CITATIONS TO BIOMECHANICS ARTICLES FROM FOUR DATABASES

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Four (Dimensions, Google Scholar, Scopus, Web of Science) multi-disciplinary databases were searched for journal articles published by one scholar to document the coverage of exercise and sports biomechanics. Cleaned searches returned 65 to 93 articles in common between these databases from 116 journals articles published between 1989 and 2019. Citations and mean citation rates were qualitatively higher for Google Scholar (3206 & 3.2) than the other three databases (1100-1400 & 1.6-2.1). Strong positive correlations (0.88-0.96) of citations between databases indicated that for this case, study citations from subscription databases (Scopus & Web of Science) could be predicted (SEE 3 to 7) from the free databases (Dimensions and Google Scholar). This case study indicated incomplete coverage and subtle inconsistences are likely between these databases in exercise and sport biomechanics. Skillful searching of multiple databases is recommended.

KEY WORDS: bibliometrics, impact, usage, searching, systematic review.

INTRODUCTION: The rapid expansion of research and journals increasingly contributes to scholars drowning in data but starving for knowledge (Forscher, 1963). Bibliometric databases are essential tools in searching for peer-reviewed research for planning studies and confirmation of qualitative evaluations of the usage/impact published research for awards, grants, or personnel decisions (Knudson, 2019a, 2019b). Scholars have many multidisciplinary and specialized databases from which to search for relevant research, consequently scholars have studied the properties of these databases and search tools.
Properties of databases and their search engines that have been examined include coverage, errors, percentage recall of relevant records, precision (percentage of relevant records), and transparency. Numerous studies consistently report greater coverage, recall, and citations from Google Scholar than curated, subscription databases like Scopus and Web of Science (Harzing & Alakangas, 2016; Martin-Martin et al., 2018, 2020). Gusenbaur and Haddaway (2020) recently reviewed search and coverage properties of 28 major bibliometric databases using 27 criteria and reported substantial differences in performance of both coverage and search systems. About half of the search systems correctly applied Boolean operators and there were differences in the effectiveness of search systems automatically interpreting user queries, limiting to explicit terms (quotation marks), and other forms of wildcards/truncation. Specifically, they concluded few free search systems can be recommended for systematic reviews of research and researchers should educate themselves on these details of search systems and databases.
Sports biomechanics research is particularly challenging to search for given it cuts across disciplinary fields/subject areas (Engineering, Health Sciences, Life Sciences, Natural Sciences) that have different coverage across databases. Searching multidisciplinary databases is desirable for greater coverage/recall, however this comes at a cost of precision. Even when searching in specialized databases (e.g., medicine) aligned with a research topic, searching using the same terms will often return low percentages (32-35%) of relevant records (recall) and with little (17%) overlap in journals covered (Minozzi, Pistotti, & Forni, 2000). Persistent and systematic searches of numerous bibliometric databases followed by critical review and cleaning of returned records are needed for scholars to accurately identify articles relevant to their research (Knudson, 2019b). The purpose of this study was to compare four commonly used multidisciplinary bibliometric databases for coverage of peer-reviewed articles published by a typical senior scholar in kinesiology, exercise and sport biomechanics. This case study provides preliminary understanding of the utility of these large databases given there are no kinesiology or biomechanics-specific databases.

METHOD: The author used his own peer-reviewed journal publication record for this study. His CV of 116 articles published or e-ahead of print between 1989 and November 18, 2020

served as a set population of scholarship in kinesiology, exercise and sports biomechanics. This case study is a representative record of a senior scholar in these fields (Knudson, 2015a, 2015b). Other peer-reviewed work in books, chapters, grants, patents, or proceedings were excluded from this analysis, although some of these databases do index these and other sources.

Two free database versions (Dimensions & Google Scholar) and two subscription databases (Scopus & Web of Science) were searched. At Texas State the "All Databases" of Web of Science includes the Web of Science Core Collection, MEDLINE, and six other databases. Multiple searches using variations of the author's names and initials (Duane Victor Knudson) were performed in each database, cleaned, and records copied or exported. Overall records for Google Scholar (GS) were recorded, as well as records indexed in common with the three curated databases. Data were input into an Excel file that included authors, title, journal, volume, issue, pages, year of publication, and citations (C). Citation rates were calculated using the formula C/(2020-year of publication). All 2020 articles were included in the analysis if they received citations in any single database, however these were not included in the analysis of citation rate (CR) if there were no citations. The mean difference in citations between the three curated databases was calculated (e.g., C_{WOS}-C_{Scopus}). Since journal coverage of these databases has been reported before, this study examined the percentage recall of articles published by the scholar studied.

Descriptive data were calculated, correlations and linear regressions between C returned by the databased were also performed. C and CR were qualitatively compared across databases given the large skew that is common in citation data (Knudson, 2015; Seglin, 1992). A study-wide type I error rate of $p < 0.05$ was selected and controlled for by adjusting critical values for the four correlations using a Holm (1979) correction.

RESULTS: Search of GS returned 112 (97%) of the 116 articles and 93 (80%) in common with the other databases (Table 1). Records from all databases required multiple searches and cleaning to ensure accuracy. For example, the 65 final records from Web of Science required multiple author name searches and exclusion of four presentation abstracts, three letters, one chapter, and one database error. Number of records, citations, and mean citation rate were qualitatively similar across the three curated databases, while values for these variables were up to twice as large in GS (Table 1). Mean differences in C from the three curated databases were between 0 and 1.1 citations, while these databases had mean differences of -17 to -24 citations from GS. GS had qualitatively superior recall (90 to 97%) than the other curated databases (56 to 75%) from this population of journal articles.

Table 1
Database Performance Variables for an Exercise and Sport Biomechanics Scholar

Database	Records	Recall (%)	Citations	Citation Rate
Dimensions	88	75	1397	1.6
Google Scholar	112 [overall]	97	3532	3.3
Google Scholar	93 [in common]	90	3206	3.2
Scopus	79	68	1203	1.8
Web of Science	65	56	1093	2.1

There were large, significant ($p < 0.001$) positive correlations ($0.877 < r < 0.959$) between all databases for C and CR (Table 2). These two strong correlations allowed regression prediction of the likely citations of this scholar in subscription database (Scopus & Web of Science) from databases free (Dimensions & GS) to researchers. Standard errors of estimates of citations in Scopus and Web of Science were 5 to 6 from citations in both Dimensions and GS. Overlap of records returned between databases varied between 70 and 95 percent (Table 2).

Table 2
Correlation and Overlap (%) of Indexed Records from Four Databases

	Google Scholar		Scopus		Web of Science	
	r	OL	*r*	OL	*r*	OL
Dimensions	0.936	95	0.955	90	0.969	77
Google Scholar			0.957	85	0.974	70
Scopus					0.987	82

Note: Overlap (OL) is the percentage of records expressed relative to the largest return from each pair of databases. All correlations statistically significant at $p < 0.001$.

DISCUSSION:

The current data provide a novel comparison of four major multi-disciplinary databases in exercise and sport biomechanics using a known population of peer-reviewed journal articles by a senior scholar. Accuracy of recall of these articles varied by database ranging from 56% for Web of Science to 97% for GS. While the overlap of the databases with each other was between 70 and 95% for these articles (Table 2), there was enough journal coverage differences to create different returned records and citation counts (Table 1). GS returned more articles than the other curated databases. The greater coverage of journals and citations by GS over curated databases is well documented across hundreds of discipline/subject categories (Harzing & Alakangas, 2016; Martin-Martin et al., 2018, 2020). The GS search program, however, was unable to find two older international, state, and specialized journal articles that did not have online access. These articles are only sometimes picked up when these articles are cited. At the other extreme, searching for the author in Web of Science returned only 56% of his published articles. This blind spot of records includes articles in journals not indexed by this database, but also articles in journals that became indexed in Web of Science in subsequent years after article publication.

These recall and overlap results support the utility of these databases and search tools for accessing a moderate to high percentage of research relevant to kinesiology, exercise and sport biomechanics. There was greater agreement of recall, citations, and citation rate between Dimensions, Scopus, and Web of Science, than with GS. The greater recall of GS resulted in larger citations and citation rates that the other databases (Table 1). Greater recall generally reduces precision, so increased coverage may not always be better (Gusenbaur & Haddaway, 2020). This is true with GS that has limited sorting features, lower reproducibility, results limited to 1000 records, and lack of a data export function. For example, searching GS for this scholar would return his personally curated *GS Profile* that, at the time of the study, had 165 records and 5127 citations. Without this profile there would be high manual user requirements to accurately search for the author, disambiguate author names, and exclude non-journal article records. Consequently, scholars should consider primary use of searches of curated databases, supplemented with searches of GS.

Searches of GS are important, given curated databases have more selective and publisher-specific coverage that limit coverage and recall of relevant research in exercise and sports biomechanics. It is also common for institutional subscriptions to databases to vary in the extent of the records they are able to access (Gusenbaur & Haddaway, 2020). The incomplete coverage and subtle inconsistences across databases also indicate that skillful searching of multiple databases is recommended.

The current case study confirmed the strong positive associations between citation counts between these databases in biomechanics that has been previously reported in kinesiology (Knudson, 2019b). For articles indexed in paired databases, regression equations could accurately (SEE 5 to 6) predict citations from free databases like Dimension and GS despite differences in timing of indexing between databases.

Limitations of this study include the analysis of a single scholar, manual searching, manual cleaning of errors and data analysis. However, many database comparison studies utilize

small samples (Harzing, 2019; Visser et al., 2020). Errors are also present in all bibliometric databases (Visser et al. 2020) and must be cleaned by users with potential errors. Despite these limitations these data provide initial evidence on the general utility and associations between searches of these multi-disciplinary databases in kinesiology, exercise and sports biomechanics.

CONCLUSION: This case study indicated that four multi-disciplinary databases could retrieve 56 to 97 percent of peer-reviewed journals articles by a senior exercise and sports biomechanics scholar. Incomplete coverage, subtle indexing inconsistences, database errors, and differences in searching and export functionality contribute to differing results in searching for exercise and sports biomechanics journal articles. Skillful searching of multiple databases is recommended to find relevant research and citation metrics in biomechanics.

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