VARIATION IN RECENT CITATION METRICS FOR BIOMECHANICS JOURNALS

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This study documented recent citation metrics in 14 biomechanics journals from 2017 until 2021. Five recent metrics were extracted to report 2021 values, absolute and relative variability and slope over the five years. Mean usage were typical based on normalized metrics (0.6 to 1.1 for SJR3 & SNIP3) and IF5 and CS4 (2.7 & 3.5). Year-to-year absolute and relative variability were 0.11 - 0.48 and 12% - 21%, respectively. There was considerable variation of journal metrics in biomechanics journals supporting previous research journal metrics should not be reported to greater than one decimal place precision and meaningful differences across time need to be at least 0.3-0.5 or 30 percent.

KEY WORDS: impact, prestige, quality, research, usage.

INTRODUCTION: Journal citation metrics are often used by scholars to select publication outlets for their research. The Clarivate Impact Factor (IF) has long dominated journal evaluation, although there are serious problems with this metric and its use as a proxy indicator of journal or research quality (Amin & Mabe, 2003; Seglen, 1997). The IF is weakly correlated ($r < 0.35$) with scholar ratings of quality/prestige of journals publishing biomechanics research (Knudson & Chow, 2008; Knudson & Ostarello, 2008).
Studies have documented the long-term inflation of the IF (Althouse et al., 2008; Neff & Olden, 2010), inconsistencies, errors, lack of transparency by Clarivate (Eston, 2005), and efforts of editors to improve journal ranking and status (Falagas & Alexiou, 2008). Adaptations of the IF and other journal metrics have been proposed as better proxy measures of journal usage and prestige (Roldan-Valadez et al., 2019). In addition, research supports the use of multiple citation metrics (Glanzel & Moed, 2002; Hicks et al., 2015; Roldan-Valadez et al., 2019).
Changes in journal citation metrics, like the IF, tend to gradually increase over several years (long-term) mixed with short-term variation/fluctuation (Dang, 2006; Haghdoost et al., 2014). Althouse et al. (2009) reported that the weighted mean IF of all JCR journals increased 2.6% a year from 1994 to 2005, with four factors being most influential in that growth. The legitimate long-term increase in journal metrics should also be interpreted in the context of annual (year to year) variation. Short-term variation differs by discipline and the number of articles published by the journal (Althouse et al., 2009; Amin & Mabe, 2003; Dang, 2006; Ogden & Bartley, 2008; Pajic, 2015). Zadpoor and Nikooyan (2011) reported that the IF of 14 biomechanics rose more slowly than similar biomedical sciences from 2003 until 2010.
Despite the extensive use and abuse of journal citation metrics (Amin & Mabe, 2003; Ioannidis & Thombs, 2019), there is limited research on short-term variability and meaningful changes in these metrics. Previous research has proposed use of statistical tests (Schubert & Glanzel, 1983), confidence intervals (Bornmann, 2017), and changes greater than 10-30% (Amin & Mabe, 2003; Haghdoost et al., 2014; Ogden & Bartley, 2008). The reporting of IF to meaningless precision (3 or more decimal places) has spurred recommendations to report and interpret them to only one decimal place (Hicks et al., 2015; Vanclay, 2012). The purpose of this study was to document the year-to-year variability and five-year trend of four recent journal citation metrics in biomechanics journals. It was hypothesized that journal metrics would have different variability and long-term (5-year) change in these metrics.

METHODS: A sample of 14 biomechanics journals (Table 1) publishing in the English language was identified by integrating journals in previous bibliometric research on biomechanics (Knudson & Chow, 2008; Zadpoor & Nikooyan, 2011). Recent journal citation metrics (Roldan-Valadez et al., 2019) were collected for the previous five years (2017-2021) that were based on the two most prestigious, curated bibliometric databases: *Scopus* and *Web of Science*. The five year window focused on current trends in citation behavior and allowed use of recent journal metrics like the Cite Score that transitioned from a 3 to a 4-year window in 2017.

Five journal citation metrics were extracted from four sources: Clarivate Analytics Journal Citation Reports, CTWS Journal Indicators, SCImago Journal Rank, and Elsevier Scopus. The 5-year Impact Factor (IF5) and Normalized Eigenfactor Score (NES5) were extracted from Journal Citation Reports. Elsevier Scopus was used to extract the Cite Score (CS4). Two other metrics using Scopus data were extracted from pubic websites: Scimago Journal Rank (SJR3) from SCImago Journal & Country Rank (https://www.scimagojr.com/journalrank.php) and the Source-Normalized Impact per Paper (SNIP3) from the Centre for Science and Technology Studies (CTWS) Leiden University (https://www.journalindicators.com/). All metrics but IF5 are normalized measures (adjusted for citation patterns in subject areas and sometimes prestige of citations) so 1.0 is typical of similar journals (CS4, SJR3, & SNIP3) or all indexed journals (NES5).
Data were extracted, entered into Excel, and checked for errors by both authors. The measures of variability calculated were the standard deviation (*SD*) and coefficient of variation (*CV*) over 5-years for each journal. The 5-year change for each journal was defined as the slope of the linear regression for the 5 annual values of each metric (Zadpoor & Nikooyan, 2011) and data were analyzed with JMP Pro 14 (SAS Institute, Cary, NC).

RESULTS: Recent (2021) and absolute variation (*SD*) of journal metrics are reported in Table 1 with relative metric (*CV*) and 5-year change (slope) in Table 2. Mean absolute variation in these journal metrics over the past five years ranged from 0.11 to 0.48, with the most variation for the CS4. Mean relative variation of these journal metrics were 12 to 16%. Five-year change varied by journal citation metric with slopes ranging from -0.28 to -0.01, and with 42% decreasing (primarily SJR3 & SNIP3) and 58% increasing.

Table 1. Five journal metrics for 2021 and Mean Absolute Variation from 2017 until 2021

Journal	2021					*SD*				
	SJR3	NES5	IF5	CS4	SNIP3	SJR3	NES5	IF5	CS4	SNIP3
Appl Ergo	1.1	1.9	4.6	6.8	2.3	0.1	0.5	0.9	1.1	0.3
Clin Biomech	0.6	1.2	2.3	3.3	1.1	0.2	0.2	0.2	0.4	0.1
Ergonomics	0.8	0.9	3.3	4.9	1.5	0.1	0.2	0.5	0.5	0.1
Gait Posture	0.7	2.7	3.3	4.3	1.2	0.2	0.5	0.2	0.4	0.2
Int Biomech	0.3	NA	NA	1.5	NA	0.2	NA	NA	0.9	NA
J Appl Biomech	0.6	0.4	2.2	2.6	0.9	0.1	0.1	0.3	0.2	0.1
J Biomech Eng	0.4	0.9	2.3	3.5	0.9	0.2	0.1	0.1	0.2	0.1
J Biomech Sci Eng	0.2	NA	NA	1.1	0.3	0.03	NA	NA	0.2	0.1
J Biomech	0.8	3.4	3.1	4.4	1.3	0.2	0.3	0.2	0.3	0.1
J Electromyogr Kines	0.6	0.7	2.6	4.5	1.3	0.1	0.1	0.3	0.5	0.03
J Mech Med Biol	0.2	0.2	0.9	1.3	0.4	0.02	0.04	0.1	0.2	0.1
Med Eng Phys	0.5	0.9	2.5	4.1	1.1	0.1	0.1	0.2	0.2	0.04
Sports Biomech	0.8	0.5	3.0	4.3	1.3	0.1	0.1	0.6	0.9	0.1
Sports Eng	0.4	0.1*	NA	2.9	1.2	0.04	0.01*	NA	0.4	0.3
M	0.6	1.2	2.7	3.5	1.1	0.11	0.19	0.33	0.46	0.13
SD	0.3	1.0	0.9	1.6	0.5	0.07	0.17	0.25	0.30	0.09

Note: Data for this metric not available (NA) or is based on < 5 years of data because of indexing*.

DISCUSSION: The 2021 mean normalized journal metrics were different in these biomechanics journals ranging from lower usage/prestige (SJR3=0.6) to better than average usage (SNIP3 & CS4 = 1.1-3.5). The mean prestige metric NES5 was also higher (1.2) than typical journals indexed by Journal Citation Reports. The 2021 mean IF5 (2.7) was larger than the mean two-year IFs (1.0 to 1.2) reported for biomechanics journals from 2003 to 2010 (Zadpoor & Nikooyan, 2011).

Table 2. Mean Relative Variation and Change of Five Journal Metrics from 2017 until 2021

Journal	CV (%)					Change (slope)				
	SJR3	NES5	IF5	CS4	SNIP3	SJR3	NES5	IF5	CS4	SNIP3
Appl Ergo	9.2	41.7	25.6	18.6	12.3	0.09	0.32	0.50	0.65	0.09
Clin Biomech	24.1	17.7	6.3	11.1	10.0	-0.12	0.08	0.03	-0.13	-0.05
Ergonomics	11.3	20.9	17.9	11.9	7.5	-0.06	0.09	0.30	0.32	-0.04
Gait Posture	22.7	21.7	6.7	10.6	13.8	-0.13	0.26	0.09	0.10	-0.10
Int Biomech	37.3	NA	NA	37.1	NA	-0.07	NA	NA	-0.28	NA
J Appl Biomech	7.4	15.6	18.9	8.4	8.0	-0.01	0.02	0.21	0.08	0.02
J Biomech Eng	26.0	9.5	4.8	4.5	6.0	-0.11	0.002	0.01	-0.03	-0.03
J Biomech Sci Eng	13.4	NA	NA	19.5	27.4	-0.01	NA	NA	0.10	-0.03
J Biomech	18.7	9.5	5.3	6.0	3.9	-0.11	0.08	0.05	-0.16	-0.01
J Electromyogr Kines	11.0	15.6	12.4	14.5	2.6	-0.04	0.01	0.14	0.29	0.003
J Mech Med Biol	9.1	25.0	9.1	9.9	18.9	-0.01	0.02	0.04	-0.04	-0.01
Med Eng Phys	9.8	10.5	9.8	4.0	3.9	-0.04	0.01	0.11	0.06	-0.02
Sports Biomech	8.5	55.4	23.9	30.0	10.0	0.003	0.08	0.32	0.54	0.05
Sports Eng	9.3	8.3*	NA	18.4	31.1	-0.02	NA*	NA	0.25	-0.04
M	15.6	21.0	12.8	14.6	12.0	-0.05	0.09	0.16	0.13	-0.01
SD	8.9	14.2	7.6	9.5	8.9	0.06	0.11	0.15	0.26	0.05

Note: Data for this metric not available (NA) or is based on < 5 years of data because of indexing*.

The hypothesis of differences in variability across metrics was supported. The mean year-to-year absolute SD was lowest for SNIP3 and SJR3 (0.13 & 0.11), respectively, while other metrics were larger (0.19 - 0.48). Mean relative variation also differed between metrics with SNIP3 and IF5 being the most consistent (12.0 - 12.8%) and SJR3 and NES5 being the most variable (16-21%). These data support recommendations that yearly variation in journal metrics should not be considered meaningful until they change more than 30% (Amin & Mabe, 2003; Haghdoost et al., 2014; Ogden & Bartley, 2008). This short-term variation in journal metrics is also relevant to understanding multi-year trends.

The 5-year trends of the journal citation metrics for these biomechanics journals were also inconsistent. Mean SRJ3 and SNIP3 tended to decrease while only the CS4, IF5 and NES5 tended to increase over 5-years. The 0.16 slope for the IF5 was larger than the 0.05 reported by Zadpoor and Nikooyan (2011) for the 2-year impact factor in biomechanics journals. Given the typical year-to-year variations in these journal metrics (0.3-0.5 or 30%), one should not conclude there is a meaningful change until exceeding this uncertainty. Scholars and editors

should not exacerbate the imprecision and bias inherent in journal metrics to create meaningless rankings of journals (Campanario, 2018; Pajic, 2015; Viiu & Paunescu, 2021) and claims of journal improvement.

CONCLUSION: There was considerable variation of journal metrics in biomechanics journals supporting previous research journal metrics not be reported to greater than one decimal place precision and meaningful differences across time need to be at least 0.3-0.5 or 30 percent.

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