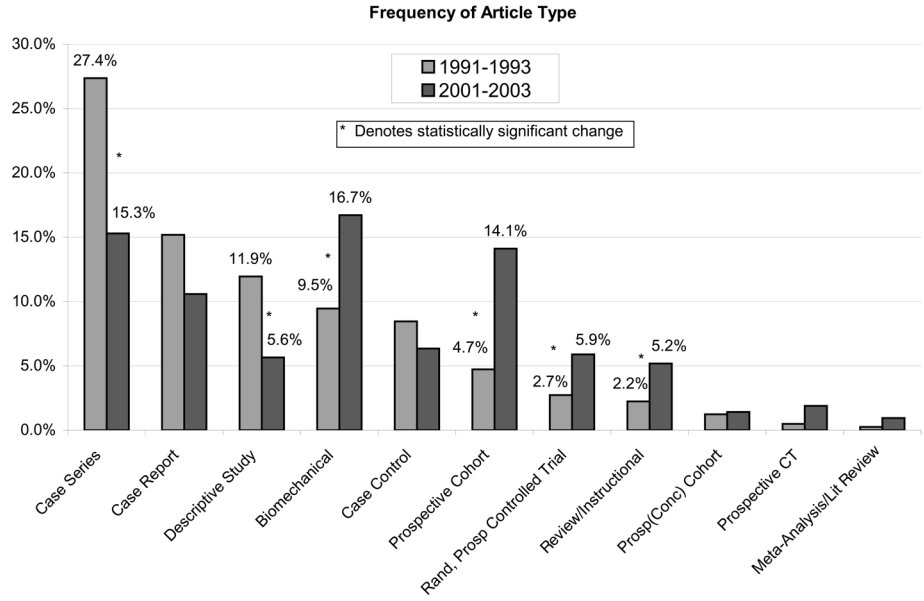

Figure 1. Frequency of article type. Data are in percentage of articles published in *The American Journal of Sports Medicine* during the 2 study periods. Rand, randomized; Prosp, prospective; Conc, concurrent; CT, clinical trial; Lit, literature.

MATERIALS AND METHODS

All articles published in *The American Journal of Sports Medicine* from 1991-1993 were reviewed and compared with all articles published in the same journal from 2001-2003. For each article, we recorded the type of study and the type of funding (if identified). We classified each study to one of the following types: case report; case series; epidemiological/population description; case control; prospective cohort; prospective (concurrent) cohort; meta-analysis/literature review; randomized, prospective clinical trial; prospective clinical trial (not randomized); review/instructional; in vivo animal; in vitro animal; cadaveric (human); biomechanical; electromyography (EMG); human cellular/genetic; and other studies. We also recorded whether each article tested a specific hypothesis, used prospective or retrospective data collection, was a randomized or controlled trial, or included blinding of patients, care providers, and/or those assessing outcomes.

We also recorded the anatomical area studied, the type of sport involved, and the gender focus of the study. Each study was assigned to one of the following anatomical areas: spine, shoulder, elbow, hand, hip, knee, foot and ankle, head, other, or not applicable. The classification of study by type of sport was as follows: American football, baseball, basketball, golf, ice hockey, lacrosse, soccer, swimming, tennis, track and field, throwing sports, varied/other, or not applicable. With regard to gender, we assessed whether each study included only male patients, only female patients, male and female patients, or if the factor of gender was not applicable.

The data set was initially entered by a single evaluator and then reviewed by 2 of the authors for accuracy. The final classification for each article was based on a consensus opinion of the authors. The statistical significance of change, if any, between the 2 study periods was assessed using Pearson χ^2 and exact tests for contingency table analysis, as appropriate. The statistical analysis was completed with SPSS Version 10.0 (SPSS Inc, Chicago, Ill) and StatXact Version 6 (Cytel Software Corp, Cambridge, Mass).

RESULTS

A total of 402 articles were reviewed in 1991-1993 and compared with 423 articles in 2001-2003. The distribution of articles by type is shown in Figure 1. The frequency of case series decreased, from 27.4% of articles in 1991-1993 to 15.3% in 2001-2003 ($P = .00003$). Case reports trended down, from 15.2% of articles in 1991-1993 to 10.6% in 2001-2003 ($P = .06$). Articles classified as descriptive studies decreased between 1991-1993 and 2001-2003, from 11.9% to 5.6% ($P = .001$). During the same period, prospective cohort studies increased, from 4.7% to 14.1% of articles ($P = .000005$); randomized, prospective clinical trials increased, from 2.7% to 5.9% of articles ($P = .04$); and biomechanical studies also increased, from 9.5% of articles to 16.7% ($P = .002$).

The frequency of articles identifying a funding source increased between 1991-1993 and 2001-2003, from 19.7% to 28.2% ($P = .004$). Controlled studies trended up during the period studied, from 15% to 20% ($P = .07$); articles testing an explicit hypothesis increased, from 41% to 59% ($P = .0000002$); and the use of prospective data collection increased, from 15% to 25% ($P = .000003$). The procedure of blinding patients as to the intervention received increased, from 1.2% to 4.5% ($P = .02$), and the method of blinding for those assessing patient outcomes also increased, from 1.0% to 6.6% ($P = .00002$).

Analysis of the anatomical focus of articles showed a fairly stable distribution between the 2 time periods. The knee was the most commonly studied area of investigation in 47.3% of articles in both 1991-1993 and 2001-2003. The only significant change was the increase in the number of

articles studying the shoulder, from 10.4% in 1991-1993 to 17.6% in 2001-2003 (P = .004). Foot and ankle studies trended down, from 12.4% to 8.5% of articles (P = .07).

Article focus by sport revealed a fairly stable distribution. The only significant change was a decrease in track and field studies, from 5.0% to 0.7% (P = .0002), although articles focusing on baseball trended up, from 2.0% to 4.5% (P = .05). No articles focused on lacrosse in either time period.

Of the articles that mentioned gender, most reported both male and female subjects (1991-1993, 49.5%; 2001-2003, 47.8%). Among articles in which all subjects were from one gender, the subjects were more often male (1991-1993, 24.1%; 2001-2003, 20.9%) than female (1991-1993, 7.7%; 2001-2003, 4.7%). No significant change in the frequency of gender focus was noted between the 2 periods.

DISCUSSION

The change in the distribution of the type of articles published in *The American Journal of Sports Medicine* may reflect a trend toward the use of EBM. Retrospective case reports and case series, as well as descriptive studies, have decreased during the study period. Randomized, prospective controlled studies, the highest standard of EBM, more than doubled, whereas prospective cohort studies tripled as a percentage of articles published. The fact that 5.9% of articles in 2001-2003 reported randomized, prospective controlled studies is encouraging, given that a recent review of leading surgical journals found that only 3.4% of all publications were randomized, controlled trials.[27] Overall, hypothesis-driven research has increased, as has prospective data collection and the use of blinding. These changes reduce the opportunity for bias (systematic error arising from the design or conduct of a study, not suggesting prejudice or willful manipulation of the data[16]), which may compromise the validity of study results.

The increased identification of funding sources represents an important shift toward transparency of research funding. Industry funding of research in medicine as a whole,[10,14] and orthopaedics and sports medicine[3,6] in particular, makes the identification of funding sources an important aspect of reporting results. The role of, need for, and potential bias from industry funding are not the focus of this article, but given the fact that industry funding of research is increasing,[4,10] it is important that funding sources are identified in conjunction with presented and published results.

The increase in biomechanical studies does not directly reflect increased use of evidence-based medicine, although most biomechanical studies are well-thought-out experiments and are not retrospective in nature. The increase in review and instructional articles hopefully reflects the increasing sophistication of sports medicine and the direction of *The American Journal of Sports Medicine*, but it has no apparent relation to any change in the underlying type of research.

The analysis of research focus by type of sport showed a dramatic decrease in the percentage of articles investigating track and field. The increase in articles focusing on baseball probably reflects the prevalence of shoulder and elbow injuries in this sport, both anatomical areas with abundant progress during the study period, in terms of diagnosis and treatment. The lack of articles on the sport of lacrosse perhaps identifies an area with potential for further research.

There was a disparity among articles in the distribution of gender focus, as male-focused research was 3 to 4 times more common than female-focused research. However, without data on the relative gender distribution of sports participation, injury, treatment, and rehabilitation, particularly at different playing levels ranging from recreational to professional, no conclusions can be drawn. Although the 2 time periods were compared, and given the growing participation and interest in female athletes fueled by Title IX among other factors, it is perhaps surprising that the percentage of articles focusing on female athletes was lower in 2001-2003, even though the change was not statistically significant.

Overall, there was a chronological shift toward more prospective and randomized research designs published in *The American Journal of Sports Medicine* from 1991-1993 to 2001-2003. This trend demonstrates an improvement in the methodological quality of research published in the latter 3-year period, compared with 10 years earlier. It should be noted that *The American Journal of Sports Medicine* changed to a structured abstract format with the Volume 30, Number 3 (2002) issue. The editorial from the next issue[15] commented on how this format helps the reader "ascertain what information is present . . . [and] identify specific desired aspects of the study,"(p461) and hoped the new format will help "lead to more hypothesis-driven research."(p462) While cause and effect is impossible to assess in this case, the desired change is taking place. This trend is promising, as sports medicine physicians seek better evidence on which to base their treatments. There remains room for improvement, particularly with regard to increasing the use of prospective data collection and controlled, randomized studies.

Nevertheless, it is important to recognize the significant role for descriptive studies in sports medicine. For studies on treatment efficacy, randomized, controlled studies are necessary to demonstrate level 1 evidence. But sports medicine encompasses much more than just treatment efficacy. For studies of prognosis or diagnosis, which are commonly used in sports medicine, prospective cohorts are the standard to demonstrate level 1 evidence. The process of injury prevention described by van Mechelen et al[25] emphasizes the importance of injury awareness, often through descriptive study, and ongoing injury surveillance—again, often descriptive. Ideally, awareness of injury mechanism, incidence, and prevalence, through more descriptive research, leads to investigation of proper intervention and treatment, better suited to randomized, controlled trials, and finally, to ongoing surveillance to assess efficacy. Such an orchestrated interplay between descriptive and evidence-based techniques provides the best mechanism for moving the science and success of sports medicine forward in the future.

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