Publication Metrics of Dental Journals – What is the Role of Self Citations in Determining the Impact Factor of Journals?

Satheesh Elangovan[a], and Veerasathpurush Allareddy[b,*]

[a]Department of Periodontics, College of Dentistry, The University of Iowa, Iowa City, IA 52242, USA
[b]Department of Orthodontics, College of Dentistry, The University of Iowa, Iowa City, IA 52242, USA

Abstract

Objectives: The objectives of the present study are to examine the publication metrics of dental journals and to delineate the role of self citations in determining the impact factor of journals.

Materials and Methods: The Journal Citation Reports database was used. All dental journals that had an impact factor assigned for year 2013 were selected. The outcomes were Impact Factor (IF), Eigenfactor™ (EF), article influence score (AIS), and proportion of self-citations to total citations. Independent variables were geographic region of journal and ranking of journal (based on IF). Non-parametric tests were used to examine the associations between outcomes and independent variables.

Results: During the year 2013, 82 journals in dentistry had an IF. Mean IF was 1.489 and mean IF without including self-citations was 1.231. Mean EF scores and AIS were .00458 and .5141 respectively. Mean percentage of self cites to total citations for all dental journals was 12.24%. Higher ranking journals were associated with significantly higher EF and AIS. Journals published in USA/Canada or Europe were associated with higher IF and EF compared to those published in other regions. There were no differences in percentages of self citations to total citations either across journal rankings or geographic region.

Conclusions: Top ranking journals tend to have higher IFs due to higher EF and AIS rather than by self-citations. Self-citations increase the impact factors of dental journals by 21%. There was no geographic influence in the percentage of self-citations to total citations thus indicating a healthy dental scientific publishing environment.

Keywords: Impact factor, Journal metrics, Self citations, Eigenfactor, Journal publishing, Journal rankings.

*Corresponding author. Department of Orthodontics, College of Dentistry, The University of Iowa, Iowa City, IA 52242, USA. Tel.: +1 319 353 5806.; E-mail: Veerasathpurush-Allareddy@uiowa.edu.

Conflict of interests disclosure statement: None of the authors have any direct or indirect financial incentives associated with the conduct of the study or publication of study findings. None of the authors have any personal relationships with other people or organizations that could inappropriately influence (bias) their work.

J Evid Base Dent Pract 2015;15:97-104
1532-3382/$36.00

http://dx.doi.org/10.1016/j.jebdp.2014.12.006

INTRODUCTION

Publishing in journals with high impact factor leading to numerous citations provides several benefits for academicians, including promotion, exposure in a specific field, aid in acquiring or renewing grant funding and salary raise.[1,2] Several metrics are currently being employed to assess the impact of a journal that includes impact factor, Eigenfactor™ and article influence score, with each having its own advantages and limitations.[3] Of these, the most prevalently used journal metric is impact factor, which is calculated by dividing the total number of citations in a year (from articles published in a journal in the previous 2 years) by the total number of citable articles.[3] Though Eigenfactor™ and article influence score metrics are calculated in a different manner, the number of citations that come out of the journal articles is a common factor in these journal metric measurements.[3] Eigenfactor™ Score calculation is based on the number of times articles from the journal published in the past 5 years have been cited, but it also considers which journals have contributed these citations so that highly cited journals will influence the network more than lesser cited journals.[4] Article influence score is calculated by dividing the journal's Eigenfactor™ Score by the number of articles in the journal.[4]

Impact factor of a journal is affected by several variables such as size of the field, skewed distribution of citations within the journal, citation density and most of all, self-citations.[5,6] Self-citations (citations from the previous articles of the same journal) affects impact factor significantly, whereas self-citations are excluded from Eigenfactor™ and Article influence score calculations and therefore, does not influence these later metrics.[6] Self-citations can be of two types: author and journal induced self-citations. Journal self-citations can be due to several reasons such as narrowness of a specialty, lack of journal choices in a field or the need for the authors to reinforce a concept by citing a previous publication from the same journal. Unfortunately, self-citations are also encouraged by some journals to boost their impact factor by forcing the authors to cite articles previously published in the same journal that is termed as 'Coercive Citation.'[7] In recent years, it has been reported in the biomedical literature that some journals are indirectly or directly employing coercive citations.[8] This in fact has led to the banning of a record 66 journals from receiving an impact factor from Thomson Reuters that employed implemented coercive citations in one way or the other.[9] This is a serious concern, which can have wide spread implications in the research community and can ultimately affect the evidence based decision making in health care industry.

The proportion of self-citation and its effect on impact factor of select medical journals were surveyed in the recent past and reported.[6,10] The effect is mixed with some assessments showing no effect or negative correlation between self-citations and journal impact factor in certain fields versus studies showing a statistically significant positive correlation between the two.[6,10] Impact factor still remains a commonly used yardstick by academicians in selecting a journal to disseminate their research findings. One easy way journals can boost their impact factors is by promoting journal self citations. Therefore, it's extremely important to know what effect does self citations has on the impact factor of dental journals, which to our knowledge has not been explored so far. The objectives of the present study are: to quantify the influence of self citations on determining the impact factor of dental journals; to examine the association between geographic region of journal publication and journal metrics (impact factor with/without including self citations, article influence score, percentage of self cites to total citations, number of citable items, Eigenfactor™); and to examine the association between journal rankings (based on year 2013 impact factors) and journal metrics (article influence score, percentage of self cites to total citations, number of citable items, Eigenfactor™).

MATERIALS AND METHODS

Study Design

The present study is a cross-sectional analysis of journal metric data for the year 2013. The study was granted Institutional Review Board (IRB) Exemption by the College of Dentistry – The University of Iowa Human Subjects protection review board. The IRB protocol number is 201409805. Data on journal metrics was obtained from the Journal Citation reports: JCR Web – ISI Web of Knowledge.[11,12]

Outcomes

The journal metrics examined included impact factor for the year 2013, impact factor by excluding self citations, Eigenfactor™, Article Influence score (AIS), number of citable items, and percentage of self citations to total citations.

Independent Variables

The independent variables of interest is the ranking of journals based on the year 2013 impact factor and geographic region in which the journal is published. The journals were sorted based on the impact factor and divided into quartiles: Ranks 1 to 20, ranks 21 to 40, ranks 41 to 60, and ranks 61 to 82. For geographic region, the journals were broadly categorized under three regions: USA/Canada, Europe, and Asia/Australia/South America.

Analytical Approach

The distribution of journal metrics and normality was assessed by the one-sample Kolmigorov Smirnov test. All metrics excluding the article influence score were skewed and not distributed normally ($p < 0.0001$). Considering the

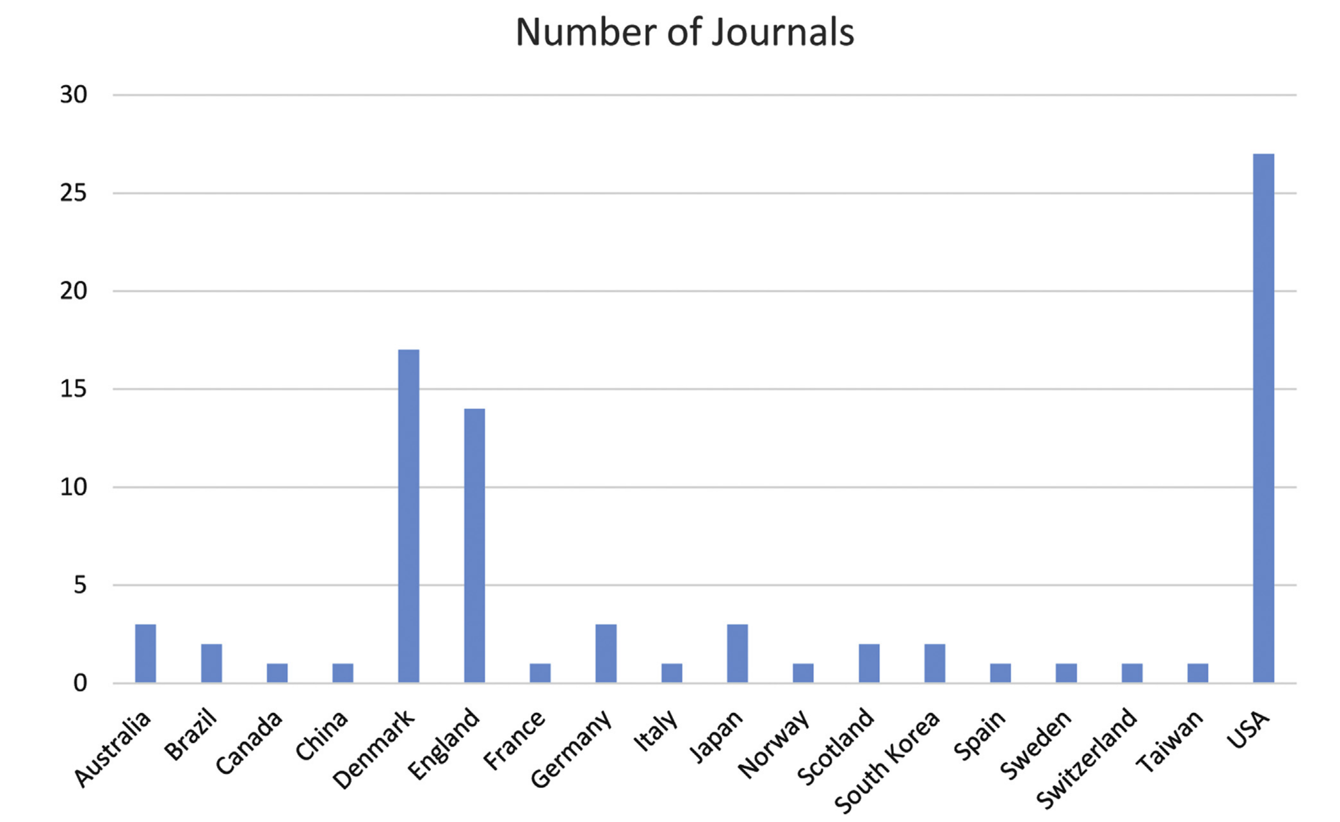

Figure 1. Countries publishing the dental journals.

nature of data distribution, non-parametric tests were used for examining the associations between the rank group of journals and outcomes and for assessing the correlations between journal metrics. Kruskal Wallis tests were used to compare the overall differences in journal metrics (Eigenfactor™, AIS, percentage of self cites to total cites, and number of citable items) across the four ranking quartiles. Following this, multiple pair-wise comparisons were conducted to examine between ranking quartile differences. A total of 6 pair-wise comparisons were conducted for each outcome variable. To avoid Type 1 errors arising out of multiple pair-wise comparisons a two-sided *p*-value of <.008 was set to be deemed to be statistically significant for comparing journal metrics between ranking quartiles. Journal metrics (Eigenfactor™, AIS, percentage of self cites to total cites, number of citable items, Year 2013 impact factor, and impact factor without including self citations) were compared by geographic region using Kruskal Wallis test. Following the Kruskal Wallis test, pair-wise comparisons were conducted to compare the differences in journal metrics between geographic regions. Since 3 pair-wise comparisons were conducted, a *p*-value of <0.017 was deemed to be statistically significant to avoid Type 1 errors. All multiple pair-wise comparisons were conducted using Man-Whitney *U* tests. Correlations between different journal metrics was conducted by using Spearman's rho correlations. For the correlations, a *p*-value of <0.05 was deemed to be statistically significant. All statistical tests were two-sided. All statistical analyses were performed using SPSS Version 22.0 software (IBM Corp, NY).

RESULTS

During the year 2013, a total of 82 journals in the field of dentistry were assigned an impact factor. Eighteen different countries published these journals (Figure 1). USA lead the list with 27 journals followed by Denmark with 17 and England with 14. Overall, 28 journals were published in USA/Canada, 42 in Europe, and 12 in Asia/Australia/South America. Characteristics of metrics for these journals are summarized in Table 1. The overall mean impact factor was 1.489 (inter-quartile range is .860 to 1.962) while the mean impact factor without including self cites was 1.231 (inter-quartile range is .722 to 1.640). The mean Eigenfactor™ scores and AIS were .00458 and .5141 respectively. The mean percentage of self cites to total citations for all the journals was 12.24% (inter-quartile range is 6.41% to 14.51%). self-citations increase the impact factors of dental journals by about 21%.

TABLE 1. Journal metrics in year 2013.

Measure		Eigenfactor	Article influence score	Impact factor in year 2013	Impact factor without self cites	Total cites	Self cites	Percentage of self cites to total cites	Number of citable items
Mean		.0045815	.51415	1.48898	1.23088	2941.06	353.28	12.24	110.41
Std. deviation		.00486570	.268340	.882934	.742111	3337.158	508.925	9.23	76.520
Minimum		.00004	.013	.152	.033	36	0	.00	21
Maximum		.02235	1.374	4.160	3.900	15,426	3197	58.33	333
Percentiles	25	.0012875	.32625	.86025	.72250	571.75	52.50	6.41	47.00
	50	.0028150	.48900	1.27400	1.03900	1630.00	171.50	10.01	89.00
	75	.0056975	.68800	1.96225	1.63975	3617.00	390.75	14.51	146.50

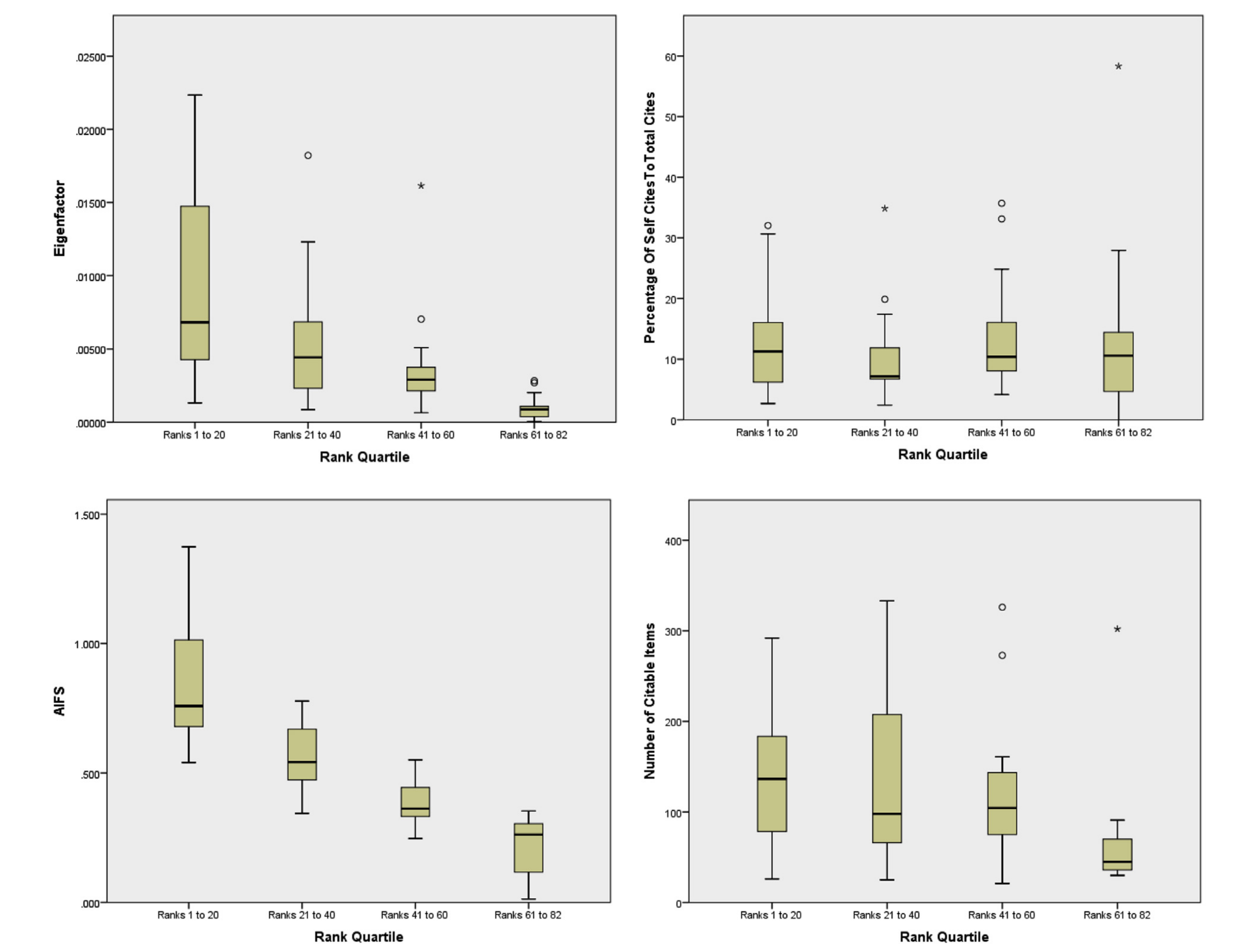

Figure 2. Metrics by rank quartile of journals. o* Outliers.

The distribution of Eigenfactor™, AIFS, percentage of self cites to total cites by ranking quartile of journals (based on year 2013 impact factor) are presented in Figure 2. Comparison of these metrics by quartile ranking of journals are summarized in Table 2. Overall, Eigenfactor™ ($p < 0.0001$), AIS ($p < 0.0001$), and total number of citable items ($p = 0.001$) were significantly different among the four ranking categories. There was no significant

TABLE 2. Comparison of journal metrics by quartile ranking of journals (multiple pair wise comparisons by non-parametric tests).

Pairwise comparison	Eigenfactor	Article influence score	Percentage of self cites to total cites	Number of citable items
Kruskal Wallis test to compare among the four rank quartiles	$p < 0.00001$	$p < 0.0001$	$p = 0.45$	$p = 0.001$
Ranks 1–20 versus ranks 21–40	$p = 0.07$	$p < 0.0001$	Pair wise comparisons were not conducted since Kruskal Wallis test was not significant	$p = 0.53$
Ranks 1–20 versus ranks 41–60	$p = 0.003$	$p < 0.0001$		$p = 0.51$
Ranks 1–20 versus ranks 61–82	$p < 0.0001$	$p < 0.0001$		$p = 0.001$
Ranks 21–40 versus ranks 41–60	$p = 0.19$	$p < 0.0001$		$p = 0.70$
Ranks 21–40 versus ranks 61–82	$p < 0.0001$	$p < 0.0001$		$p = 0.007$
Ranks 41–60 versus ranks 61–82	$p < 0.0001$	$p < 0.0001$		$p < 0.0001$

A total of 6 pair wise comparisons were conducted. To avoid Type 1 errors, a p-value of <0.008 was deemed to be statistically significant.

difference in percentage of self cites to total cites among the four ranking categories ($p = 0.45$). Journals ranked 1 to 20 were associated with significantly higher AIS when compared to those ranked 21 to 40 ($p < 0.0001$). Journals ranked 1 to 20 were associated with significantly higher Eigenfactor™ ($p = 0.003$) and AIS ($p < 0.0001$) when compared to those ranked 41 to 60. Journals ranked 1 to 20 were associated with significantly higher Eigenfactor™ ($p < 0.0001$), AIS ($p < 0.0001$), and number of citable items ($p = 0.001$) when compared to journals ranked 61 to 82. Journals ranked 21 to 40 were associated with significantly higher AIS when compared to journals ranked 41 to 60 ($p < 0.0001$). Journals ranked 21 to 40 were associated with significantly higher Eigenfactor™ ($p < 0.0001$), AIS ($p < 0.0001$), and number of citable items ($p = 0.007$) when compared to journals ranked 61 to 82. Journals ranked 41 to 60 were associated with significantly higher Eigenfactor™ ($p < 0.0001$), AIS ($p < 0.0001$), and number of citable items ($p < 0.0001$) when compared to journals ranked 61 to 82.

The distributions of Eigenfactor™, AIS, percentage of self cites to total cites, number of citable items, year 2013 impact factor, and impact factor without self citations by geographic continents are presented in Figure 3 and the pair wise comparisons are summarized in Table 3. Overall, the Eigenfactor™ ($p = 0.02$), year 2013 impact factor ($p = 0.004$), and impact factor without self citations ($p = 0.005$) were significantly different among the different continents. AIS, percentage of self cites to total cites, and number of citable items were not significantly different among the different continents. Following multiple pair wise comparisons, there was no statistically significant differences in Eigenfactor™, impact factor, and impact factor without including self citations between journals published in USA/Canada and journals published in Europe. The journals published in USA/Canada were associated with significantly higher Eigenfactor™ ($p = 0.008$), impact factor ($p = 0.01$), and impact factor without including self citations ($p = 0.01$) when compared to journals published in Asia/Australia/South America. Journals published in Europe had higher impact factor ($p = 0.002$) and impact factor without including self citations ($p = 0.003$) when compared to journals published in Asia/Australia/South America.

Overall, the Eigenfactor™ was significantly correlated with the impact factor metrics (both including self-citations and excluding self-citations impact factors) ($p < 0.0001$). Similarly the article influence scores were highly correlated with the impact factor metrics (both including self-citations and excluding self-citations impact factors) ($p < 0.0001$).

DISCUSSION

The present study used impact factor, AIS, and Eigenfactor™ as the end outcomes to assess the quality of a journal. Each of these metrics though widely used have several limitations.[13–15] The relative strengths and weaknesses of these metrics are summarized in Table 4. The present study conducted a cross-sectional analysis of journal metrics data for the year 2013 to examine the associations between journal metrics and geographic region/ranking of journals based on impact factor. This study also examined if self-citations contributed to higher impact factors. Results of the present study show that during the year 2013, a total of 82 journals in the field of dentistry were assigned an impact factor. The mean self-citation percentage and its range values are consistent with prior published estimates.[3,16] Institute for Scientific Information (Thomson Reuter's previous entity) in 2002 published an extensive report on self-citation rates of all then existing journals with impact factor.[16] Of the 5676 journals they examined, close to 82% of them had a self-citation rate at or below 20% and the mean self-citation rate was reported to be 12.41 (with a median of

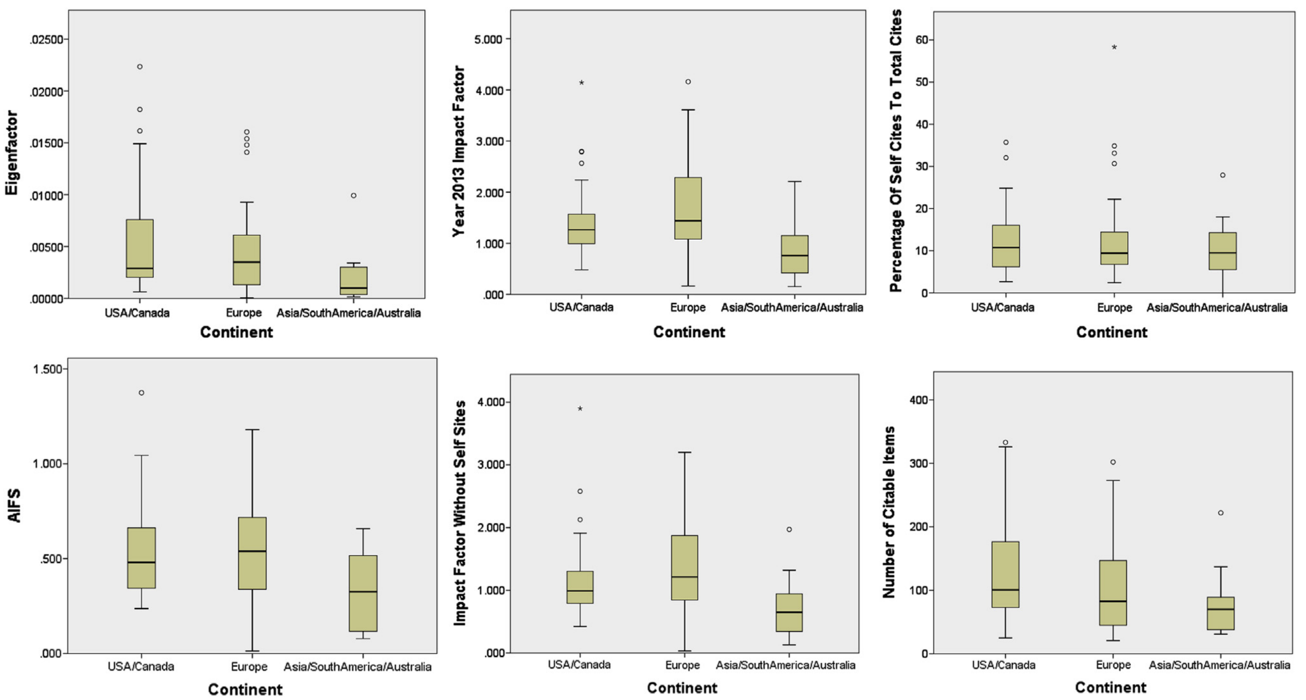

Figure 3. Metrics by continent of journal. o* Outliers.

TABLE 3. Comparison of journal metrics by continent of publishing journal (multiple pair wise comparisons by non-parametric tests).

Pairwise comparison	Eigenfactor	Article influence score	Percentage of self cites to total cites	Number of citable items	Impact factor	Impact factor without self citations
Kruskal Wallis test to compare among the Continents	$p = 0.02$	$p = 0.054$	$p = 0.84$	$p = 0.18$	$p = 0.004$	$p = 0.005$
USA/Canada versus Europe	$p = 0.55$	Pair wise comparisons were not conducted since Kruskal Wallis test was not significant			$p = 0.17$	$p = 0.13$
USA/Canada versus Asia/Australia/South America	$p = 0.008$				$p = 0.01$	$p = 0.01$
Europe versus Asia /Australia /South America	$p = 0.02$				$p = 0.002$	$p = 0.003$

A total of 3 pair wise comparisons were conducted. To avoid Type 1 errors, a *p*-value of <0.017 was deemed to be statistically significant.

9.04). This assessment further revealed that journals with high impact factor had low self-citation rates and vice versa.[16] Additionally, the study failed to identify any strong correlations between self-citation rate and impact factor of the journal, possibly due to the small population of the outliers.[16] Our study findings are consistent with these estimates. Our study results demonstrate that the overall mean percentage of self cites to total citations is 12.2%. Furthermore, there was no statistically significant differences in proportion of self-citation rates between high ranking and low ranking journals (based on impact factor) or even across different geographic regions.

The Institute for Scientific Information also conducted a sub analysis after eliminating the self-citations from the

TABLE 4. Relative strengths and weaknesses of journal metrics.

Journal metric	Definition	Strengths	Weaknesses
Impact factor	Impact factor is the arithmetic mean of citations received by a "citable article" published in a journal during the preceding 2 years.	Most commonly used metric to assess the quality of a journal. Higher impact factors are purported to indicate higher importance of a journal within a scientific discipline. It is straightforward to compute.	Impact factor only considers the number of citations and not the quality or significance of citations. Consequently, one cannot categorically state that a journal is of high quality based on solely the impact factor. Impact factor relies on 2-year citation data and consequently, the long term impact of articles is not taken into consideration.
Eigenfactor™	Eigenfactor™ Score is a quantitative measure of a journal's importance to the scientific community.	Higher Eigenfactor™ score indicates that the journal is exerting a higher impact in the field of endeavor. Eigenfactor™ scores adjust for citation differences across disciplines and allows for better comparison across disciplines.	Eigenfactor™ score takes into consideration the number of articles published in a journal annually. As a result, journals which publish a large number of articles tend to have a higher Eigenfactor™ scores.
Article influence scores	This is a measure of the influence of articles during the first 5 years following publication in a journal.	Article influence scores take into consideration 5-year citation data and hence the long term impact of articles/journals can be relatively better quantified compared to impact factor. Article influence scores adjust for citation differences across disciplines.	Computation of article influence score is dependent on the "Field," "Discipline" or "Category" to which a journal is assigned to.

Source: Eiggenfactor.org – Ranking and mapping scientific knowledge. www link is http://www.eigenfactor.org/whyeigenfactor.php. Accessed 12.02.14.

top 10 journals (based on impact factors in 2003) to see if this changes its impact factor and its ranking in the scientific world. Little effect of self-citations on these top tier journals was observed.[16] In agreement to this previous assessment, in our assessment, we found no statistically significant difference between the percentage of self cites to total citations between the journals with respect to their ranking tiers. Apart from examining differences in proportion of self citations to total citations across journal ranking quartiles, we also conducted a sensitivity analysis where we examined differences in self-citation proportions between the top 10 journals (based on impact factor) and the rest 72 journals in dentistry. The mean percentage of self cites to total citations for the top 10 journals was 12.93% while this metric for the rest of 72 journals was 12.15%. This clearly shows that the impact factor difference noted between top tier dental journals versus the rest of journals are independent of self-citation rates and is more to do with the true impact of and wider reach of the articles published in the top tier journals.

Overall, the Eigenfactor™ was significantly correlated with the impact factors (both including self-citations and excluding self-citations). Similarly the AISs were highly correlated with the impact factors (both including self-citations and excluding self-citations). It appears that self-citations increase the impact factors of dental journals by about 21%. It is clear that self-citations do influence the impact factors of dental journals but the self-citation rate in dental journals is within the acceptable range for journals in any field.

With the increasing number of newer dental journals coming to the scientific publishing world from all parts of the world, it is important to see if the bibliometrics especially the self-citation percentage changes with respect to the geographic location of the journal. From our analysis, it is evident that the mean Eigenfactor™ and AIS scores were higher in journals published in USA/Canada as well as in Europe, compared to journals from the rest of the world. But the geographic location of the journal did not have an effect on the self-citations and they all remained within the acceptable range. It is apparent from this analysis that the self-citation rate is not statistically different between the top tier dental journals (based on impact factor) and rest of the journals, with no geographic influence. Therefore, the results of this analysis are clearly suggestive of a healthy scientific publishing environment in dentistry today. In order to sustain this healthy environment in the future, it's important that the journals should make every effort not to promote self-citations to boost impact factors and to keep the contribution of self citation to impact factor within acceptable levels. Also, the authors should be aware of the significant effects that self citation can have on impact factors of journals and report coercive citations to the scientific community. As a follow-up study, it will be interesting to look at the trend in these self-citations rate for dental journals over a specified period of time.

CONCLUSIONS

Top ranking dental journals tend to have higher impact factors due to higher Eigenfactor™ and article influence scores rather than by self-citations. In addition, there was no geographic influence in the proportion of self-citations to total citations among dental journals thus indicating a healthy dental scientific publishing environment.

ACKNOWLEDGMENTS

None.

REFERENCES

1. Adler KB. IF and its role in academic promotion. Am J Respir Cell Mol Biol 2009;41:127.
2. Hyland K. Self-citation and self-reference: credibility and promotion in academic publication. J Am Soc Inf Sci Technol 2003;54:251-9.
3. Mavrogenis Andreas F, Ruggieri Pietro, Papagelopoulos Panayiotis J. Editorial: self-citation in publishing. Clin Orthop Relat Res 2010 October;468(10):2803-7.
4. Journal Citation Report 2012 – www link is http://admin-apps.webofknowledge.com/JCR/help/h_eigenfact.htm; Accessed 01.12.14.
5. Garfield E. The history and meaning of the journal impact factor. JAMA 2006 Jan 4;295(1):90-3.
6. Fassoulaki A, Paraskeva A, Papilas K, Karabinis G. Self-citations in six anaesthesia journals and their significance in determining the impact factor. Br J Anaesth 2000 Feb;84(2):266-9.
7. Wilhite AW, Fong EA. Coercive citation in academic publishing. Science 2012;335:542-3.
8. Mahian O, Wongwises S. Is it ethical for journals to request self-citation? Sci Eng Ethics 2015;21(2):531-3.
9. Van Noorden R. Nature Blogs – New Record: 66 Journals Banded for Boosting Impact Factor with Self-citations. www link is, http://blogs.nature.com/news/2013/06/new-record-66-journals-banned-for-boosting-impact-factor-with-self-citations.html; 2013. Accessed 08.10.14.
10. Motamed M, Mehta D, Basavaraj S, Fuad F. Self citations and impact factors in otolaryngology journals. Clin Otolaryngol Allied Sci 2002 Oct;27(5):318-20.
11. Journal Citation Reports – ISI Web of Knowledge. Thomson Reuters. www link to website is, http://thomsonreuters.com/journal-citation-reports/; 2014. Accessed 24.09.14.
12. Journal Citation Reports – Web of Science. Thomson Reuters. www link to website is, http://wokinfo.com/products_tools/analytical/jcr/; 2014. Accessed 24.09.14.
13. Bergstrom CT, West JD, Wiseman MA. The Eigenfactor™ metrics. J Neurosci 2008;28(45):11433-4.
14. Fersht A. The most influential journals: impact factor and Eigenfactor. Proc Natl Acad Sci U S A 2009 Apr 28;106(17):6883-4. http://dx.doi.org/10.1073/pnas.0903307106. Epub 2009 Apr 20.
15. Eigenfactor.org – Ranking and Mapping Scientific Knowledge. www link is http://www.eigenfactor.org/whyeigenfactor.php; Accessed 02.12.14.
16. Journal Citation Reports – 2002. www link is http://wokinfo.com/essays/journal-self-citation-jcr/; Accessed 02.10.14.