A comparison of citation coverage of traditional and web citation databases in medical science

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ABSTRACT

This study aimed to analyse the quantitative similarities between traditional citations coverage (Web of Science and Scopus) and citations taken from the Web (Google Scholar), specifically targeting articles from 23 Open Access ISI-indexed journals within the field of General and Internal Medical Science published in 2007. This method enables us to comprehend the number of citations that exist on the Web and their efficiency as an important source for Medical Science research evaluation. More specifically, the correlation tests are used as an indirect approach to assess the extent of the relationship between traditional and Web-based citation coverage. It also investigates the percentage of overlap between conventional and Web citations databases in the selected journals. The findings show that the Web incorporates more citation data targeting general and internal medical journal articles that cannot be traced by traditional citation databases. The significant association between both conventional citations databases and Google Scholar found in this study, suggest that both the traditional and Web-based citation database are possible tools for measuring identical aspects, however, Web-based citations have the capability to be used for effective and accurate evaluation.

Keywords: Citation Analysis; Web Citation; Google Scholar; Web of Science; Scopus; General and Internal Medicine; Open Access Journals.

INTRODUCTION

With the increasing volume of scientific resources on the Web, the citation impact of electronic resources have been considered in the scholarly communication and a new research field identified as webometrics has been proposed. One of the most important applications of webometrics is Web citation analysis and comparing results with traditional citation sources such as the Web of Science (WoS) and Scopus.

Several studies have analysed the relationship between the Institute of Scientific Information (ISI) citations as a scholarly source with Web-based citations (Vaughan and Shaw 2005; Zhao 2005; Pauly and Stergiou 2005; Kousha and Thelwall 2006; Kousha 2009; Mikki 2010; Mingers 2010). In many instances the Web-based citations correlated with ISI citations and found remarkable disparities in the overall numbers of citations, with some exceptions (Kousha and Thelwall 2007). According to these results, there have been allegations that the Web could be an alternative to the ISI for citation calculations (Vaughan and Shaw 2005; Kousha and Thelwall 2006). However, there are disagreements in the extent of citations obtained by disciplines published on the Web and those written in journal articles (Kling and McKim 1999; Fry and Talja 2004) and hence these claims need

confirmation. Direct relationships between the WoS citation and Web citation expose the importance of web citation as a useful resource for evaluation of research within a subject / discipline.

In the present study, we explored the commonality between conventional and Web-extracted citation patterns for Open Access journals in General and Internal Medicine. The outcome can be regarded as additional evidence to highlight the commonality between traditional and Web -extracted citations in medical research. Also by comparing traditional and Web-based citation patterns, it is possible to explore whether the Web citation extraction techniques and tools could be used as an alternative for the traditional citations. The findings can also be useful for scholars and students who have no access to fee-based citation indexes, such as WoS and Scopus, to use Google Scholar for identifying useful and scholarly information.

LITERATURE REVIEW

One of the dimensions of webometrics is applying traditional bibliometrics methods to explore scholarly communication pattern on the Web. From this basis, many researchers have examined Web links by utilizing bibliometrics and informetrics analyses. Almind and Ingwersen (1997) introduced the application of bibliometrics and informetrics on the Web and called it 'webometrics'. They showed how bibliometrics and informetrics methods could be used on the Web by comparing the citation performance of the three Scandinavian countries: Denmark, Sweden and Norway in the citation indexes and on the Web. They confirmed the possible usage of bibliometrics and informetrics on the Web, but did not test citation analysis on the Web. Rousseau (1997) studied link analyses between sites on the Internet and applied the term 'sitation' to refer to a cited website. Rousseau also suggested the need for more studies about the differences between 'websiting' and citations in scientific articles. In a subsequent paper, Ingwersen (1998) defined 'Web Impact Factor' as a Web counterpart of the Institute of Scientific Information's (ISI) impact factor and began to apply it to assess the influence of websites.

Web links have been studied by researchers (Smith 1999; Harter and Ford 2000; Vaughan and Hysen 2002; Vaughan and Thelwall 2003; Vaughan and Shaw 2003) as a new data source for assessing scholarly communication on the Web and many quantitative studies have analysed the relationship between 'Web links' as an online variable with ISI citation counts or journal impact factor as the offline variable.

With the existence of Google Scholar, several studies can be found in the literature, which discuss its advantages, disadvantages and citation tracking capabilities (Jacso, 2005; Notess 2005; Friend 2006; Sanni and Zainab 2010). In addition, other studies have assessed content and coverage of Google Scholar in relation to WoS and Scopus (Neuhaus et al. 2006; Norris and Oppenheim 2007; Walters 2007). Google Scholar offers citation information from many publishers and this has resulted in many comparative studies using Google Scholar to measure citation counts, citation ranking, citation overlapping and h-index. Several studies have compared citations from Google Scholar,WoS and Scopus in general and in particular disciplines (Bauer and Bakkalbasi 2005; Pauly and Stergiou 2005; Nourozi 2005; Bakkalbasi et al. 2006; Mingers and Lipitakis 2010; Kousha and Abdoli, 2010). Also, there are several studies that examined the relationship between these databases with similar goals (Kousha and Thelwall 2007). Other comparative studies using Google Scholar, WoS and Scopus citations have been motivated by ranking of publications,

institutions or scientists (Bar-IIan and Levene 2007; Meho and Yang 2007; Bar-Ilan 2008; Mikki 2010). Some of the studies explored the characteristics of sources of Google Scholar unique citations, which do not overlap with WoS and Scopus (Kousha and Thelwall 2008; Sember, Utrobičić and Petrak 2010).

OBJECTIVES

This study attempts to analyse the quantitative similarities between traditional citation coverage (WoS and Scopus) and citations taken from the Web (Google Scholar) using articles from Open Access ISI-indexed journals in Medical Science published in 2007. The specific objectives are to:

a) analyse quantitatively (citation count) similarities between traditional citation coverage (WoS and Scopus) and citations taken from the Web (Google Scholar) in Medical Science.
b) study the correlation between traditional citation pattern and citations taken from the Web of articles from selected Open Access ISI-indexed medical journals.
c) assess the overlap percentage between Web of Science and Scopus citations, and Google Scholar citations of articles from selected Open Access ISI-indexed medical journals.

The study hopes to answer the following research questions.

a) Is there a significant correlation between traditional citation coverage and citations taken from the Web of selected articles from the Web (Google Scholar) in Medical Science?
b) Is there a correlation between Web of Science citation counts and Google Scholar citation counts of selected articles from the Web (Google Scholar) in Medical Science?
c) Is there a correlation between Scopus citation counts and Google Scholar citation counts of selected articles from the Web (Google Scholar) in Medical Science?
d) Are they any overlap(s) between these citations? If so, what is the overlap percentage between traditional citations (Web of Science and Scopus) citations and Google Scholar citations of selected articles from the Web (Google Scholar) in Medical Science?

METHODOLOGY

The Journal Citation Report (JCR) was used to identify journals with impact factor in General and Internal Medicine subject area. The search yielded 153 journals and each of the journals under the subject category of General and Internal Medicine in JCR was searched in the *Directory of Open Access Journals* (DOAJ) in order to further identify Open Access journals in the disciplines. This process yielded 23 Open Access journals that are indexed in WoS. These 23 journals produced 2,082 research articles in English language that are published in the year 2007.

The number of citing sources of each article was identified using the option “times cited” in WoS and exported to EndNote X5. As a result, 15,845 records (citations) were yielded in this process. Scopus was searched using the title of each article, and the number of citations was recorded using the option “Cited By” field of the respective bibliographic record. Since Scopus does not provide the Z39.50 data extraction, to export data in

EndNote, the citing sources for each article was downloaded as a "RIS" file format and subsequently exported to EndNote X5. As a result, a total of 19,015 records were obtained. For Google Scholar citation count, the titles of all 2,082 articles were searched as phrases in the Google Scholar's search page and the number of citation counts recorded for each article was obtained by clicking the "cited by" option available below each retrieved record. Google Scholar also does not support the Z39.50 protocol, therefore Zotero (open source software) was used to download the citing sources of selected articles and were saved as a "RIS" file format in order to export to EndNote X5. In this process, 28,040 records were obtained.

An algorithm was developed to identify the overlapping and unique citing references. For each journal, the algorithm divided all of its citing references into four groups:

1. Overlap between Google Scholar and WoS: (GS ∩ WoS)
2. Overlap between Google Scholar and Scopus: (GS ∩ Scopus)
3. Overlap between WoS and Scopus: (WoS ∩ Scopus)
4. Overlap between Google Scholar, WoS and Scopus: (GS ∩ WoS ∩ Scopus)

RESULTS

Comparing Citation Counts from Web of Science, Scopus and Google Scholar

The total number, mean and median of citations of the 23 General and Internal Medicine journals from WoS, Scopus and Google Scholar databases are presented in Table 1.

Table 1: Citation coverage for 23 Open Access Medical Science Journals in the Web of Science, Scopus and Google Scholar

No	Databases	No. of Citations (%)	Mean	Median
1	Google Scholar	28,040 (45)	13.47	6.00
2	Web of Science	15,845 (25)	7.61	3.00
3	Scopus	19,015 (30)	9.13	4.00
	Total	62,900 (100)	-	-

It is found that the number, mean and median of Google Scholar citations is much higher than those obtained from WoS and Scopus. It is also observed that the mean and median value of WoS citations is lower than that of Scopus. The results indicate that Web contains more citation data targeting General and Internal Medical journal articles. Previous studies in some scientific fields such as Computing, Biology, Physics, and Oncology, have indicated dissimilarities in citation counts among these databases and indicate that the citation counts of these databases vary with different time period and also across different disciplines.

Relationship between Traditional Citation Patterns and Citations taken from the Web

The relationship between traditional citations (WoS and Scopus) and Web-based citation (Google Scholar) was examined through correlation tests. Since the frequency distribution of citation counts is unsymmetrical or skewed and the normality requirement of the Pearson correlation tests is not met (Vaughan 2001), the Spearman correlation tests were applied.

a) Correlation between Article Citation Counts from Google Scholar, Web of Science and Scopus

In this section the correlation coefficient of citation counts was calculated using individual papers. The Spearman correlation confidence for WoS citation counts and Google Scholar citation counts indicates a positive relationship (r = 0.804**, P = 0.01). The result shows that scholarly Open Access journal articles with more citations in the WoS database also have more citations in Google Scholar. There is a significant correlation between citation counts from Scopus and Google Scholar (r=0.840**; p = 0.01), the results also indicate significant correlation between citation counts from WoS and Scopus (r=0.856**; p = 0.01). A higher correlation is obtained between citations from Scopus and Google Scholar than WoS and Google Scholar. This indicates that citation counts from both Scopus and Google Scholar cover a wider range of scholarly documents (i.e., conference papers), which are covered only selectively by the WoS databases.

b) Correlation between Journal Citations Counts from Web of Science, Scopus and Google Scholar

In this section, the correlation tests are reported for two different traditional citations counts (WoS and Scopus) and Web-extracted citations count (Google Scholar) for each 23 Open Access ISI-indexed General and Internal Medicine journals. Table 2 shows the correlation value between Google Scholar and WoS; Google Scholar and Scopus; and WoS and Scopus that were extracted using the same test. It shows that the correlation value between Google Scholar and WoS fall in the range of 0.6 to 0.9 except for three journals (*Clinics, Danish Medical Bulletin* and *Turkish Journal of Medical Sciences*). In the case of Google Scholar and Scopus the correlation value also falls in the range of 0.6 to 0.9 except for five journals (*Acta Clinica Croatica Journal, Clinics, Danish Medical Bulletin, MedicinskiGlasnik* and *Turkish Journal of Medical Sciences*). All Open Access journals in WoS and Scopus show high positive correlation.

c) Correlation between Journal Citation Averages from Web of Science, Google Scholar and Scopus

The relationship between the three databases was also found by using the average number of citation count of each journal. For each journal, the average numbers of citations can be counted by the overall number of citations divided by the number of articles published in the journal (Kousha and Thelwall 2007). The correlation tests for the citation averages of the 23 journals from WoS, Google Scholar and Scopus were performed to justify the relationship between Web–extracted citations and citations taken from the conventional databases.

The results show there is high significant correlation between journal citation averages from the WoS and the Google Scholar (r=0.941, p=0.01) and the citation averages between Scopus and the Google Scholar (r=0.925, p=0.01). There is also significant correlation between the journal citation averages from WoS and Scopus (r=0.984, p=0.01). It is interesting to note that there is higher correlation between WoS and Google Scholar citation averages than between Scopus and Google Scholar. Thus, it is inferred that Open Access journals tend to have higher citation averages in both WoS and Google Scholar.

Table 2: Correlation between Journal Citations Counts from Web of Science, Scopus and Google Scholar

No	Journal Title	No. of Articles	GS &WoS Correlation	GS & Scopus Correlation	WoS & Scopus Correlation
1	Acta Clinica Croatica Journal	32	0.696**	0.575**	0.787**
2	Archives of Medical Science	62	0.626**	0.700**	0.750**
3	BMC Family Practice	64	0.699**	0.805**	0.611**
4	BMC Medicine	37	0.816**	0.873**	0.859**
5	Canadian Family Physician	70	0.700**	0.862**	0.807**
6	Cleveland Clinic Journal of Medicine	27	0.822**	0.768**	0.712**
7	Clinics	85	0.394**	0.535**	0.715**
8	Croatian Medical Journal	74	0.638**	0.684**	0.625**
9	Danish Medical Bulletin	27	0.462**	0.547**	0.635**
10	Family Medicine	67	0.901**	0.890**	0.921**
11	Indian Journal of Medical Research	86	0.705**	0.694**	0.670**
12	Internal Medicine	367	0.777**	0.817**	0.804**
13	Journal of International Medical Research	104	0.858**	0.905**	0.946**
14	Journal of Korean Medical Science	235	0.814**	0.833**	0.897**
15	Journal of Postgraduate Medicine	35	0.784**	0.811**	0.667**
16	MedicinskiGlasnik	5	0.803**	0.363**	0.791**
17	Plos Medicine	150	0.906**	0.895**	0.878**
18	Swiss Medical Weekly	86	0.659**	0.754**	0.905**
19	Tohoku Journal of Experimental Medicine	127	0.846**	0.813**	0.851**
20	Turkish Journal of Medical Sciences	64	0.562**	0.534**	0.801**
21	Upsala Journal of Medical Sciences	29	0.903**	0.877**	0.917**
22	West Indian Medical Journal	101	0.703**	0.806**	0.794**
23	Yonsei Medical Journal	148	0.679**	0.718**	0.896**

** Correlation is significant at the 0.01 level (2-tailed).

d) Correlation between Journal Impact Factor and Citation Count Averages in Web of Science, Scopus and Google Scholar

The correlations between ISI Journal Impact Factors (JIF) and Google Scholar/Web citation counts average was calculated for all 23 journals. The impact factor of the studied journals was obtained from the 2011 edition of ISI Journal Citation Report (JCR).

A significant correlation were found between JIFs and the citation averages from Google Scholar(r = 0.714**), Scopus (r = 0.709**) and WoS (r = 0.710**). The correlation coefficient was also found between JIFs and Google Scholar citations average by Kousha and Thelwall (2007) for Science and Social Sciences (r = 0.624). The results indicate that journals with higher ISI Impact Factors also had higher average Web-extracted citations.

Comparison of Traditional Citation Sources with Web Citation Source

In order to determine the extent of citing references of a particular database, the amount of citing references existing in two or all the three databases and the citations overlapping between the three databases were analysed.

a) Overlap of Citations from Google Scholar and Web of Science

The overlap between Google Scholar and WoS citations is calculated and presented in Table 3. There were 20,979 unique citations from Google Scholar and 8,784 unique citations from WoS identified from the total citations in a particular database. It is also found that there is a 32% citation overlap between Google Scholar and WoS.

Table 3: Citation Overlap between Web of Science and Google Scholar

No.	Database	No. of Citations	Percentage (%)
1	Google Scholar Unique Citations	20,979	48
2	Web of Science Unique Citations	8,784	20
3	Overlapping	14,122	32
	Total	43,885	100

b) Overlap of Citations from Google Scholar and Scopus

Table 4 shows that there are 18,655 unique citations from Google Scholar (those not overlapping with Scopus citations) out of 28,040 Google Scholar citations to articles in 23 Open Access ISI–indexed journals. The results also indicate that out of 19,015 Scopus citations to articles, 20% do not overlap with those from Google Scholar. It is also found that there is 40% overlap between Scopus and Google Scholar. This is comparatively little higher than the overlap percentage between Web of Science and Google Scholar (32%).

Table 4: Citation Overlaps between Scopus and Google Scholar

No.	Database	No. of Citations	Percentage (%)
1	Google Scholar Unique Citations	18,655	40
2	Scopus Unique Citations	9,630	20
3	Overlapping	18,770	40
	Total	47,055	100

c) Overlap of Citations from Web of Science and Scopus

The overlap between Scopus and WoS is presented in Table 5. Out of 15,845 total citations from WoS, 6,973 records are not found in the Scopus search results. Also 10,143 unique citations from Scopus (out of 19,015 citations), were not in WoS. The results also show that the citations overlap between WoS and Scopus is 51%.

Table 5: Citation Overlaps between Web of Science and Scopus

No.	Database	No. of Citations	Percentage (%)
1	Web of Science Unique Citations	6,973	20%
2	Scopus Unique Citations	10,143	29%
3	Overlapping	17,744	51%
	Total	34,860	100%

d) Overlap of Citations from Google Scholar, Web of Science, and Scopus

A sum of 18,004 (29%) unique citations was obtained from Google Scholar that did not present either in Scopus or WoS (Table 6). In case of Scopus and WoS the percentage of unique citation is 11% and 10% respectively. The result of this study confirms the result obtained by Sember, Utrobičić and Petrak (2010) carried out using *Croatian Medical Journal*, that found the greatest number of unique citations from Google Scholar (22%) among the three databases. Bakkalbasi et al (2006), however, found a very small amount of difference (1%) of overlap between unique citations from Google Scholar and Scopus for Oncology journals.

Table 6: Citation Overlaps between Google Scholar, Scopus and Web of Science

No.	Citation Statement	No. of Citations	Percentage (%)
1	Google Scholar Unique Citations	18,004	29
2	Web of Science Unique Citations	6,322	10
3	Scopus Unique Citations	7,168	11
4	Overlapping between Google Scholar & Web of Science	1,302	2
5	Overlapping between Google Scholar & Scopus	5,950	9
6	Overlapping between Web of Science & Scopus	4,924	8
7	Overlapping between all Databases	19,230	31
	Total	62,900	100

The unique citations count and overlapping citations count between the three databases are presented in Figure 1, using a Venn diagram.

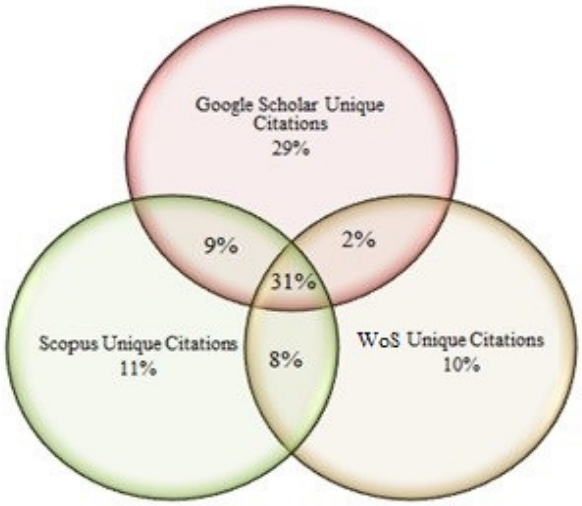

Figure 1: Distribution of the Unique and Overlapped Citations

The distribution of unique and overlapping citations received by the Google Scholar, WoS and Scopus show that among the 62,900 citations, 19,230 (31%) are tracked in all the databases. The high percentage of overlap is found between Google Scholar and Scopus (40%), followed by Scopus and WoS (39%) and WoS and Google Scholar (33%).

CONCLUSION

This study demonstrated that Google Scholar provided considerable materials for citations in the fields of General and Internal Medicine. The results also confirm the findings of Kousha and Thelwall (2007) for disciplines in Science and Social Sciences; Mingers and Lipitakis (2010) in the areas of Business and Management; and Sember, Utrobičić and Petrak (2010) for *Croatian Medical Journal* in 2005 and 2006. As suggested by Bauer and Bakkalbasi (2005), and Bakkalbasi et al. (2006), Google Scholar can be used as an alternative to WoS and Scopus in the studied disciplines. Therefore, researchers may consult Google Scholar in addition to WoS and Scopus for research evaluation.

The results of correlation tests at different levels were expected and in accordance with findings in different fields of study (Belew 2005; Pauly and Stergiou 2005; Kousha and Thelwall 2007; and Mikki 2010). Therefore, the significant correlation between the Web-based citations (Google Scholar) and conventional citation databases (WoS and Scopus) of Open Access scholarly journals in Medical Science indicate that conventional and Web-based citations patterns are likely to be similar and have the potential to be useful for impact assessment. Therefore, it is plausible to use citation statistic retrieved from Google Scholar for impact calculations, especially when citation data from WoS or Scopus is not accessible for medical research.

Previous studies have indicated high overlap percentage between the three databases (Bakkalbasi et al. 2006; Della Seta 2006). This study has also found a remarkable amount of overlapping materials in Medical Science, indicating that the three databases can be regarded as mutually complimentary. Also, the significant citation overlap between the conventional databases (WoS and Scopus) and Google Scholar indicates that Google Scholar maybe regarded as a good and alternative source for citation information.

In conclusion, a large amount of unique citations from Google Scholar for the studied journals may be due to the indexation of a wider form of Web materials, which are not indexed by traditional bibliographic and citation databases such as WoS or Scopus. Hence, this infers that Google Scholar as a resource freely available to anyone can be considered as an important resource complimenting the other bibliographic indexes.

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