TWENTY- FIVE YEAR TRENDS OF AUTHORSHIP AND SAMPLING IN ISBS PROCEEDINGS

Duane Knudson[1] and Rafael Bahamonde[2]

[1]Texas State University, San Marcos, TX, USA
[2]Indiana University Purdue University Indianapolis, Indianapolis, IN, USA

This study documented the trends in authorship and sampling in *ISBS Proceedings* over the last 25 years. Original research articles of the 1984, 1989, 1994, 1999, 2004, and 2009 proceedings were reviewed for data on authors, sample sizes, sample-author ratio, and rates of single authorship and hyperauthorship (6 or more). Narrative reviews, modeling papers, and technical notes, were excluded from analysis. The mean number of authors per paper significantly increased (71%), along with increased rates of hyperauthorship, and a decline in rates of single authorship (92%) since 1984. Sample sizes varied widely across papers and did not appear to change over time. Increased collaboration in sports biomechanics has not increased sample sizes of original research published in *ISBS Proceedings*.

KEY WORDS: bibliometrics, coauthor, collaboration, subjects.

INTRODUCTION: Current biomedical research tends to be written by teams (Wuchty, Jones, & Uzzi, 2007) with increasing numbers of coauthors (Weeks et al., 2004; Cronin, 2001; Papatheodorou, Trikalinos, & Ioannidis, 2008). Biomedical research is well known for problems with promiscuous coauthorship or hyperauthorship (Cronin, 2001). The growth of numerous coauthors has created problems in the assignment of credit and responsibility for scientific research (Shapiro, Wenger, & Shapiro, 1994; Cronin, 2001; Claxton, 2005) and prompted many journals to limit the number of authors or require declarations of contributions of all authors and collaborators (Osborne & Holland, 2009; McDonald, Neff, Rethlefsen, & Kallmes, 2010).

Sport and exercise biomechanics is a discipline that might be influenced by collaboration and publication trends in biomedicine. Bibliometric studies of biomechanics research have focused on statistical errors (Knudson, 2005) and relevance of the impact factor relative to prestige ratings by biomechanics scholars (Knudson, 2007; Knudson & Chow, 2008; Knudson & Ostarello, 2008). An analysis of the 2009 volumes of three applied biomechanics serials observed that research reports averaged four authors with mean sample sizes of 15 to 42 subjects (Knudson, 2011). The average rates of hyperauthorship (6 or more authors) in these serials were similar to other exercise science disciplines (6 to 23% of papers). A follow-up study of twenty year trends in applied biomechanics reported significant increases in the number mean authors and hyperauthorship over twenty years in the *Journal of Applied Biomechanics* and *ISBS Proceedings*. (Knudson, 2012). The purpose of this study was to extend the analysis of trends in authorship and sampling practice in sports biomechanics articles in the *ISBS Proceedings* to the last twenty-five years.

METHOD: A bibliometric review of the 1984, 1989, 1994, 1999, 2004, and 2009 volumes of *ISBS Proceedings* was conducted. All articles from these proceedings were retrieved and reviewed. All original research articles were included, with reviews, modeling papers, and technical notes excluded from analysis. Technical notes were studies that proposed experimental methodology, research technology, or evaluated data processing.

Several dependent variables related to research collaboration were retrieved from the text of each original research report: the number of authors, sample size, sample-author ratio (SA ratio), single-author rate and hyperauthorship rate. Sample size was defined as the total number of subjects, animals, or tissue samples used in the experiment or series of experiments in the research report. The sample-author ratio was the sample size divided by the number of authors. The single author rate was the percentage of papers with a single author in that volume of the proceedings. The hyperauthorship rate was the percentage of

papers with 6 or more authors in that proceedings (Flanagin, Carey, Fontanarosa, Phillips, Pace, Lundberg, & Rennie, 1998). Descriptive data were calculated and compared to the 1984 baseline data of the same serial using 95% confidence intervals. To explore potential the associations between these authorship and sampling variables, Pearson correlations were calculated between sample size, authors, and SA ratio for each proceedings and all the papers analyzed.

RESULTS: One third of 1984 proceedings original research reports had one author and no reports had 6 or more coauthors (Table 1). The mean number of authors at baseline was 2.1 [1.5, 2.7]. Statistically significant increases (48-71%) in the mean number of authors began in the 1999 proceedings and continued through 2009. This was similar to the steady declining trend of single authorship rates and increasing hyperauthorship rates over time (Table 1). The papers written by single authors declined 92% from 1984 to 2009 (Figure 1).
The baseline mean [95% CI] samples size and SA ratios were 17.2 [8.6, 25.8] and 9.3 [4.8, 13.8] subjects, respectively. Sample sizes had considerable variability and no clear trend over time (Table 1). The 1994 and 1999 proceedings had significantly larger sample sizes, but this could be due to skew introduced by a few studies with very large samples (e.g. 491, 900).
There was a significant ($P < 0.05$) but weak inverse ($r = -0.17$) association between number of authors and SA ratio. There was no correlation between authors and sample size, but there was a strong positive ($r = 0.83$) correlation between authors and SA ratio. Associations between these variables were consistent across each volume of *ISBS Proceedings* studied.

Table 1
Authorship and Sampling of Research Published in *ISBS Proceedings*

	N	Sample *M* (*sd*)	Authors *M* (*sd*)	SA Ratio *M* (*sd*)	HAR (%)	SAR (%)
1984 Colorado Springs	18	17.2 (18.7)	2.1 (1.2)	9.3 (9.7)	0	33.3
1989 Melbourne	18	16.4 (19.5)	1.8 (0.8)	11.8 (19.8)	0	38.9
1994 Budapest	64	40.4 (118.3)*	2.6 (1.2)	21.2 (56.1)*	1.6	20.3
1999 Perth	61	30.7 (69.2)*	3.1 (1.3)*	8.9 (14.2)	4.9	9.8
2004 Ottawa	124	18.5 (45.6)	3.1 (1.4)*	6.9 (14.0)	4.1	5.7
2009 Limerick	239	19.0 (34.2)	3.6 (1.4)*	7.0 (21.7)	9.4	2.6

Note: SA Ratio: Sample/Author Ratio; HAR: Hyper-authorship Rate; and SAR: Single-Author Rate (See methods for details). *Significantly ($P < 0.05$) different from the 1984 proceedings values.

DISCUSSION: This study reinforced the trends observed in authorship and sampling for the *Journal of Applied Biomechanics* and *ISB Proceedings* reported by Knudson (submitted). Over twenty-five years the mean number of authors has increased from 2.1 to 3.6 (71%) with a parallel decline (91%) in papers written by single authors. Statistically significant increases in mean authorship began with the 1999 proceedings. This overall trend of greater collaboration is reflected in the percentage of papers with very large numbers of authors or hyperauthorship. Hyperauthorship in *ISBS Proce*edings increased from 0% in 1984 to 9.4% of the papers in 2009. It appears that *ISBS Proceedings,* as well as other exercise sciences (Knudson, 2011), does not have high rates of hyperauthorship which is more common in biomedical research (Cronin, 2001).

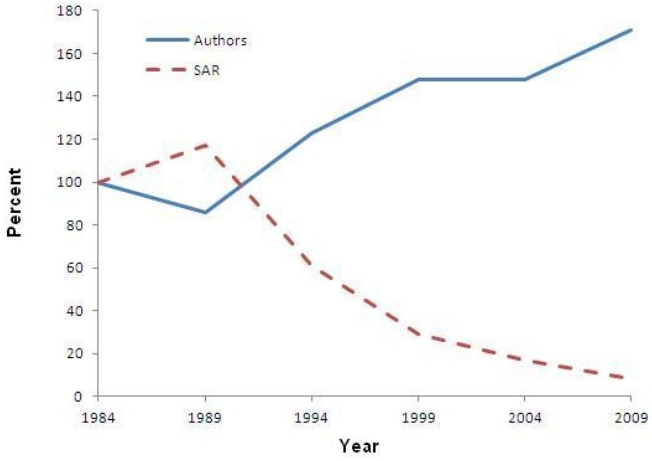

Figure 1: Percentage change in mean authorship and single authorship rate (SAR) in *ISBS Proceedings* since 1984.

There was large variability in the sample sizes used in sport biomechanics research reports in each proceedings. This is logical given that different studies (correlation versus comparison) and populations (e.g. beginner, trained, elite) influence possible sample sizes. Even though technical notes were excluded from the analysis, many papers reported analyses of single subjects, while other reports presented data from several hundred subjects. There were no clear trends given this large variability, however, it was interesting that given the advancements in automation of some biomechanical data analysis systems and the increase in collaboration that there had not been some increase in the sample sizes in research reports. The weak negative association (r = -0.17) between authors and SA ratio indicated that the increase in collaboration was weakly associated with smaller sample sizes. A similar but slightly larger negative correlation (r = -.46) was reported for an exercise physiology journal by Knudson (2011). This lack of improvement or even decline in sample sizes in sports biomechanics is a weakness in some biomechanics and exercise science literature that should be addressed. Despite widespread recommendations to improve samples sizes in the literature, this weakness has also been reported in psychology research (Marszalek, Barber, Kohlhart, & Holmes, 2011).
Limitations of the current study were the multiple comparisons (15) and correlations (3) subjected to statistical tests from the same data set. However, given comparisons were being made with the whole population of published research reports and several significant effects were observed, it is not likely that type II errors influenced most of the results of this study. Much of the *ISBS Proceedings* data were similar to a portion the Knudson (2012) study, but the addition of the 1984 volume provided new baseline data and confidence intervals with which to evaluate trends in authorship and sampling practice in sports biomechanics. The 1984 proceedings had similar bibliometric values as the 1989 proceedings (Table 1). This supports the hypothesis of a fairly stable pattern of authorship and sample sizes in sports biomechanics research published in *ISBS Proceedings* in the 1980s from which the observed trends in authorship have emerged. Qualitatively it appears that increasing coauthorship in sports biomechanics began in the 1990s (Figure 1).

CONCLUSION: Original sports biomechanics research reports published in *ISBS Proceedings* from 1984 to 2009 show clear trends of increased numbers of coauthors, percentages of articles with 6 or more authors, and decreasing percentages of articles by single authors. The sample sizes used in sports biomechanics research reports varied widely and has not likely changed over the last 25 years. The trends toward increased collaboration by sports biomechanics researchers has not had a positive influence on improving sample sizes of original research published in *ISBS Proceedings*.

REFERENCES:

Claxton, L. D. (2005). Scientific authorship Part 2: history, recurring issues, practices, and guidelines. *Reviews in Mutation Research* 589, 31-45.
Cronin, B. (2001). Hyperauthorship: a postmodern perversion or evidence of a structural shift in scholarly communication practices? *Journal of the American Society for Information Science and Technology* 52, 558-569.
Flanagin, A., Carey, L., Fontanarosa, P. B., Phillips, S. G., Pace, B. P., Lundberg, G. D., & Rennie, D. (1998). Prevalence of articles with honorary authors and ghost author in peer-reviewed medical journals. *Journal of the American Medical Association*, 280, 222-224.
Knudson, D. (2005). Statistical and reporting errors in applied biomechanics research. In Q. Wang (Ed.) *Proceedings of XXIII international symposium on biomechanics in sports: volume 2* (pp. 811-814). Beijing: China Institute of Sport Science.
Knudson, D. (2007). Prestige of sport biomechanics serials. In H.J. Menzel, & M.H. Chagas (Eds.) *Proceedings of the XXVth International Symposium on Biomechanics in Sports* (pp. 374-376). Belo Horizontae: Federal University of Mineas Gerais.
Knudson, D. (2011). Authorship and sampling practice in selected biomechanics and sports science journals. *Perceptual and Motor Skills*, 112, 838-844.
Knudson, D. (2012). Twenty-year trends of authorship and sampling in applied biomechanics research. *Perceptual and Motor Skills,*114, 16-20.
Knudson, D., & Chow, J. (2008). North American perception of the prestige of biomechanics serials. *Gait & Posture*, 27, 559-563.
Knudson, D., & Ostarello, J. (2008). International prestige of sports biomechanics serials. In Y.H. Kwon, J. Shim, & I.S. Shin (Eds.) *Proceedings of the XXVIth International Conference on Biomechanics in Sports* (pp. 62-66). Seoul: Seoul National University.
Marszalek, J. M., Barber, C., Kohlhart, J. & Holmes, C. B. (2011). Sample size in psychological research over the past 30 years. *Perceptual and Motor Skills*, 112, 331-348.
McDonald, J. R., Neff, K. L., Rethlefsen, M. L., & Kallmes, D. F. (2010). Effects of author disclosures and numeric limitations on authorship trens. *Mayo Clinic Proceedings*, 85, 920-927.
Osborne, J.W., & Holland, A. (2009). What is authorship, and what should it be? A survey of prominent guidelines for determining authorship in scientific publications. *Practical Assessment, Research & Evaluation*, 14, 1-19.
Papatheodorou, S. I., Trikalinos, T. A., & Ioannidis, J. P. A. (2008). Inflated number of authors over time have not been just due to increasing research complexity. *Journal of Clinical Epidemiology*, 61, 546-551.
Shapiro, D. W., Wenger, N. S., & Shapiro, M. F. (1994). The contributions of authors to multiauthored biomedical research papers. *Journal of the American Medical Association*, 271, 438-442.
Weeks, W. B., Wallace, A. E., & Kimberly, B. C. S. (2004). Changes in authorship patterns in prestigious US medical journals. *Social Science & Medicine*, 59, 1949-1954.
Wuchty, S., Jones, B.F., & Uzzi, B. (2007). The increasing dominance of teams in the production of knowledge. *Science*, 316, 1036-1039.