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Original Research

Altmetrics and Citation-Based Indicators in Dentistry Articles of Tehran and Shahid Beheshti Universities of Medical Sciences during 2014-2019

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Abstract

By attention to the problems related to metrics such as H-index, impact factor, citations, and so on, a new concept called altmetrics was introduced. This index assesses the impact of an article in almost real-time using multiple markups and conversations and enables researchers to identify the impact of their work more quickly than traditional metrics. The purpose of this study was to determine and compare altmetrics indicators and citations of dental research articles of Tehran University of Medical Sciences (TUMS) and Shahid Beheshti University of Medical Sciences (SBMU) available at altmetrics.com and Scopus between 2014 and 2019. This is a practical comparative study that has been performed with the scientometrics method. The study population included 810 dentistry articles of TUMS and SBMU during 2014-2019 in the Scopus database. The altmetrics data of articles were collected using altmetrics.com bookmarklet. Data were analyzed using descriptive and analytical statistics in SPSS 21. 73.1% of articles in TUMS and 71.3% in SBMU were cited, which indicates TUMS had a slightly greater share. The articles of TUMS with 17.6% had higher altmetrics coverage than SBMU (14.8%). There was a significant positive correlation between Scopus citations and Dimensions citations ($p<0.001$, $r=0.945$) and Mendeley readers ($p=0.000$, $r=0.660$) and weak positive correlation between Scopus citations and altmetrics attention score ($r=0.115$, $p=0.000$). There was a positive and moderate correlation between Mendeley readers with CiteScore ($p=0.000$, $r=0.523$), SJR ($p=0.000$, $r=0.557$) and SNIP ($r=0.508$, $p=0.000$). Also, there was a positive and weak correlation between CiteScore with altmetrics attention score ($r=0.135$, $p=0.000$) and Twitter mentions ($p=0.049$, $r=0.133$), between SJR and altmetrics attention score ($p=0.000$, $r=0.098$) and mentions in Twitter ($p=0.010$, $r=0.174$) as well as SNIP with Twitter ($p=0.043$, $r=0.136$). The altmetrics indicators of dentistry articles in the selected medical universities were not favorable. It is necessary to provide the background to introduce these indicators to researchers and publishers.

Keywords: Altmetrics Indicators, Citation-Based Indicators, Dentistry Articles, Iran.

Introduction

After world war II, measuring and evaluating research was appeared as a key policy-making tool to justify investment in scientific research around the world (Das, 2015). Scientometrics is one of the most common methods for evaluating research and research management which has been formed around a core concept called "citation". The practice of "citation" to other researches creates communication between individuals, ideas, journals, and institutions, and it forms a network that can be quantitatively analyzed. Moreover, citation provides communication between the resources of a work and its subsequent citations.

Citations have been widely used in research assessments since 1960. However, it has always been acknowledged that citations solely cannot include all aspects of research impact. For example, non-cited research that students or scientists may have used for educational or professional purposes may not have been cited anywhere (Mohammadi, Thelwall, Haustein & Larivière, 2015). Citations only measure scientific impact and do not provide social or economic impact information. Citation rates are also affected by self-citation and editorial policies (Knight, 2014; Szomszor, Pendlebury & Adams, 2020). Publication and citation data are slow indicators that must have already gone through processes such as peer review and publication cycle, which may take up to two years depending on its field (Aksnes, Langfeldt & Wouters, 2019). Another notable limitation is that the citation analysis is exclusively in the hands of several information agencies. The information databases of these institutions are limited to a portion of scientific publications, and publications that are not indexed on these databases are not considered (Muppidi & Reddy, 2018).

Traditional metrics that include peer review, citation count, and journals' impact factor measure only academically significant and theoretically relevant among the huge volume of scientific literature produced. On the other hand, traditional citation-based metrics focus solely on journals and articles and do not calculate other types of outputs such as blogs and datasets (Garcovich, Wu, Sucar & Martin, 2020; Williams, 2017). The types of indicators developed in citation analysis, such as journal impact factor and H-index are not considered as article-level indicators and usually assess the location of the article (journal) or the author (the researcher) occurrence (Thelwall, Haustein, Larivière & Sugimoto, 2013). In 2012, Jason Priem introduced a new concept called altemetrics or alternative metrics, which measures the scientific impact based on working in online environments and tools such as social networks (Cronin & Sugimoto, 2014). Alternate metrics are called this way to indicate their differentiation from bibliometrics and webometrics. These metrics do not just consider citations but also include other aspects of document impact such as article views, saves, bookmarks, downloads, likes, mentions, saves in reference managers, blog posts, etc. (Navidi & Mansourian, 2014). Measuring and assessing articles are the results of integrating different data sources and integrating the content of services across various social networks. The sources of data depend on the tool used, including academic, social networks (ResearchGate, Academia), Public social Media (Facebook, Twitter, YouTube, Google Plus, etc.), reference management tools (Mendeley), blogs, news media, etc. (Dalili-Saleh & Salami, 2016). Contrary to traditional metrics, altmetrics also incorporates significant research outputs that fall outside the parameters of reviewed journals. Altmetrics assesses the impact of an article in almost real-time using multiple markups and conversations and enables researchers to identify the impact of their work more quickly than traditional metrics (Williams, 2017).

At the same time, with the development of the altmetrics concept, some tools for exploring

the web were developed to collect altmetrics data. One of these tools is altmetrics.com, a British startup supported by Digital Science Company; Euan Adie established the first in 2011 (Repiso, Castillo-Esparcia & Torres-Salinas, 2019). This system observes the attention received by research outputs, including scientific articles and datasets, and uses a variety of sources to extract data, including policy documents, mainstream media, blogs, online reference managers (Mendeley and CiteULike), post-publication peer-review forums (Pub-Peer & Publons), social media (Twitter, Facebook, Reddit, Google Plus (g+), Pinterest & Linkedin), patents, other online resources (Wikipedia, F1000, YouTube, online tutorials, question and answer sites, Web of Science and Diamonds citations, etc.) (Nuredini, 2021).

To track the amount of attention to scientific outputs, altmetrics needs a stable identifier including Digital Object Identifier (DOI), PubMed Identifier, etc. After collecting the data, altmetrics depicts the quantity and quality of attention to the research output in a circular format with colored bands. The number within the colored circle is the Altmetrics Attention Score of the research output (Saenko, Teyssier, Van Der Marel & Milinkovitch, 2013), which is the weighted score of the amount of attention that altmetrics receives from a variety of sources for research output and it shows the quality and quantity of attention that a product receives. Referring to research output in different sources has a different score. For example, referring to output is considered to have eight points on the news, one point on Twitter, and 0.25 points on Facebook (Tang, Tseng, & Vann, 2020).

The assessment of most relevant researches has indicated that altmetrics status and citations of articles published in different countries have been studied using altmetrics tools. Konkiel & Guichard (2018) studied New Zealand's research achievements in social media and traditional metrics. In another study, Cho (2017) examined the impact of Korean researches using altmetrics and scientific indices. Erdt, Aw, Aung, Mohammadi & Theng (2016) in Singapore studied the status of altmetrics coatings for articles in various disciplines (Erdt et al., 2016). Other altmetrics studies have been performed on articles in a particular field. Ruan, Chen, Cohen, Singhal, Lin & Lee (2018) studied the relationship between citations, download rates, altmetrics scores, and Mendeley readers' scores in plastic and reconstructive surgery articles. In another study, Jabaley et al. (2018) studied high visible sepsis publications. Rosenkrantz, Ayoola, Singh & Duszak Jr (2017) reviewed traditional citations and alternative metrics in popular radiology journal articles (Rosenkrantz et al., 2017). Several studies have also studied articles of a particular database in terms of altmetrics indices. Zahedi, Costasand, and Wouters (2014) examined the presence and distribution of altmetrics in a set of publications indexed in the Web of Science database.

Some studies in Iran have assessed articles using altmetrics tools. Asemi, BasirianJahromi & SeyyedHosseini (2018) investigated the attention rate to the articles of Iranian researchers in the field of prevalent cancers in social networks. Nemati-Anaraki, Aghajani-Koupaei & Alibeyg, (2018) studied the effectiveness of Iranian articles in the pediatric medical field in 2010-2016. Erfan-Manesh (2016), in a study, reviewed the presence of international Iranian articles on information science and librarianship in social media (Erfanmanesh, 2017). Some studies also assessed Iranian articles on specific social networks. Esmaeilpour-Bandboni, Batooli, Ramezani, Ranjbar-Pirmousa, and Ramezani-Pakpourlangeroudi, (2016) studied the citation rate of scientific outputs of Guilan University of Medical Sciences using altmetrics indices in the social science networks of ResearchGate and Mendeley. Some other studies were performed on articles in a particular field without focusing on Iranian articles. Kolahi and

Khazaee study (2018) on dental articles in PubMed, Sedighi (2019) study on scientometrics articles in the two famous journals in this field (Sedighi, 2019,) and finally, Goltaji and Jokar's (2017) study on medical informatics articles in Web of Science database are among them. In another study, Asgary, Sabbagh, Shirazi, Ahmadyar, Shahravan & Akhoundi (2016), conducted a scientometrics study on Iranian Dental Publications Indexed in PubMed.

The strengths of this study over previously performed studies are that this study has considered a comprehensive view and has assessed roughly all of the citation and altmetrics based indicators necessary for analyzing and comparing research outputs of universities. In other words, This study has assessed and comprised citation coverage, including the trend of indexing articles in the Scopus database, mean citations, and FWCI; altmetrics coverage including articles with DOI and attention score, and also articles in dimensions, Mendeley, Twitter, Facebook and Google plus; and lastly altmetrics distribution including altmetrics attention score, citations in Dimensions, readers in Mendeley, mentions in Twitter, Mentions in Facebook and Mentions in Google plus for TUMS and SBMU in 2014-2018 are studied. The final purpose of this study was to determine and compare altmetrics indicators and citations of dental research articles of Tehran University of Medical Sciences (TUMS) and Shahid Beheshti University of Medical Sciences (SBMU) available at altmetrics.com and Scopus between 2014 and 2018.

Materials and Methods

This is a practical comparative study that has been performed with the scientometrics method. The research population included articles published by researchers at TUMS and SBMU between 2014 and 2019 indexed in the subject area of dentistry at the Scopus citation database, which included 810 documents.

The articles were first extracted by searching the Scopus citation database for each university. As an example, the search strategy was as follows for TUMS:

AF-ID ("Tehran University of Medical Sciences" 60027708) AND (LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SUBJAREA, "DENT"))

That way, using a similar search strategy, the study articles for each university were retrieved individually, and each article was extracted in CSV file format. The CSV files were saved and columned in an Excel file format. The checklist required for the research was designed in this Excel file. In the next step, the articles of each university were retrieved from the Scopus database, and the citation data were inserted into the relevant checklist by clicking on each article. Simultaneously, the altmetrics data of each article was obtained by clicking on the Bookmarklet tool, which previously was stored on the web browser through the altmetrics site titled “altmetric it” and was entered into the checklist. This tool invokes the article's altmetrics information on the page related to the article using the article's DOI It shows it as a small window at the top of the screen, which then enters the details page by clicking on it and displays its complemental information. Finally, the data of each university were collected individually aggregated into an Excel file. Data were collected from 19/July/2020 to 21/July/2020. Data were analyzed using descriptive and analytical statistics (Pearson correlation) in SPSS 21.

Results

The study of dental articles of TUMS and SBMU in the Scopus citation database indicated that 409 articles were indexed in this database totally for TUMS in the period from 2014 to 2019, and the number of articles increased from 72 articles (17.6%) in 2014 to 103 articles (25.2%) in 2019. The number of articles of SBMU during this period was 401, which increased from 41 articles (10.2%) in 2014 to 219 articles (28.9%) in 2019. This indicates a significant increase in the number of articles in the study period.

Coverage rate and distribution of citations by year of publication

In the section of study on citations of dental articles of selected medical universities in the Scopus citation database, in addition to the number of citations, another index called FWCI was studied. Table 1 indicates the status of citations and FWCI index of dental articles of TUMS in 2014-2019 at the Scopus citation database. Accordingly, the number of articles citations has decreased from 2014 to 2018. 95.9% of articles published in 2015 received citations, while 38.8% of 2018 articles were cited. The 2014 articles with a mean of 8.93 ± 10.51 (643 citations) had the highest citations, and the 2018 articles with a mean of 0.70 ± 1.22 (72 citations) had the lowest citations. The most number of articles with the FWCI index were also devoted to 2014 and 2015, the mean value of this index for all articles was approximately 1 except for 2016 articles with a mean of 1.67 ± 6.54 and 2018 with a mean of 1.55 ± 9.67, which had a mean higher than 1. 73.1% of the articles (299 articles) of this university were cited during the study period and these articles have cited a total of 1831 times (mean citation per article 4.48 ± 6.80). The FWCI index with a mean of 1.29 ± 5.73 had a value higher than 1. Table 1 also indicates the status of citation indicators for dental articles of SBMU in 2014-2018 in the Scopus citation database. According to the table, the number of articles with citations in this university had a decreasing trend from 2014 to 2018. 100% of articles in 2014 and 39.7% of articles in 2018 were cited. The highest number of citations belonged to 2014 articles with a mean of 8.83±8.01 citations, and the lowest number of citations belonged to 2018 articles with a mean of 0.97 ± 1.83 citations. The FWCI index for these university articles, except for 2014 and 2017 which was 1 on average, was lower than 1 for other years. Totally, 286 articles (71.3%) of this university articles were cited, so they were cited 1513 times (mean 3.77 ± 5.23). The mean FWCI index was reported to be less than 1 (96.0 ± 1.34).

Table 1
Citation coverage and FWCI of TUMS and SBMU articles in 2014-2018

	Year	N. articles	Articles with citation		Mean citations			Articles with FWCI		Mean FWCI		
			F	P	Total	Mean	SD	F	P	Total	Mean	SD
TUMS	2014	72	67	93.1	643	8.93	10.51	62	86.1	71.76	1.00	1.11
	2015	73	70	95.9	513	7.03	6.94	70	95.9	78.11	1.07	1.07
	2016	81	68	84.0	362	4.47	4.77	66	81.5	134.96	1.67	6.54
	2017	80	54	67.5	241	3.01	5.07	53	66.2	84.63	1.06	1.63
	2018	103	40	38.8	72	0.70	1.22	33	32	159.67	1.55	9.67
	Total	409	299	73.1	1831	4.48	6.80	284	69.4	529.13	1.29	5.73
SBMU	2014	41	100	362	8.83	8.01	40	97.6	43.07	1.05	0.99	41
	2015	48	95.9	369	6.25	7.13	48	81.4	54.49	0.92	1.05	48
	2016	80	88.9	397	4.41	3.81	80	88.9	88.06	0.98	0.86	80
	2017	71	74.7	272	2.86	3.74	69	72.6	94.88	1.00	1.28	71

	Year	N. articles	Articles with citation		Mean citations			Articles with FWCI		Mean FWCI		
			F	P	Total	Mean	SD	F	P	Total	Mean	SD
	2018	46	39.7	113	0.97	1.83	41	35.3	102.72	0.89	1.84	46
	Total	286	71.3	1513	3.77	5.23	278	69.3	383.22	0.96	1.34	286

F= Frequency, P= Percent, N= number, SD= Standard Deviation

Altmetrics coverage by the source of attention and year of publication

In the section of altmetrics study of articles obtained from altmetrics.com, since this site only provides altmetrics information for articles with single identification such as DOI, the study articles were assessed for having this ID. The results showed that from 16 sources that altmetrics follow to track attention to scientific outputs, there was no mention of the study articles in the six sources of Publons, PubPeer, Reddit, Patents, F1000, and Q & A sites. Some other sources, such as news, YouTube, blogs, Wikipedia, and policy documents, were excluded due to poor coverage and distribution between universities.

Table 2 shows the altmetrics coverage of dental articles by TUMS and SBMU based on altmetrics attention sources in 2014-2018. According to the table, 84.8% of the articles had DOI. The percentage of articles with DOI has increased from 2014 to 2018. This is while the percentage of articles with altmetrics attention score has decreased from 25.5% in 2014 to 12.4% in 2018, except for 2017 which indicates an increase (20.3%). Mendeley and Twitter had the highest coverage in terms of altmetrics attention sources throughout the years that was 17.3% for Mendeley and 16.1% for Twitter. Google Plus had the lowest coverage (0.9%) in all years and total.

As this table indicates totally, 86% of articles in SBMU had DOI, and the number of articles with this identifier has increased from 2014 to 2015, but articles with altmetrics attention scores have decreased from 28.6% in 2015 to 9.9% in 2018. The highest coverage by the altmetrics attention sources was reported for Mendeley (14.5%), Twitter (13.3%), and Dimensions (13.1%). Google plus had the lowest coverage (0.9%)

Table 2

Altmetrics coverage of dental articles of TUMS and SBMU in 2014-2018

	Year	Articles	Articles with DOI		Articles with attention score and DOI		Articles in Dimensions		Articles in Mendeley		Articles in Twitter		Articles in Facebook		Articles in Google plus	
			F	P	F	P	F	P	F	P	F	P	F	P	F	P
TUMS	2014	72	51	70.8	13	25.5	12	23.5	12	25.5	12	23.5	3	5.9	0	0
	2015	73	57	78.1	12	21.1	12	21.1	12	21.1	11	19.3	1	1.8	0	0
	2016	81	67	82.7	9	13.4	7	10.4	9	13.4	9	13.4	3	4.5	1	1.5
	2017	80	74	92.5	15	20.3	12	16.2	15	20.3	13	17.6	1	1.4	1	1.4
	2018	103	97	94.2	12	12.4	7	7.2	12	12.4	11	11.3	3	3.1	1	1.0
	total	409	347	84.8	61	17.6	50	14.4	60	17.3	56	16.1	11	3.2	3	0.9
SBMU	2014	41	22	53.7	2	9.1	2	9.1	2	9.1	2	9.1	0	0	0	0
	2015	59	35	59.3	10	28.6	9	25.7	10	28.6	8	22.9	3	8.6	0	0
	2016	90	83	92.2	16	19.3	15	18.1	16	19.3	15	18.1	2	2.4	2	2.4
	2017	95	94	98.9	12	12.8	11	11.7	11	11.7	10	10.6	0	0	1	1.1
	2018	116	111	95.7	11	9.9	8	7.2	11	9.9	11	9.9	0	0	0	0
	total	401	345	86.0	51	14.8	45	13.0	50	14.5	46	13.3	5	1.4	3	0.9

DOI: Digital Object Identifier, F: Frequency, P: Percent

The distribution rate of altmetrics in the study articles by altmetrics attention source and year of publication

In this part of the study, the altmetrics distribution rate of dental articles of TUMS and SBMU is investigated in each of the altmetrics attention sources and the studied years that the results are presented in Table 3. Accordingly, 2016 articles of TUMS received the highest altmetrics attention score (2.44±3.97) and the highest mention rate in Google Plus (mean 3). Although 2015 articles received the highest citation in Dimensions (13.25±11.41) and reader in Mendeley (30.25±25.75), they obtained the lowest altmetrics attention score (1.08±0.28). This is because Dimensions citations and Mendeley readers have no score in calculating altmetrics attention score. The lowest citations in Dimensions (1.69±2.52) and reader in Mendeley (14.42±12.27) belonged to the 2018 articles. The 2017 articles were more frequently mentioned on Twitter (2.62±3.88). Overall, the highest distribution was reported for Mendeley readers (21.45±19.31) and the lowest distribution for Facebook mentions (1.27± 0.90).

Table 3 also shows the distribution of altmetrics of dental articles of SBMU based on altmetrics attention sources for the years 2014 to 2018. As this table indicates, the highest altmetrics attention score (4.36±8.42) and the highest mention rate in Twitter (4.73±11.37) belonged to the 2018 articles. Among the sources studied, Twitter and Google Plus had the highest calculating altmetrics scores. So they have a direct relationship with the altmetrics attention score. The lowest altmetrics attention score (mean 1) belonged to 2014 articles. However, articles in 2014 obtained the highest number of citations in Dimensions (18.50±21.92) and the highest number of readers in Mendeley (23±11.31). Most Facebook (3±1.41) and Google Plus (2±1.41) mentions are also related to 2016 articles. Overall, the highest degree of distribution belonged to Mendeley readers (20.91±17.72) and the least to Facebook mentions (1.50±1.37).

Table 3

Altmetrics distribution of dental articles of TUMS and SBMU in 2014-2018

	Year	Altmetrics attention score		Citations in Dimensions		Readers in Mendeley		Mentions in Twitter		Mentions in Facebook		Mentions in Google plus	
		T	Mean	T	Mean	T	Mean	T	Mean	T	Mean	T	Mean
TUMS	2014	17	1.31 ±0.6	162	12.46±11.0	388	29.85±22.1	17	1.31±1.1	3	1.0	0	0
	2015	13	1.08 ±0.2	159	13.25±11.4	363	30.25±25.7	14	1.27±0.4	1	1.0	0	0
	2016	22	2.44 ±3.9	34	3.78 ±3.6	148	16.44±13.7	17	1.89 ±2.6	6	2.0±1.7	3	3.0
	2017	36	2.40±3.1	71	4.73±7.3	258	16.13±14.8	34	2.62±3.8	1	1.0	1	1.0
	2018	18	1.50±0.9	22	1.69±2.5	173	14.42±12.2	21	1.91±1.3	3	1.0	1	1.0
	Total	106	1.74±2.2	448	7.23±9.2	1330	21.45±19.3	103	1.81±2.2	14	1.27±0.9	5	1.67±1.1
SBMU	2014	2	1	37	18.50±21.9	46	23.00±11.3	2	1.00	0	0	0	0
	2015	28	2.80±4.3	94	9.40±11.6	242	24.20±24.9	12	1.20±0.9	3	0.75±0.5	0	0
	2016	33	2.06±2.9	73	4.56±3.4	294	18.37±12.5	26	1.73±2.0	6	3.00±1.4	4	2.00±1.4
	2017	34	2.83±3.5	85	6.07±7.4	284	20.29 ± 15.5	27	2.25±4.0	0	0	1	1.00
	2018	48	4.36±8.4	44	4.00±4.4	242	22.00±22.0	52	4.73±11	0	0	0	0
	Total	145	2.84±4.8	333	6.28±7.9	1108	20.91±17.7	119	2.38±5.7	9	1.50±1.3	5	1.67±1.1

T= Total

Figure 1 shows the altmetrics coverage and citations of the articles of the universities under study. As the figure indicates, two studied universities, with a slight difference, are in the same position in terms of altmetrics coverage and citations. 73.1% of articles in TUMS and 71.3% of

articles in SBMU were cited, which indicates TUMS had a slightly greater share. Regarding altmetrics coverage, the articles of TUMS with 17.6% had higher coverage than SBMU (14.8%). However, the share of articles with DOI in SBMU was higher (86%). As figure 2 indicates, TUMS had a higher mean citation and FWCI than SBMU, while the articles of SBMU had a higher mean altmetrics attention score.

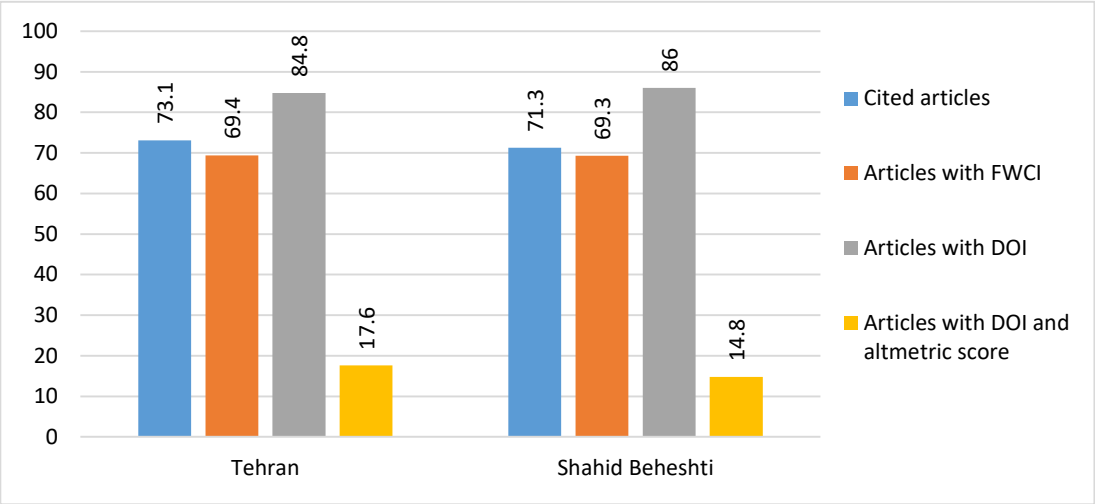

Figure 1*:* Altmetrics coverage and citations of articles from the universities under study Tehran= Tehran University of Medical Sciences or TUMS, Shahid Beheshti= Shahid Beheshti University of Medical Sciences or SBMU

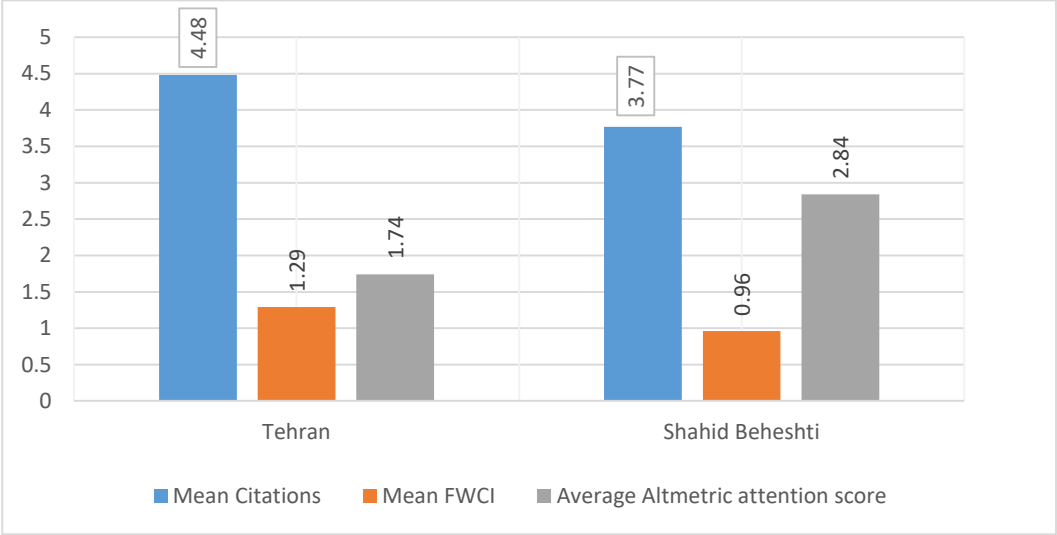

Figure 2*:* Citation indicators and altmetrics attention score of the articles of the universities under study Tehran= Tehran University of Medical Sciences or TUMS, Shahid Beheshti= Shahid Beheshti University of Medical Sciences or SBMU

Correlation between altmetrics and citation indices

The results of the Pearson correlation test indicated that there is a significant positive correlation between Scopus citations and Dimensions citations ($p<0.001$, $r=0.945$) and Mendeley readers ($p=0.000$, $r=0.660$) and a weak positive correlation between Scopus citations and altmetrics attention score ($r=0.115$, $p= 0.000$).

The correlation between altmetrics indicators and citation indicators of journals indicated a positive and moderate correlation between Mendeley readers with CiteScore (p=0.000, r=0.523), SJR (p=0.000, r=0.557) and SNIP (r=0.508, p= 0.000). Also, there was a positive and weak correlation between CiteScore with altmetrics attention score (r=0.135, p=0.000) and Twitter mentions (p=0.049, r=0.133), between SJR and altmetrics attention score (p=0.000, r=0.098) and mentions in Twitter (p=0.010, r=0.174) as well as SNIP with Twitter (p=0.043, r=0.136). The relationship between other indicators was not statistically significant.

Discussion

This research studied altmetrics indicators and citations of articles by dental researchers of TUMS and SBMU at altmetrics.com and Scopus between 2014 and 2018. The results indicated that the number of articles indexed in the Scopus citation database in the subject area of dentistry has an increasing trend in both universities from 2014 to 2018. The assessment of citation indicators of the studied articles indicated that 73.1% of TUMS articles were cited, so these articles were cited 1831 times (4.48±6.80). The mean FWCI for these articles was 1.29±5.73. In SBMU, 71.3% of articles received 1513 citations, a total (3.77±5.23), and the mean FWCI for these articles was 0.96±1.34. The number of cited articles and mean citations for articles from 2014 to 2018 decreased at both universities. In a study by Asgary et al. (2016), 49.05% of the studied articles were cited in Scopus, which is inconsistent with the present study.

In this study, the research population was dental articles indexed in PubMed, which may be justified as all articles may not necessarily be indexed in Scopus. In the study of Esmaeilpour-Bandboni et al. (2016), 56.56% of Guilan University of Medical Sciences articles were cited, and the average citation per article was 3.79. In the study by Konkiel and Guichard (2018), 63.6% of the New Zealand researchers' articles were cited, and the average citation per article was 3.58 (Konkiel & Guichard, 2018). In a study done by Rosenkrantz et al. (2017), 96.4% of the articles were cited, which is expected to have a higher chance of citation given that the research population was the published articles in 4 renowned public radiology journals (Rosenkrantz et al., 2017). Overall, it seems that the citation status of dental articles of the studied medical universities was in an acceptable status compared to similar studies and also based on the FWCI weighting index that shows the general view of articles citation status. It seems that in parallel with the advancement of science in various fields, including biosciences and particular dentistry, researchers in this field have understood the need to carry out more extensive research activities to keep up with these advances.

The FWCI index also shows that despite citation decline over time, the citation performance of the articles is almost close to the global average of the similar articles by subject and year of publication. Asgary et al. (2016), in their study, while pointing to the increasing number of dental publications in Iran as well as an increase in the number of dental research centers, have considered such achievements as a result of the national movement toward research development (Asgary et al., 2016). Asemi et al. (2018) have stated high competitiveness in research activities to survive under the slogan of “Write and Stay Alive” that has shadowed over the activities of the scientific community.

The assessment of altmetrics indicators of the studied articles indicated that 84.8% of the TUMS articles had DOI, 17.6% had altmetrics attention score, and at least one time was considered (attention) in one of the sources that track the altmetrics site. 86% of SBMU articles had DOI, and 14.8% received altmetrics attention scores. The studies performed on Iranian

articles, including Asemi et al. (2018), Nemati-Anaraki et al. (2018), and Erfanmanesh (2017), have obtained similar results. In the studies performed on articles from other countries, Erdt et al. (2016) found similar results for the Singapore articles, but Konkiel & Guichard (2018), with altmetrics coverage of 49.5% for New Zealand articles, achieved contradictory results (Erdt et al., 2016; Konkiel & Guichard, 2018). Also, the studies on articles from other fields (or majors), including Jabaley et al. (2018) with altmetrics coverage of 49.6% for sepsis articles, Rosenkrantz et al. (2017) with altmetrics coverage of 41.8% for radiology articles, Zahedi et al. (2014) with altmetrics coverage of 36% for medical articles, Kolahi and Khazaei (2018) with altmetrics coverage of 36% for dental articles and Sedighi (2019) with altmetrics coverage of 48% for scientometrics articles have obtained contradictory results in comparison with the country study.

Mean altmetrics attention score per article was obtained 1.74±2.22 for TUMS articles and 2.84±4.89 for SBMU articles in the present study, which are lower than other studies including Rosenkrantz et al. (2017) with a mean of 3.13±3.3, Kolahi and Khazaei (2018) with a mean of 3.5±21 and the Nemati-Anaraki et al. (2017) with mean of 4±31. This indicates the unfavorable status of these indicators compared to studies in other countries and disciplines. This may be due to the lack of familiarity of Iranian researchers with altmetrics indicators and social media capabilities.

Each altmetrics service provider, including altmetrics.com, covers only some part of the vast expanse of the Web and thus scientific publications, and it does not cover all scientific publications. Zahedi et al. (2014), Asemi et al. (2018), and Erfanmanesh (2017) also mentioned this problem in their study. Not having identifiable codes such as DOI or Pubmed ID in some articles may be another reason for the low altmetrics performance of articles. Nemati-Anaraki et al. (2018) also confirmed this result. Asemi et al. (2018) pointed out the lack of researchers' understanding of knowledge translation and the provision of specialized knowledge in a simple and understandable language by the general public. Cho (2017) has introduced the language issue as an important factor in the low altmetrics performance of articles. The usual social media followed by the altmetrics site that has the English language are more used in English-speaking countries. In addition, English-language articles published in these media outlets have a larger audience than non-English-language articles.

Unlike the study by Erdt et al. (2016), Zahedi et al. (2014), Sedighi (2019), and Erfanmanesh (2017), that have reported an increase in the altmetrics coverage over time, there was no clear decreasing or increasing trend in the coverage rate and Altmetrics distribution in the two studied universities over time. However, it was expected to be an increasing trend in the present rate and attention to these articles over time, and researchers identified more altmetrics indicators and utilization of social media. This may indicate that researchers in this field and even publishers have not deliberately attempted to share their articles on social media, and the presence of these articles on social media has been more accidental.

This study's most frequently used sources were Mendeley, Twitter, and Dimensions. In TUMS, the mean presence of articles in Mendeley, Twitter, and Dimensions was 17.3%, 16.1%, and 14.4%, respectively. The average number of readers in Mendeley was 21.45±19.31, mean mentions in Twitter was 81.1±27.2, and mean citations per article in Dimensions was 7.23±9.24. Mean article presence in Mendeley, Twitter, and Dimensions for SBMU was 14.5, 13.3, and 13, respectively. Also, mean readers in Mendeley was 20.91±17.72; the mean mentions in Twitter was 2.38±5.76, and mean citations per article in Dimensions was

6.28±7.97. In other abroad and internal studies, such as Rosenkrantz et al. (2017), Cho (2017), Zahedi et al. (2014), Kolahi and Khazaei (2018), Sedighi (2019), Asemi et al. (2018), Nemati-Anaraki et al. (2018), and Erfanmanesh (2017) also used Mendeley and Twitter more than other sources, which may indicate the strength of these two media in providing altmetrics data, due to their popularity and generality among researchers. The average use of Mendeley was higher than that of Twitter both in the present and other Iranian studies, which may be due to the popularity of Mendeley reference management tool among Iranian researchers and Twitter filtering in the country.

Correlation analysis between altmetrics and citation indicators showed a positive and strong significant correlation between the number of article readers in Mendeley and the number of citations in Scopus. Cho (2017), Rosenkrantz (2017), Erdt et al. (2016), Zahedi et al. (2014), Sedighi (2019), Esmailpour-Bandboni et al. (2016), and Erfanmanesh (2017) achieved similar results. Since Mendeley is a comprehensive reference management tool, articles studied in this tool are more likely to be cited. Thus, the number of readers in Mendeley may be a representative of future citation of articles. However, given the high average of Mendeley readers to citations, it can be concluded that these articles are not merely studied for research purposes, but also professionals use them for other purposes. In addition, in the present study, there was a positive and weak correlation between the number of citations in Scopus and the altmetrics attention score of the articles. The studies by Jabaley et al. (2018), Rosenkrantz (2017), Erdt et al. (2016), and Sedighi (2019) also showed a correlation between these two indicators.

Overall, it seems that except for Mendeley readers who had a high average and strongly correlated with the number of citations, other altmetrics indicators cannot currently be substituted for traditional indicators. However, the role of social media and altmetrics indicators cannot be ignored, either in terms of increasing visibility and resulting in traditional citations of articles or as indicators that measure impacts other than scientific impact.

Conclusion

Although citing is a time-consuming process, and in contrast, altmetrics indicators through a single observation, click or sharing more quickly reflect the attention to a document, so it was expected that the altmetrics index of articles in comparison with their citation index has a better performance at least in the recent years. However, it was not so. Altmetrics indicators need to be more recognized by internal researchers and publishers, and to this end, policy-making and planning by the related organizations can be an important step. The policies that have been developed over the years in the field of scientometrics, conducted by the Iran Ministry of Health and Medical Education, including the process of evaluation and promotion of faculty members in universities based on the quantity and quality of the published articles, can be considered as an effective factor in improving the number of outputs and their citation status. On the other hand, the number of citations had a decreasing trend over time, which is not unexpected given that citations of articles are completed over time. By attention to low altmetrics attention score per article for the studied universities, holding educational courses on altmetrics indicators and social media capabilities for the researchers is necessary.

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