

VISIBILITY AND USAGE OF ISBS PROCEEDINGS AT FORTY YEARS

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This study described the visibility and usage of research published in ISBS conference proceedings articles from 1983 to 2022. The 6,688 articles were downloaded 1,955,728 times in total, and 78% were indexed by Google Scholar. In recent proceedings, the number of articles and total downloads have decreased but downloads per article per year of availability have increased steeply. Top (1%) cited articles in Google Scholar had citations and citation rates similar to articles in biomechanics journals. While visibility has grown, there is limited citation of most ISBS proceedings articles compared to journal articles.

KEY WORDS: bibliometrics, citation, history, impact, research, usage.

INTRODUCTION: The International Society of Biomechanics in Sports (ISBS) strives to advance knowledge of sports biomechanics and bridge the gap between researchers and coaches. ISBS is holding its 40th conference in Milwaukee, Wisconsin in 2023. The society is about 40 years old given one can begin counting at different points (incorporation or meetings, including those cancelled or moved online). Irrespective of how you define age, it is a good time to review the contributions of the published ISBS proceedings (ISSN 1999-4168) to the science of sports biomechanics and the society's applied mission. It has also been 15 years since two previous summaries of the early history of ISBS were published. Fortenbaugh (2007) reviewed 25 years of ISBS conference proceedings (ISBSCP) authors, affiliations, countries, and collaborations. Ostarello (2008) reviewed the founding of ISBS, early meetings and leaders, and major issues faced by the society in the emerging field of sports biomechanics. Despite the open online availability of 39 years of ISBSCP articles, it is not clear how this research is used in subsequent biomechanics research. Proceedings articles are equal in prestige to journal articles in several fields (Kochetkov et al., 2022) but this is unclear in biomechanics. A survey of American Society of Biomechanics members affiliated with "exercise/sport science" rated ISBSCP between *moderate* to *low* "quality/impact" (Knudson, 2007), while the same survey of ISBS members rated ISBSCP between *moderate* and *high* (Knudson & Ostarello, 2010). The purpose of this study is to document the visibility and usage of ISBSCP articles based on indexing, download, and citation metrics.

METHODS: The visibility and usage of articles published in the 1983-2022 ISBSCP were documented with bibliometric methods from three sources: the overall proceedings archive systems [<https://isbs.org/conferences/proceedings-archive>]; Google Scholar (GS); and specifically, the 2022 ISBSCP. Google Scholar was used because it indexes more scientific publications than other databases, including proceedings articles like ISBSCP. Its web crawler programs search publisher sites, repositories, and references in published research. However, the greater coverage comes with additional difficulty of manual effort in extracting data and cleaning irrelevant records. GS was searched for major variants of ISBSCP titles up to 30 November 2022 (Table 1). Authors, titles, and citations from selected GS searches were manually extracted and cleaned of duplicate records, non-ISBSCP articles, and ISBSCP documents that were not keynote, oral, poster, or applied session articles. Visibility was examined via views and downloads data extracted from the two online archives (University of Konstanz 1983-2017 and Northern Michigan University 2017-2022) up to 25 January 2023 and indexing in GS. For each volume (year) of the proceedings, total articles, and downloads, mean and median downloads per article, downloads per year since publication, and downloads per article per year since publication were all reported. Usage was examined by searches of GS for total citations and citation rate (CR) of the top 70 (1%) most cited ISBSCP articles identified from the search for "ISBS-Conference Proceedings Archive".

Content analysis of the most cited articles was reported. Internal usage was examined as percentage of references in 2022 ISBSCP articles citing other ISBSCP articles.

RESULTS: The society has published 6,688 articles within 39 proceedings from 1983 until 2022, receiving a total of 1,955,728 downloads. Annual articles increased steadily from 35 in 1983 to a peak of 376 articles in 2015, before decreasing to 196 in 2022 (Figure 1a).

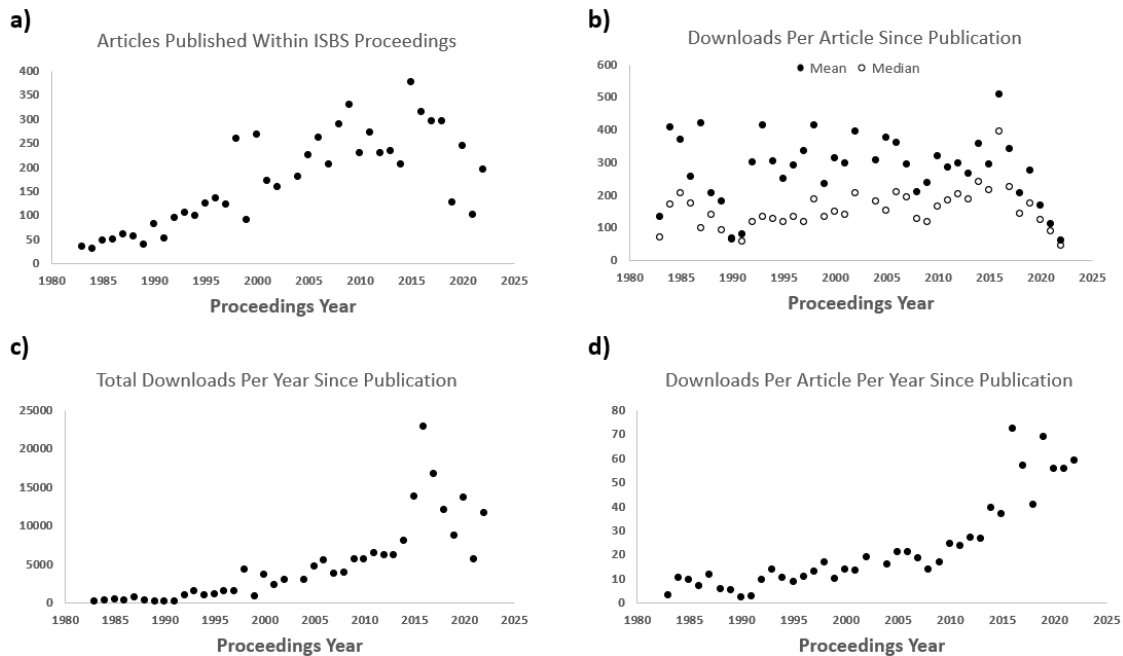


Figure 1. Metrics per proceedings year: a) number of articles; b) downloads per article; c) downloads per year since publication; d) downloads per article per year since publication.

The visibility of ISBSCP based on the GS search of the unified proceeding archive title “ISBS-Conference Proceedings Archive” was 78% of the 6,688 articles (Table 1). It is difficult to estimate the actual percentage of ISBSCP articles indexed in GS given the variability in proceeding titles and various online access to articles in repositories as well as indexed citations in other articles. GS web crawlers pick up citations within articles that may have errors in reporting of ISBSCP details.

Table 1. Google Scholar Search Results for Variants of ISBSCP Titles

Search	Uncleaned	Cleaned
“ISBS”	7,190	NA
“ISBS Proceedings”	6,690	NA
“ISBS-Conference Proceedings Archive”	5,220	NA
“International Society of Biomechanics in Sports”	151	151
“International Society on Biomechanics in Sports”	18	19
“ISBS Symposium”	272	218
“Symposium on Biomechanics in Sports”	339	356
“Conference on Biomechanics in Sports”	58	55
“Biomechanics in Sports”	1,050	5
ISSN “1999 4168”	108	22

Note: Total records returned using “Returned articles published in” option of the advanced search feature of Google Scholar. Cleaned records eliminated duplicate and non-ISBSCP articles. Some cleaned totals were not available (NA) because Google Scholar only returns the top 1,000 records for any search along with an “About [number] results” summary.

Article downloads often exceeded page views (e.g., 11,608 vs 8,735 for the 2022 volume), perhaps due to GS linking directly to the article pdf file. These results therefore focus on download metrics. Downloads per volume follow a similar trend to the number of articles, with no clear trend in downloads per article (mean \pm SD of 280 ± 103 ; Figure 1b). Downloads per year since publication (Figure 1c) and especially downloads per article per year of availability (Figure 1d) have risen in recent years. As an example of the lifetime of ISBSCP articles, those from 2017 (the first year of the current repository) received 20,204, 16,163, 19,111, 20,956, and 18,664 downloads in each of 2018-2022, respectively.

Total scholarly usage in subsequent research as measured by citations was difficult to determine given the limitations of GS. GS limits returned records to the top 1000 based on their page rank algorithm. Returned results had to be manually reviewed and cleaned of similar wording and abbreviations for organizations (e.g., International Sustainable Building Symposium; International Society for Biopharmaceutical Statistics), issues (e.g., Inter-System Biases), and methods (e.g., In-Situ Bubble Stretching). Articles were also hard to identify because of changes in ISBSCP titles. The first four proceedings were published as volumes entitled “Biomechanics in Sports” and numerous meetings and proceedings names were used mixing “symposium”, “conference”, and Arabic and Roman numerals.

The top ten articles received between 66 and 221 citations, with citation rates between 1.7 and 10.5 citations/year (Table 2). Top 1% cited ISBSCP articles in GS had ≥ 33 citations and citation rates between 1 to 11 citations per year. The majority of the highly cited articles focused on swimming (25%), running (13%), basketball (7%), and taekwondo (7%). Only 2% of references within 2022 ISBSCP articles were to previous ISBSCP articles.

Table 2. Top Ten ISBSCP Articles Indexed in Google Scholar by Citations

Authors	Title	Year	Citations	Citation Rate
Cossor & Mason	Swim start performances at the...	2001	221	10.5
Karamanidis et al.	Symmetry and reproducibility... [run]	2002	153	7.7
Mason & Cossor	What can we learn from... [swimming]	2000	120	5.5
Elmer et al.	Joint-specific power... [cycling]	2010	115	9.6
Schollhorn & Bauer	Identifying individual... [javelin]	1998	109	4.5
Arellano et al.	Modelling competitive swimming in...	2001	96	4.6
Velotta et al.	Relationship between leg... [balance]	2011	95	8.6
Kleshnev	Propulsive efficiency of rowing	1999	80	3.5
Hudson	A biomechanical analysis... [basketball]	1983	73	1.9
Mann & Sprague	Kinetics of sprinting	1983	66	1.7

DISCUSSION: The 6,688 articles published in ISBSCP from 1983 until 2022 (and now those from 2023) are available for free in ISBSCP archives. In 2016 the two repositories (pre- and post-2017) were organized under the same title of “ISBS-Conference Proceedings Archive”. This distinct online presence made the published articles visible to web crawler programs, so now many articles (78%) are indexed by GS. ISBSCP articles, however, are not visible to scholars who rely solely on databases like Web of Science and Scopus. ISBS owes a debt of gratitude to Manfred Vieten who ensured early print articles were scanned and uploaded to the archive and subsequent Vice Presidents for Publications who have worked with scientific committees to maintain the archive for open access to all researchers.

While the number of articles per year rose steadily until 2015, the reasons for the recent decrease are unclear. This may be partly but not fully due to factors such as the global COVID-19 pandemic and an increase in year-round online science communication beyond annual conferences. The recent decrease in total downloads per article may be attributable to the lesser time available to accrue downloads since publication. Contrastingly, or perhaps consequentially due to articles focusing on topical issues, the most recent proceedings have received greater numbers of downloads per year, and particularly downloads per article per year. The case study of 2017 proceedings articles, however, indicated no evidence of a decline in downloads during the first 5 years post-publication. This suggests good initial longevity and that the articles are still being used long after the conference. It also implies that

the recent rise in downloads per year of availability may be indicative of generally greater use and not purely a time-constrained consequence of article recency.

This strong visibility has resulted in a small percentage of ISBSCP articles becoming well-cited. The top cited ISBSCP articles in GS represent strong short-term and long-term contributions to the field with CR between 2 and 11 citations per year (Table 2). These CR are high and consistent with top research and award winners in biomechanics (Knudson 2015, 2017, 2018, 2020). It is clear that many articles published in ISBSCP are used extensively in subsequent biomechanics research. This high usage is consistent with the esteem for ISBSCP by ISBS members (Knudson & Ostarello, 2010). Similar high usage has been reported for the ISBS journal *Sports Biomechanics* (Knudson & Chow, 2008; Knudson, 2020). Citations to the majority of ISBSCP papers are, however, lower than citations to most Sports Biomechanics articles. Only 2% of references in 2022 ISBSCP articles cited previous ISBSCP articles. This was consistent with findings that proceedings articles published in journals receive fewer citations than regular articles in many fields (Zhang & Glanzel, 2012). ISBS authors should be encouraged to consider greater citation of relevant research from previous ISBSCP articles, but the society should also consider what can be done to maintain and/or increase the influence and prestige of the proceedings. We should not forget the applied mission of the society and intended benefits beyond scholarly citation. Opinions regarding digital object identifiers, the relationship between ISBSCP and the society's journal *Sports Biomechanics*, and ISBSCP article length should be explored with members at this conference and beyond.

CONCLUSION: ISBSCP archives provide a wealth of sports biomechanics knowledge free to scholars worldwide. Archive data show growing and sustained visibility. GS data indicate some well-cited articles but mostly limited usage as citations for most ISBSCP articles compared to biomechanics journal articles.

REFERENCES:

- Fortenbaugh, D. (2007). 25 years of the ISBS: A silver salute to sports biomechanics research presentations. *ISBS-Conference Proceedings Archive*, 25, 377-380.
- Knudson, D. (2007). Prestige of sport biomechanics serials. In H-J. Menzel, & M.H. Chagas (Eds.) *ISBS-Conference Proceedings Archive*, 25, 374-376.
- Knudson, D. (2015). Biomechanics scholar citations across academic ranks. *Biomedical Human Kinetics*, 7, 142-146.
- Knudson, D. (2017). Profiles of excellence in sports biomechanics research. *ISBS-Conference Proceedings Archive*, 35, 831-834.
- Knudson, D. (2018). Profiles of young scholar award winners in biomechanics. *ISBS-Conference Proceedings Archive*, 36, 52-55.
- Knudson, D. (2020). Top cited research over fifteen years in *Sports Biomechanics*. *Sports Biomechanics*, 19(6), 808-816.
- Knudson, D., & Chow, J. (2008). North American perception of the prestige of biomechanics serials. *Gait & Posture*, 27, 559-563.
- Knudson, D., & Ostarello, J. (2010). Influential literature in applied sports biomechanics. *ISBS-Conference Proceeding Archive*, 28, 765-768.
- Kochetkov, D. et al. (2022). The importance of conference proceedings in research evaluation: a methodology for assessing conference impact. In V. Vishnevskiy et al. (Eds) *Distributed Computer and Communication Networks* (pp. 359-370). Springer
- Ostarello, J.Z. (2008). ISBS: The evolution of a revolution. *ISBS-Conference Proceedings Archive*, 26, 2-16.
- Zhang, L., & Glanzel, W. (2012). Proceedings papers in journals versus "regular" journal publications. *Journal of Informetrics*, 6, 88-96.