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Correlation between Altmetric and Scientometric Indicators

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ABSTRACT

Objective: Despite the increasing attention to altmetric indicators in scientometric research, there is still doubt about the validity of these indicators in evaluating research. The purpose of this study was to investigate the relationship between scientometric and altmetric indices on scientific products.

Materials and Methods: In the altmetric indices section, 5 indicator classes presented in Scopus and 36 sub-indices were examined. The Spearman correlation indicator was used to evaluate the correlation between altmetric and scientometric indices. The SPSS software version 16 was used to analyze data. The significance level was also considered less than 0.05.

Results: The correlation between the number of citations to documents and Usage, Citations, and Capture was significant. There was no significant relationship between social media and mention. Also, there is a significant and positive relationship between the citations to documents and sub-indices of Abstract views, Link out, Readers, Export/saves, and Citation indicator.

Conclusion: Given the important relationship between citation rates and altmetric indicators, it can be said that web-based platforms like scientific databases or social media that are publicly accessible play a very important role in increasing the visibility and citation rate and thus the effectiveness of research.

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Introduction

Assessing the impact of researchers and their research on scientific communication has always been an important issue in research policy-making (Fenner, 2014; Rosenkrantz et al., 2017). Traditionally, peer review has been the most appropriate way to confirm scientific advances. From the beginning of the first scientific revolution, the discussion and agreement of the scientific community on scientific theories and discoveries was considered as a way to confirm and accept new knowledge. This approval process has been proposed as a suitable tool for accepting the most scientific products in academic journals, allocating research budgets, or selecting and promoting academic staff (Ortega, 2019; Ravenscroft et al., 2017). In this regard, in recent years, we have seen changes in the methods of qualitative evaluation of research individually and by peers to systematic quantitative evaluations using citation analysis of journal articles. Of course, the real impact of research cannot be quantified, and citation methods are lacking in comprehensive evaluations; However, approaches such as considering journals as a way to identify relevant scientific content and considering the impact factor of journals as a tool to determine the quality of journals are the focus of research on the quality and relevance of scientific products (Fenner, 2014).

In this regard, the citation has been an influential metric in a scientific publication for decades. But in recent years, scientometrics seems to be at a similar point in development in the 1960s. In scientometric research, the focus has shifted from web citation analysis to analysis of the use of social media, now known as "altmetrics" (Bornmann, 2014). This approach appeared almost simultaneously with the emergence of the idea in scientific policy that to evaluate the impact of research, not only on the research itself but also on other examples of the impact of research at other levels of society should be aware. Therefore, altmetrics indicators can be expected to be considered in research evaluation (Bornmann, 2015).

Alternative metrics or altmetric are considered interesting options for assessing the social impact of research because they offer new ways to measure interaction with research results. Altmetric is a term used to describe web-based metrics for the impact of scientific content, with an emphasis on social media as data sources. (Bornmann et al., 2019; Bornmann et al., 2016; Saberi & Ekhtiyari, 2019). Altmetrics is currently one of the most popular research topics in scientometric research (Bornmann, 2014). Recent attempts have been made to investigate the effect of altmetrics on scientific effect (Wang et al., 2014).

Some previous studies confirm a significant correlation between some altmetric indicators and citations, while others have yielded conflicting results. Chang et al (2019), for example, concluded that there was no correlation between the altmetrics score of highly cited articles and journals IF in pediatric surgery and that there was a weak correlation with the number of citations to articles. But in general, altmetric indicators can be predictors of the number of citations to articles in the field of pediatric surgery (Chang et al., 2019). A meta-analysis study found that correlation with traditional citations was very low for micro-blogging counts, low for blog counts, and moderate to

high for bookmarking online reference managers (Bornmann, 2015). Therefore, there are still important questions about the relationship between scientometrics and altmetrics. Also, the accuracy of individual indicators should be considered separately because each of the patterns has its characteristics (Wang et al., 2014).

Golestan University of Medical Sciences in Iran with more than 300 faculty members of basic and clinical sciences, is a good example of the medical community that analysis of the altmetric and scientometric status of its scientific products, can provide a good perspective on the interaction of these two variables. Therefore, due to the need to study this issue in the field of medical sciences, in this study, all altmetric indicators and their relationship with the traditional quality indicators of scientific products (number of citations), based on information from scientific products of Golestan University of Medical Sciences in Scopus database are examined.

Materials and Methods

This cross-sectional study was performed with a scientometric approach. For this, we considered all scientific products of Golestan University of Medical Sciences as a statistical sample in the Scopus database. For this purpose, all scientific products of Golestan University of Medical Sciences were searched and retrieved using the Affiliation Search option. 2386 articles were found in this search. Then, for each article, citations and altmetric indices were extracted. In this study, in the altmetric indices section, 5 indicator classes presented in Scopus, including Citations, Captures, Usage, Mentions, Social Media, and 36 sub-indices were examined. Based on the compliments provided in Scopus, Usage indicates whether anyone is reading the articles or otherwise using the research. Captures track when end users bookmark, favorite, become a reader, become a watcher, etc.

Capture metrics indicate that someone wants to come back to the work. Mentions are a measurement of activities such as news articles or blog posts about research. They indicate that people are actively engaging with the research. Social Media can help measure “buzz” and attention. This category includes tweets, Facebook likes, etc. that reference the research. Citation is a category for both traditional citation indicators such as Scopus, and a place to capture new citations that help indicate social impact such as Clinical or Policy Citations (Elsevier, 2021). These indicators and detailed descriptions of each are presented in Table 1. Scientometric indices in this study are first presented using descriptive indices such as frequency, mean, standard deviation, and minimum and maximum. Then, the Spearman correlation indicator was used to evaluate the correlation between altimetric and scientometric indices. These analyzes were performed in SPSS software version 16. The significance level was also considered less than 0.05.

Table 1. The definitions of used indicators in the study

Metrics	Definition	Sub-metric	Source(s)	Description
Usage	Usage indicates whether anyone is reading the articles or otherwise using the research. After citations, Usage is the top statistic researchers want to know.	Abstract Views	Airiti iRead eBooks, Airiti Library, CABI, Digital Commons, DSpace, EBSCO (historical only), ePrints, Expert Gallery Suite, RePEc, SciELO, SSRN	The number of times the abstract of an artifact has been viewed.
		Clicks	bit.ly	The number of clicks of a URL
		Collaborators	GitHub	The number of collaborators of an artifact
		Downloads	Airiti iRead eBooks, Airiti Library, Digital Commons, Dryad, DSpace, EBSCO (historical only), ePrints, Expert Gallery Suite, figshare, Github, Institutional Repositories, Mendeley Data, Pure (for select customers only), RePEc, Slideshare, SSRN	The number of times an artifact has been downloaded
		Full Text Views	Airiti iRead eBooks, CABI, EBSCO (historical only), OJS Journals, PLOS, PubMedCentral (for PLOS articles only), SciELO	The number of times the full text of an article has been viewed
		Holdings	WorldCat	The number of libraries that hold the book artifact
		Link Outs	EBSCO (historical only)	The number of times an outbound link has been clicked to a library catalog or link resolver
		Plays	Digital Commons, Vimeo, YouTube, SoundCloud	The number of times the video or audio has been played
		Views	Mendeley Data, Dryad, figshare, Slideshare	The number of times the artifact has been viewed
Capture	Capture metrics indicates that someone wants to come back to the work. Captures can be an early indicator of citations.	Bookmarks	Delicious (historical only)	Number of times an artifact has been bookmarked
		Favorites	Slideshare, SoundCloud, YouTube	The number of times the artifact has been marked as a favorite
		Followers	GitHub	The number of times a person or artifact has been followed
		Forks	Github	The number of times a repository has been forked
		Readers	CiteULike (historical only), Goodreads, Mendeley, SSRN	The number of people who have added the artifact to their library/briefcase
		Exports/Saves	EBSCO (historical only), SSRN	This includes the number of times an artifact's citation has been exported direct to bibliographic management tools or as file downloads, and the number of times an artifact's citation/abstract and HTML full text (if available) have been saved, emailed or printed.
		Subscribers	Vimeo, YouTube	The number of people who have subscribed for an update
		Watchers	Github	The number of people watching the artifact for updates
Mention	Mentions are a measurement of activities such as news articles or blog posts about research. They indicate that people are actively engaging with the research.	Blog Mentions	Blog lists curated by PlumX	The number of blog posts written about the artifact
		Comments	Reddit, Slideshare, Vimeo, YouTube	The number of comments made about an artifact
		Forum Topic Count	Vimeo	The number of topics in a forum discussing the artifact
		Gist Count	GitHub	The number of gists in the source code repository
		News Mentions	News source lists curated by PlumX	The number of news articles written about the artifact
		Q&A Site Mentions	Stack Exchange	The number of mentions found about an artifact
		References	Wikipedia	The number of references found to the artifact
		Reviews	Amazon, Goodreads, SourceForge	The number of reviews written about the artifact

Social Media	Social Media can help measure "buzz" and attention. This category includes tweets, Facebook likes, etc. that reference the research.	Likes	Vimeo, YouTube	The number of times an artifact has been liked
		Shares, Likes & Comments	Facebook	The number of times a link was shared, liked or commented on
		Ratings	Amazon, Goodreads, SourceForge	The average user rating of the artifact.
		Recommendations	Figshare, SourceForge	The number of recommendations an artifact has received
		Scores	Reddit	The number of upvotes minus downvotes on Reddit
		Tweets	Twitter via Gnip	The number of tweets and retweets that mention the artifact
Citation	This is a category for both traditional citation indexes such as Scopus, and a place to capture new citations that help indicate social impact such as clinical or policy citations.	Citation Indexes	Airiti Academic Citation Index	The number of Airiti ACI works that cite the artifact
			Chinese Science Citation Database	The number of Chinese Citation Database (CSCD) works that cite the artifact
			CrossRef	The number of articles that cite the artifact according to CrossRef
			PubMed Central	The number of PubMed Central articles that cite the artifact
			PubMed Central Europe	The number of PubMed Central Europe articles that cite the artifact
			RePEc	The number of RePEc works that cite the artifact as computed by CiTEc
			SciELO	The number of SciELO articles that cite the artifact
			Scopus	The number of articles that cite the artifact according to Scopus
			SSRN	The number of SSRN works that cite the artifact
		Patent Citations	USPTO	The number of patents that reference the artifact according to the United States Patent and Trademark Office
		Patent Family Citations	EPO, IPO, JPO, USPTO, WIPO	The number of patent families that reference the artifact according to the European Patent Office (EPO), World Intellectual Property Organization (WIPO), Intellectual Property Office of the United Kingdom (IPO), United States Patent and Trademark Office (USPTO) and Japan Patent Office (JPO)
		Clinical Citations	Dynamed Plus Topics (historical only)	The number of Dynamed Plus Topics that reference the artifact
			PubMed Clinical Guidelines	The number of Clinical Guidelines from PubMed that reference the artifact
			National Institute for Health and Care Excellence (NICE) – UK	The number of Clinical Guidelines from NICE that reference the artifact
		Policy Citations	Policy document source lists curated by PlumX	The number of policy documents that reference an artifact

Results

The results shows that the scientific products of Golestan University of Medical Sciences in the Scopus database have been a total of 2384 articles, of which 39536 have received citations. In other words, mean ±standard deviations of citations for each article were 16.58±101.31. Among the altmetric indices presented in this database, the usage indicator with 309606 counts has been the highest altmetric indicator related to these scientific products. Mean ±standard deviations, each of the scientific products had 129.87±875.75 uses. The lowest counts of the indices was assigned to Mention with 3037 with mean ±standard deviations of 1.27±18.97. Information on other indicators is presented in Table 2.

Table 2. Statistical indicators of five metrics related to the scientific products

Metrics	Citations to documents	Usage	Captures	Mentions	Social Media	Citations
Sum (Min-Max)	39536 (0-2406)	309606 (0-20854)	158570 (0-25460)	3037 (0-635)	68730 (0-30328)	17593 (0-1261)
Mean±SD*	16.58±101.31	129.87±875.75	66.51±715.73	1.27±18.97	28.83±654.38	7.38±53.17

Findings also show that among the Usage sub-indices, Full-Text Views with 187796 counts and mean ±standard deviations of 78.77±814.946 and Abstract Views with 106742 counts and mean ±standard deviations of 44.77±159.461 had the most cases and the plays indicator has no counts. It is noteworthy that in the usage indicator, more than 95% of the statistics were related to the two indicators, Abstract Views, and Full-Text Views, and other sub-indices of this total accounted for less than 5% of the statistics. In the Capture indicator, more than 94% of the statistics were related to the Readers sub-indicator, and other sub-indicators together accounted for a little over 5% of the statistics. Also, the Favorites, Followers, and Forks sub-indices did not counts. In the Mention indicator, the situation is such that News Mentions with 1975 counts and mean ±standard deviations of 83±13.820 had the highest ratio among the Mention sub-indices. The findings show that the News Mentions and References sub-indices alone accounted for 83.11% of the Mention sub-indices and the other sub-indices had less than 17% in this area. Among the Social Media indices, only two sub-indices Shares, Likes & Comments (60.63%) and Tweets sub-indicator (39.37%) were among these sub-indices and other sub-indices had no counts. Regarding Citations Indices, the findings show that almost all counts of this indicator were related to Citation indicators, and only the Patent Family Citations sub-indicator had a counts of 47. Other sub-indicators did not counts. Other findings are presented in Table 3.

Table 3. Metrics and sub-metrics related to scientific outputs

	Descriptive Statistics						
Metrics	**Sub-metric**	Minimum	Maximum	Sum	Mean	Std. Deviation	% in Metrics
Usage	Clicks	0	105	440	.18	3.677	0.14
	Downloads	0	482	1581	.66	11.486	0.51
	Views	0	1451	2554	1.07	30.798	0.82
	Library Holdings	0	56	56	.02	1.147	0.02
	Plays	0	0	0	.00	.000	0.00
	Abstract Views	0	2632	106742	44.77	159.461	34.48
	Collaborators	0	2521	2575	1.08	51.640	0.83
	Full Text Views	0	20752	187796	78.77	814.946	60.66
	Link Outs	0	934	7862	3.30	24.303	2.54
Captures	Bookmarks	0	4	4	.00	.082	0.002
	Favorites	0	0	0	.00	.000	0
	Followers	0	0	0	.00	.000	0
	Forks	0	0	0	.00	.000	0
	Readers	0	25410	150278	63.04	713.359	94.77
	Exports/Saves	0	370	8270	3.47	14.853	5.21
	Subscribers	0	17	17	.01	.348	0.01
	Watchers	0	1	1	.00	.020	0.0006
Mentions	Blog Mentions	0	42	209	.09	1.186	6.88
	Comments	0	281	296	.12	5.758	9.75

	Forum Topic Count	0	0	0	.00	.000	0.00
	Gist Count	0	0	0	.00	.000	0.00
	News Mentions	0	580	1975	.83	13.820	65.03
	Q&A Site Mentions	0	5	5	.00	.102	0.16
	References	0	232	549	.23	6.655	18.08
	Reviews	0	3	3	.00	.061	0.10
Social Media	Likes	0	0	0	.00	.000	0.00
	Shares, Likes & Comments	0	20593	41674	17.48	450.908	60.63
	Ratings	0	0	0	.00	.000	0.00
	Recommendations	0	0	0	.00	.000	0.00
	Scores	0	0	0	.00	.000	0.00
	Tweets	0	9735	27056	11.35	214.026	39.37
Citations	Citation Indexes	0	1258	17472	7.33	52.962	99.31
	Patent Citations	0	9	12	.01	.188	0.07
	Patent Family Citations	0	47	70	.03	.969	0.40
	Clinical Citations	0	3	39	.02	.164	0.22
	Policy Citations	0	0	0	.00	.000	0.00

Correlation between citations to documents and Usage indicator showed that there was a moderate and positive correlation between them ($r = 0.43$, $P < 0.001$). In addition, a strong and positive correlation was observed between citations to documents and Citations indicator ($r = 0.63$, $P < 0.001$). There was also a moderate and positive correlation between citations and capture ($r = 0.55$, $P < 0.001$) (Table 4).

Table 4. Correlation between altmetric metrics

			Cited by	Usage	Capture	Mention	Social media	Citations
Spearman's Rho	Citations to documents	Correlation Coefficient	1.000	.432**	.553**	.132**	.182**	.637**
		Sig. (2-tailed)		.000	.000	.000	.000	.000
		N		2384	2384	2384	2384	2384
	Usage	Correlation Coefficient		1.000	.663**	.184**	.303**	.632**
		Sig. (2-tailed)			.000	.000	.000	.000
		N			2384	2384	2384	2384
	Capture	Correlation Coefficient			1.000	.176**	.332**	.657**
		Sig. (2-tailed)				.000	.000	.000
		N				2384	2384	2384
	Mention	Correlation Coefficient				1.000	.344**	.160**
		Sig. (2-tailed)					.000	.000
		N					2384	2384
	Social Media	Correlation Coefficient					1.000	.269**
		Sig. (2-tailed)						.000
		N						2384
	Citations	Correlation Coefficient						1.000
		Sig. (2-tailed)						
		N						

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

Examination of the correlation between citations to documents and Usage sub-indices showed that there is a moderate, direct, and significant correlation with Abstract view ($r = 0.43$, $P < 0.001$) and link out ($r = 0.33$, $P < 0.001$). While the correlation between citations to documents and other usage items is weak. The correlation between usages sub-items was also examined that its results are shown in Table 5.

Table 5. Correlation between citations to documents and Usage sub-metrics and internal correlation between Usage sub-metrics

			Cited by	Clicks	Downloads	Views	Library Holdings	Plays	Abstract Views	Collaborators	Full Text Views	Link Outs
Spearman's Rho	Citations to documents	Correlation Coefficient	1.000	.134**	.137**	.060**	.029	.	.438**	.023	.196**	.334**
		Sig. (2-tailed)		.000	.000	.004	.162	.	.000	.267	.000	.000
		N		2384	2384	2384	2384	2384	2384	2384	2384	2384
	Clicks	Correlation Coefficient		1.000	.311**	-.007	-.002	.	.134**	-.004	-.011	.157**
		Sig. (2-tailed)			.000	.721	.921	.	.000	.843	.593	.000
		N			2384	2384	2384	2384	2384	2384	2384	2384
	Downloads	Correlation Coefficient			1.000	.559**	-.003	.	.173**	-.005	.094**	.149**
		Sig. (2-tailed)				.000	.903	.	.000	.807	.000	.000
		N				2384	2384	2384	2384	2384	2384	2384
	Views	Correlation Coefficient				1.000	.278**	.	.091**	-.003	.176**	.037
		Sig. (2-tailed)					.000	.	.000	.882	.000	.070
		N					2384	2384	2384	2384	2384	2384
	Library Holdings	Correlation Coefficient					1.000	.	.037	-.001	.059**	.035
		Sig. (2-tailed)						.	.069	.967	.004	.089
		N						2384	2384	2384	2384	2384
	Plays	Correlation Coefficient							.	.	.	.
		Sig. (2-tailed)							.	.	.	.
		N							2384	2384	2384	2384
	Abstract Views	Correlation Coefficient							1.000	.018	.536**	.755**
		Sig. (2-tailed)								.372	.000	.000
		N								2384	2384	2384
	Collaborators	Correlation Coefficient								1.000	.010	.021
		Sig. (2-tailed)									.630	.311
		N									2384	2384
	Full Text Views	Correlation Coefficient									1.000	.293**
		Sig. (2-tailed)										.000
		N										2384
	Link Outs	Correlation Coefficient										1.000
		Sig. (2-tailed)										
		N										

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

Examination of the correlation between citations to documents and Captures sub-indices showed that there was a moderate, direct, and significant correlation between them ($r = 0.54$, $P < 0.001$) and Exports / Saves ($r = 0.38$, $P < 0.001$). However, the citations to documents was not significant correlated with Bookmarks, Favorites, Followers, Forks, Subscribers and Watchers (Table 6).

Table 6. Correlation between citations to documents and Capture sub-metrics and internal correlation between Capture sub-metrics

			Cited by	Bookmarks	Favorites	Followers	Forks	Readers	Exports/Saves	Subscribers	Watchers
Spearman's Rho	Citations to documents	Correlation Coefficient	1.000	.035	NA	NA	NA	.548**	.387**	.026	.010
		Sig. (2-tailed)		.090	-	-	-	.000	.000	.209	.631
		N		2384	-	-	-	2384	2384	2384	2384
	Bookmarks	Correlation Coefficient		1.000	NA	NA	NA	.029	.042*	.000	.000
		Sig. (2-tailed)			-	-	-	.154	.040	.984	.984
		N			-	-	-	2384	2384	2384	2384
	Favorites	Correlation Coefficient			1.000	NA	NA	NA	NA	NA	NA
		Sig. (2-tailed)				-	-	-	-	-	-
		N				-	-	-	-	-	-
	Followers	Correlation Coefficient				1.000	NA	NA	NA	NA	NA
		Sig. (2-tailed)					-	-	-	-	-
		N					-	-	-	-	-
	Forks	Correlation Coefficient					1.000	NA	NA	NA	NA
		Sig. (2-tailed)						-	-	-	-
		N						-	-	-	-
	Readers	Correlation Coefficient						1.000	.551**	-.027	.032
		Sig. (2-tailed)							.000	.185	.122
		N							2384	2384	2384
	Exports/Saves	Correlation Coefficient							1.000	.045*	-.012
		Sig. (2-tailed)								.027	.558
		N								2384	2384
	Subscribers	Correlation Coefficient								1.000	.000
		Sig. (2-tailed)									.984
		N									2384
	Watchers	Correlation Coefficient									1.000
		Sig. (2-tailed)									
		N									

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

*. Correlation is significant at the 0.05 level (2-tailed).

NA: Not available

Examination of the correlation between citations to documents and Mentions sub-indices showed that there is a weak correlation of less than 0.2 between them. However, there was significant correlations between Blog Mentions with News Mentions ($r = 0.54$, $P < 0.001$) and References ($r = 0.49$, $P < 0.001$) (Table 7).

Table 7. Correlation between citations to documents and Mention sub-metrics and internal correlation between Mention sub-metrics

			Cited by	Blog Mentions	Comments	Forum Topic Count	Gist Count	News Mentions	Q&A Site Mentions	References	Reviews
Spearman's Rho	Citations to documents	Correlation Coefficient	1.000	.136**	.073**	NA	NA	.129**	.035	.170**	.024
		Sig. (2-tailed)		.000	.000	-	-	.000	.084	.000	.241
		N		2384	2384	-	-	2384	2384	2384	2384
	Blog Mentions	Correlation Coefficient		1.000	.272**	NA	NA	.548**	.154**	.496**	.151**
		Sig. (2-tailed)			.000	-	-	.000	.000	.000	.000
		N			2384	-	-	2384	2384	2384	2384
	Comments	Correlation Coefficient			1.000	NA	NA	.208**	-.001	.265**	-.001
		Sig. (2-tailed)				-	-	.000	.963	.000	.963
		N				-	-	2384	2384	2384	2384
	Forum Topic Count	Correlation Coefficient				1.000	NA	NA	NA	NA	NA
		Sig. (2-tailed)					-	-	-	-	-
		N					-	-	-	-	-
	Gist Count	Correlation Coefficient					1.000	NA	NA	NA	NA
		Sig. (2-tailed)						-	-	-	-
		N						-	-	-	-
	News Mentions	Correlation Coefficient						1.000	.118**	.480**	.117**
		Sig. (2-tailed)							.000	.000	.000
		N							2384	2384	2384
	Q&A Site Mentions	Correlation Coefficient							1.000	.150**	.000
		Sig. (2-tailed)								.000	.984
		N								2384	2384
	References	Correlation Coefficient								1.000	-.003
		Sig. (2-tailed)									.890
		N									2384
	Reviews	Correlation Coefficient									1.000
		Sig. (2-tailed)									
		N									

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

NA: Not available

Examination of the correlation between citations to documents and Social media sub-indices showed that there is a weak correlation of less than 0.2 between them. Examination of the correlation between Shares, Likes & Comments with Tweets showed that there is a positive, moderate, and significant correlation. For other social media sub-items, the correlation coefficient was not comparable due to a lack of sufficient data (Table 8).

Table 8. Correlation between citations to documents and Social Media sub-metrics and internal correlation between Social Media sub-metrics

			Cited by	Likes	Shares, Likes & Comments	Ratings	Recommendations	Scores	Tweets
Spearman's Rho	Citations to documents	Correlation Coefficient	1.000	NA	.181**	NA	NA	NA	.165**
		Sig. (2-tailed)		-	.000	-	-	-	.000
		N		-	2384	-	-	-	2384
	Likes	Correlation Coefficient		1.000	NA	NA	NA	NA	NA
		Sig. (2-tailed)			-	-	-	-	-
		N			-	-	-	-	-
	Shares, Likes & Comments	Correlation Coefficient			1.000	NA	NA	NA	.359**
		Sig. (2-tailed)				-	-	-	.000
		N				-	-	-	2384
	Ratings	Correlation Coefficient				1.000	NA	NA	NA
		Sig. (2-tailed)					-	-	-
		N					-	-	-
	Recommendations	Correlation Coefficient					1.000	NA	NA
		Sig. (2-tailed)						-	-
		N						-	-
	Scores	Correlation Coefficient						1.000	NA
		Sig. (2-tailed)							-
		N							-
	Tweets	Correlation Coefficient							1.000
		Sig. (2-tailed)							
		N							
**. Correlation is significant at the 0.01 level (2-tailed).									
NA: Not available									

Examination of the correlation between citations to documents and Citations sub-indices showed that there is a strong correlation between them. ($r = 0.63$, $P < 0.001$). However, citations to documents has a weak correlation with other Citation sub-items (Table 9). Correlations between citation sub-items are shown in Table 9.

Table 9. Correlation between citations to documents and Citations sub-metrics and internal correlation between Citations sub-metrics

			Cited by	Citation Indexes	Patent Citations	Patent Family Citations	Clinical Citations	Policy Citations
Spearman's Rho	Citations to documents	Correlation Coefficient	1.000	.634**	.019	.082**	.159**	NA
		Sig. (2-tailed)		.000	.341	.000	.000	-
		N		2384	2384	2384	2384	-
	Citation Indexes	Correlation Coefficient		1.000	.046*	.088**	.173**	NA
		Sig. (2-tailed)			.023	.000	.000	-
		N			2384	2384	2384	-
	Patent Citations	Correlation Coefficient			1.000	.106**	-.005	NA
		Sig. (2-tailed)				.000	.824	-
		N				2384	2384	-
	Patent Family Citations	Correlation Coefficient				1.000	.072**	NA
		Sig. (2-tailed)					.000	-
		N					2384	-

	Clinical Citations	Correlation Coefficient					1.000	NA
		Sig. (2-tailed)						-
		N						-
	Policy Citations	Correlation Coefficient						1.000
		Sig. (2-tailed)						
		N						
**. Correlation is significant at the 0.01 level (2-tailed).								
*. Correlation is significant at the 0.05 level (2-tailed).								
NA: Not available								

Discussion

This study discusses the correlation of altmetric and scientometric indices. The data show that the usage, capture, social media, citation, and mention indices had the highest counts, respectively. These results are very similar to the research conducted by Saberi and Ekhtiyari (2019). In the mentioned research, highly cited articles in the field of librarianship and information had the highest counts in usage metrics, capture metrics mentions metrics, and social media metrics (Saberi & Ekhtiyari, 2019).

In this study, it was found that there is a significant correlation between the number of citations to scientific products and usage, citations, capture, and there was no significant relationship with social media and mention. Also, there is a significant and positive relationship between the number of citations to scientific products and sub-indices Abstract views, link out, readers, export/saves, and citation indicator. There is a strong, direct, and significant correlation between Abstract view under link out, Readers and exports / saves indices, and between link out and exports/saves. Considering that the mention and social media indicators are indicators based on social networks and interactive media, it can be said that this situation can probably be due to reasons such as unwelcome or lack of awareness of social networks or new platforms in the study population of this research and as the role of altmetric-based social networks or media expands, we will see different results. We see the same situation with the studied sub-indicators. So that none of the social media and mentions sub-indices had a significant relationship with the citation rate. The interpretation of these conditions is similar to the interpretation of the indicators. Another possible reason for this situation could be that because in this study, all scientific products have been reviewed without a time limit and many studies have been published in older years. Older studies at the time of publication were less likely to be present on platforms such as social networks, and many new platforms had not yet emerged. Saberi and Ekhtiyari (2019) have presented a similar situation and interpretation. They also concluded that the correlation between usage, mentions, and social media and Google Scholar Citations could not be verified, which could be due to the publication date of the studies under review (Saberi & Ekhtiyari, 2019). In similar studies, it has been found that a positive significant correlation between article readers and the number of paper citations in CiteULike and article readers and the number of paper citations in Mendeley that is similar to our results (Li & Thelwall, 2012). Also, another study showed that there was positive

significant correlation between Capture metrics and Google Scholar Citations (Saberi & Ekhtiyari, 2019). In other studies It has been found that the number of tweets to articles has a significant and positive relationship with the number of citations (Bornmann, 2014; Eysenbach, 2011; Haustein et al., 2014; Priem & Hemminger, 2010; Thelwall et al., 2013).

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In this study, it was found that there is a significant correlation between the number of citations to scientific products and usage, citations, capture, and there was no significant relationship with social media and mention. In addition, there is a significant and positive relationship between the number of citations to scientific products and sub-indices Abstract views, link out, readers, export/saves, and citation indicator. There is a strong, direct, and significant correlation between Abstract view under link out, Readers and exports / saves indices, and between link out and exports/saves. Of course, considering that the Mention and Social Media indicators are indicators based on social networks and interactive media, it can be said that this situation can probably be due to reasons such as unwelcome or lack of awareness of social networks or new platforms in the study population of this research and as the role of altmetric-based social networks or media expands, we will see different results. We see the same situation with the studied sub-indicators. So that none of the social media and mentions sub-indices had a significant relationship with the citation rate. The interpretation of these conditions is similar to the interpretation of the indicators. Another possible reason for this situation could be that because in this study, all scientific products have been reviewed without a time limit and many studies have been published in older years. Older studies at the time of publication were less likely to be present on platforms such as social networks, and many new platforms had not yet emerged. Saberi and Ekhtiyari (2019) have presented a similar situation and interpretation. They also concluded that the correlation between usage, mentions, and social media and Google Scholar Citations could not be verified, which could be due to the publication date of the studies under review (Saberi & Ekhtiyari, 2019). In similar studies, it has been found that a positive significant correlation between article readers and the number of paper citations in CiteULike and article readers and the number of paper citations in Mendeley that is similar to our results (Li & Thelwall, 2012). Also, another study showed that there was positive significant correlation between Capture metrics and Google Scholar Citations (Saberi & Ekhtiyari, 2019). In other studies, it has been found that the number of tweets to articles has a

significant and positive relationship with the number of citations (Bornmann, 2014; Eysenbach, 2011; Haustein et al., 2014; Priem & Hemminger, 2010; Thelwall et al., 2013).

Conclusion

This study aimed to determine the correlation between altmetric and scientometric indices. The results of this study show that although there is a relationship between web-based altmetric metrics and the number of citations to articles, web-based platforms, especially databases, play a very important role in increasing the visibility and citation of articles. But there are doubts about altmetric indicators based on social networks and interactive media. These conditions are probably due to reasons such as the lack of acceptance of these platforms due to lack of awareness of researchers and in the future and with the expansion of their use and also the passage of time required to increase the number of scientific products published after the arrival of social and interactive networks, we will probably see different results.

Author Contributions

Conceptualization, M.M.; methodology, M.M. and A.R.; software, Z.P and M.A.; validation, M.M., A.R. and M.R.H.; formal analysis, A.R. and M.A.; investigation, M.R.H.; resources, Z.P.; data curation, Z.P. and M.A.; writing—original draft preparation, M.M.; writing—review and editing, A.R.; supervision, M.R.H; project administration, M.M; funding acquisition, M.M. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Not applicable

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Not applicable

Ethical considerations

This research is the result of a research project with ethics code IR.GOUMS.REC.1399.409 which has been done in Golestan University of Medical Sciences in Iran. The authors avoided from data fabrication and falsification.

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Conflict of interest

The authors declare no conflict of interest

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