The online attention to certain nuclear medicine topics: An altmetrics study vs. a citation analysis

Original Article

Shohreh Seyyedhosseini[1], Abdolrasoul Khosravi[1], Majid Assadi[2], Narges Jokar[2], Reza Basirian Jahromi[1]

[1]Department of Medical library and Information Science, Bushehr University of Medical Sciences, Bushehr, Iran
[2]Department of Molecular Imaging and Radionuclide Therapy, The Persian Gulf Nuclear Medicine Research Center, Bushehr Medical University Hospital, School of Medicine, Bushehr University of Medical Sciences, Bushehr, Iran

(Received 28 November 2020, Revised 8 February 2021, Accepted 15 February 2021)

ABSTRACT

Introduction: Traditional citation analysis has been greatly criticized because the process of citation accumulation requires considerable time after publication. So, the term "altmetrics" was proposed in 2010 to measure the scientific and social impact of a paper. We performed a search for certain nuclear medicine topics using the altmetrics approach to report the correlation between the altmetrics index and the number of citations.

Methods: In this descriptive-analytical study, we retrieved the articles entitled with a few nuclear medicine keywords that published from 2010 to 2019 in the Web of Science (WoS). The number of 730 original papers included in this study. Altmetrics data were derived via an altmetrics bookmarklet. Statistical analysis was performed to measure the correlation between the altmetrics score and the citation count of nuclear medicine papers.

Results: Mendeley and Twitter had the highest score of attention on social media platforms. Demographic information revealed that the most number of tweets and Mendeley's attention in nuclear medicine belonged to the United States (US). Moreover, researchers had the highest rate of shares in Mendeley. The correlation between the altmetrics score and citation index was significant ($p < 0.05$).

Conclusion: The authors have to pay more attention to social activities on the web for wide dissemination and proper evaluation of their scientific publications.

Key words: Nuclear medicine; Altmetrics; Social media; Citation; Bookmarklet

Iran J Nucl Med 2021;29(2):65-72
Published: July, 2021
http://irjnm.tums.ac.ir

Corresponding author: Reza Basirian Jahromi, Department of Medical library and Information Science, Bushehr University of Medical Sciences, Salaman Farsi Blvd, Bushehr, Iran. E-mail: rezabsrn@gmail.com

INTRODUCTION

In today's sophisticated and competitive world, researchers and scholars have widely disseminated their studies and discoveries by publishing in books and journals to meet the requirement and improve scientific knowledge in various fields [1]. The assessment of research articles is measured through the number of times it has been cited [2].

The development of the Internet and social media has significantly increased the rapidity of dissemination of scientific publications among different groups of audiences or readers [3]. Traditional citation analysis has been greatly criticized due to long time which it takes to determine the impact of an article among scholars of the specific field. Therefore, the term "altmetrics" has served as an alternative to article-level metrics. This parameter was proposed in 2010 to measure the extent of the scientific and social impact of published articles [4]. According to the definitions, altmetrics are metrics and quantitative data giving us quite an information about how often the journal articles and other scholarly outputs like datasets are discussed and used around the world. Altmetrics include sharing online tools (Twitter, Topsy, Facebook, Reddit, News articles, Blog posts, Google+, YouTube, Figshare, Mendeley), adaptations (Github), scholarly social networks (ResearchGate or Academia), online reference managers (CiteULike, Zotero, and Mendeley), save tools (Mendeley, CiteULike, Delicious, Github, Twitter, Slideshare), reviews (Faculty of 1000, blog posts, article comments, Facebook comments), conference organization sites (Lanyrd.com), and social usage statistics (Figshare, Slideshare, Dryad, Facebook, Youtube) [5, 6]. The altmetrics score is widely applied by the research community to measure the scientific and social impact of individual articles [4].

In every scientific field, researchers should be aware of the social impact of their scholarly products as well as the professional impact. Nuclear medicine, as an academic discipline, has a significant role in the diagnosis and treatment of diseases. Because of the importance of nuclear medicine studies in the patient care process, it becomes a necessity for the researchers to know more about their publication's effectiveness on social media alongside the rate of attention to them in scientific databases. According this study aimed to perform a comprehensive investigation of nuclear medicine publications using the altmetrics approach to report data related to nuclear medicine publication. Finally, we measured the correlation between the altmetrics index of published articles by nuclear medicine scholars in the Web of Science database (one of the most significant products of Clarivate Analytics) during 2010-2019 and the number of traditional bibliometric citations of these articles. So, this study has two primary purposes:

1. To study the status of the original articles in nuclear medicine on social media using an altmetrics approach; and

2. To assess the correlation between the altmetrics attention score of the original papers in nuclear medicine and the number of citations they received.

METHODS

Data collection

In this descriptive-analytical study, on February 12, 2020, we retrieved the articles discussing certain nuclear medicine topics published 2010 to 2019 using search terms: "Nuclear radiology" OR "Positron emission tomography" OR "PET" OR "Single-photon emission computed tomography" OR "SPECT" OR "nuclear medicine" OR "radionuclide imaging" OR "radioisotope scanning" OR "scintigraphy" OR "gamma camera imaging".

The keywords were input in a title field that refers to the title of a journal article, proceedings paper, book, or book chapter. But in this research, just the title of a journal article, original articles, was chosen to include in the study. These keywords were selected via consultation nuclear medicine specialist. They were the most frequently used words to search for topics related to nuclear medicine. This data extracted from the "Web of Science" database. The Web of Science database was selected because it allows access to multiple databases of cross-disciplinary research, as well it offers the number of article citations. In order to remove duplicate articles in this database, all of the results were entered into endnote software and the section for deleting duplicate items was activated. Accordingly, a total of 3823 articles were retrieved from the Web of Science database, of which 3,575 articles were selected after deleting duplicate articles. All of 3,575 articles related to nuclear medicine indexed in the Web of Science database validated with the article's identifiers including digital object identifier (DOI) or PubMed ID. Then, altmetrics data were derived via altmetrics bookmarklet (Altmetric.com), a quick and easy to understand tool that describes the frequency of attention and specify social media sources.

The altmetric database monitors the following sources for mentions of research outputs to bring the audience the most relevant and up to date picture of the online activity and discussion: public policy documents, mainstream media, online reference managers, post-publication peer-review platforms, Wikipedia, open syllabus projects, patents, blogs, research highlights, social media (including Facebook, Twitter, Linkedin, Google+, Sin Weibo, and Pinterest), multimedia and other online platforms (including YouTube, Reddit, Q & A).

Today the altmetric database contains 60 million mentions of over 9 million research outputs (including journal articles, datasets, images, white papers, reports, and more), and is permanently growing.

All results were examined and verified, and if there was a discrepancy, a consensus decision was achieved following reading the full text of articles. The information on altmetrics donuts was written in detail. Along with, the citations counts were also extracted from the Web of Science (WOS) database. The most common sources of social media platforms, as well as the geographic breakdown of the countries with the number of tweets and Mendeley related to nuclear medicine, was extracted.

Statistical analysis

Continuous variables are reported as mean ± SD. The normality of continuous variables was evaluated using the Kolmogorov-Smirnov test. Spearman's correlation analysis was applied to investigate the relationship between the number of citations and the altmetrics score. A P-value<0.05 was measured statistically significant. The data were analyzed using SPSS software.

RESULTS

Search output

The search keywords, after deleting duplicating items, yielded a total of 3,575 outputs that as shown in Figure 1, of which, 1,329 articles (37%) lacked DOI and PMID, so making them impossible to examine using the altmetrics explorer. Among the DOI articles, only 730 articles (21%) were mentioned on social media and subsequently had altmetrics score, while 1,516 articles (42%) were not mentioned on any of the social networks. So, 730 articles with paired altmetrics and citation data included in this study.

According to Table 1, the number of articles with altmetrics score was 725, of which 17 articles in 2010, 32 articles in 2011, 59 Articles in 2012, 74 articles in 2013, 63 articles in 2014, 102 articles in 2015, 101 articles in 2016, 91 articles in 2017, 100 articles in 2018, and finally 86 articles in 2019. The number of nuclear medicine articles on social networks has increased from 2010 to 2015 and fluctuated between 2016 and 2019. The average per year of altmetrics score was 2.86±SD.

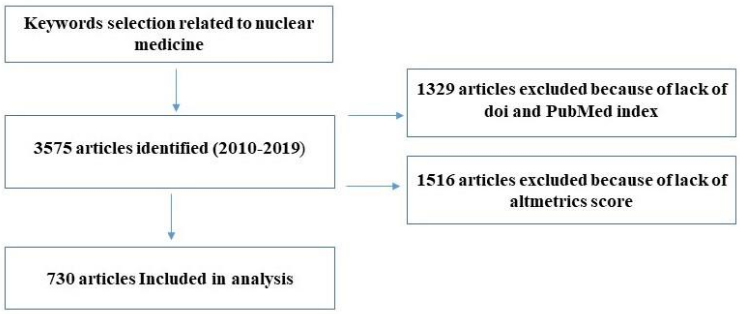

Fig 1. The process of data gathering.

Table 1: The demographic characteristics of nuclear medicine articles with altmetrics scores between 2010-2019

Year	Number of articles	Number of articles with the altmetrics score	Sum of the altmetrics score (mean)
2010	273	17	53 (3.12)
2011	318	32	122 (3.81)
2012	318	59	86 (1.46)
2013	330	74	164 (2.22)
2014	337	63	116 (1.84)
2015	393	102	212 (2.08)
2016	395	99	365(3.69)
2017	401	91	265 (2.91)
2018	405	100	458 (4.58)
2019	405	86	257 (2.99)

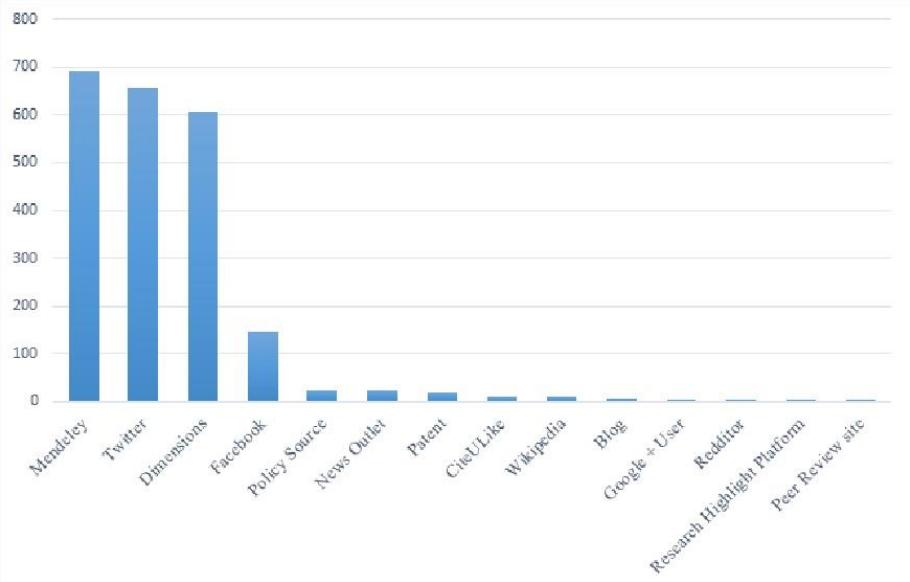

Fig 2. The number of altmetrics data resources for nuclear medicine articles on social network platforms.

Analysis of altmetrics status on social networks platform

The number of altmetrics data resources for nuclear medicine articles is shown in Figure 2. Mendeley and Twitter were prominent sources of attention on social media platforms. For Twitter, 657 (90.62%) articles were shared 1,760 times, with a total of 2,443,690,675 followers. The highest attention score on different social media platforms belonged to Dimensions with 604 articles (83.31%), and 8435 sharing; Facebook with 147 articles (20.88%), and 162 sharing; Policy source with 25 articles (3.45%), and 25 sharing, accordingly.

The breakdown of countries with tweets related to nuclear medicine

Considering geolocation distribution of tweets using the altmetrics bookmarklet and based on the information in the sender's profile and geotagged tweets the highest percentage (25.18%) of tweets attention in the nuclear medicine fields are originated the United States (U.S) (n=425). The subsequent countries were the United Kingdom 7.11% (n=120), Australia (n=30) 1.77%, and Saudi Arabia with 1.72% (n=29). Also, in 52.43% of tweets, due to incomplete information on the sender's profile, it was not possible to identify the geographical location of the tweets. The geotagging is used rarely due to not being a default setting. The demographic breakdown of the top countries with the number of tweets related to nuclear is shown in Table 2.

Moreover, 76% of all tweets were carried out by ordinary people (members of the public), practitioners (doctors, other healthcare professionals) by 7.69%, scientists by 8.04%, and science communicators (journalists, bloggers, editors) by 8.27%.

Therefore, member of the public has the largest contribution for tweets of nuclear medicine articles.

Table 2: Demographic breakdown of the top countries based on number of tweets related to nuclear medicine.

Country	Total of tweets (%)
US	425 (25.18)
UK	120 (7.11)
Australia	30 (1.77)
Saudi Arabia	29 (1.72)
Spain	24 (1.42)
Canada France	15 (0.89)
Germany	11 (0.65)
Switzerland	8 (0.47)
India Brazil Netherland	7 (0.41)
Argentina Portugal Turkey	6 (0.35)
Other	15 (0.89)
Unknown	885 (52.43)

Geographic and demographic distribution of nuclear medicine articles in Mendeley

The demographic breakdown of the top ten countries with the number of referral articles related to nuclear medicine in Mendeley is shown in Table 3.

Table 3: Geographic breakdown of the number of reads related to nuclear medicine in Mendeley

Country	Number of reads (%)
US	54 (0.50)
Spain	39 (0.36)
Brazil	34 (0.31)
UK	28 (0.26)
Japan	14 (0.12)
Italy India Denmark	10 (0.09)
Switzerland Australia	9 (0.08)
Canada Korea, Republic of	8 (0.07)
Sweden	6 (0.06)
Portugal South Africa	5 (0.05)
Other Unknown	10 (0.1) 10489 (97.23)

Similar to Twitter, the highest percentage of citations by nuclear medicine researchers was originated from the US (n=54). The next, Spain, Brazil, and the United Kingdom were 0.36%, 0.31%, and 0.26 %, respectively.

Also, due to the incomplete profile information of the referrals, in about 97.23% of the references in the nuclear medicine articles it was not possible to locate the geographical location.

The findings of Table 4 show that a total of 16.57% of all referrals are from nuclear medicine researchers in Mendeley.

Table 4: Demographic breakdown of the reader of nuclear medicine articles in Mendeley.

Rank	Readers by professional status	Number of readers (%)
1	Researcher	1851 (16.57)
2	Ph.D. Student	1655 (14.82)
3	Master Student	1557 (13.94)
4	Bachelor Student	1177 (10.54)
5	Postgraduate Student	503 (4.50)
6	Doctoral Student	459 (4.11)
7	Associate Professor	361 (3.23)
8	Professor	265 (2.37)
9	Lecture	83 (0.74)
10	Librarian	77 (0.69)
11	Senior Lecture	35 (0.31)
12	Unknown/Unspecified/Other	3147 (28.18)

Therefore, researchers have the largest share in the citation of articles in Mendeley. Ph.D. Student is next with 14.82 percent, master Student with 13.94 percent, and bachelor Student with 10.54 percent, were next category in terms of the number of citations to nuclear medicine articles in Mendeley. Also, in 28.18% of Mendelian referrals, it was not possible to identify the role of referrals due to incomplete profile information of the sender.

The thematic analysis based on referral to the nuclear medicine articles in Mendeley

The thematic analysis was applied to specify what the most filed referred to the articles related to nuclear medicine in Mendeley library. As shown in Table 5, a total of 47.62% of the referral to the nuclear medicine articles in Mendeley related to the medical & dentistry field. The next field was included agricultural & biological science with 4.24 %, engineering with 3.83%, nursing & health professions with 3.64 %. Additionally, 21.58% of Mendeley's referrals, due to incomplete profile information of the sender, was not possible to identify the thematic areas of the referrals.

Altmetrics versus conventional citation correlation

In order to measure the correlation between the altmetrics score and the citation count of nuclear medicine articles, the Kolmogorov-Smirnov test was performed. The value of z calculated in the Kolmogorov – Smirnov test is not significant for the altmetrics score and citation Index ($P>0.05$). Therefore, non-parametric analysis (Spearman correlation coefficient) was used to measure the correlation between these two variables.

The correlation coefficient between the altmetrics score and citation index was significant ($R=0.43$, $P<0.05$).

DISCUSSION

There are progressing research studies on altmetrics assessment and its impact on scholarly material. Nuclear medicine and molecular imaging groups have focused on the development and evaluation of multimodality imaging probes for improving diagnostic and therapeutic Methods in Medical Fields. Nowadays, the availability of scholars and publications has become a matter of necessity for nuclear medicine researchers as a result of dramatically increasing publications and significant innovations in this field.

This study is one of the first altmetrics analyses of articles related to the nuclear medicine field so far. In one of the studies, Baek et al. collected the maximum number of citations and the highest altmetrics score of articles related to nuclear medicine [7].

Table 5: The thematic analysis based on a referral to the nuclear medicine articles in Mendeley.

Rank	Readers by discipline	Number of readers (%)	Rank	Readers by discipline	Number of readers (%)
1	Medical & dentistry	5947(47.62)	15	Material Sci.	49(0.39)
2	Agricultural & Biological Sci.	529(4.24)	16	Chemical Engineering	45(0.36)
3	Engineering	478(3.83)	17	Environmental Sci.	44(0.35)
4	Nursing & Health Professions	455(3.64)	18	Arts and Humanities	36(0.29)
5	Physics & Astronomy	376(3.01)	19	Sports & Recreations	34(0.27)
6	Psychology	366(2.93)	20	Business, Management & Accounting	27(0.22)
7	Chemistry	304(2.43)	21	Economics, Econometrics & Finance	23(0.18)
8	Neurosciences	242(1.94)		Mathematics	17(0.14)
9	Biochemistry, Genetics & Molecular Biology	236(1.89)	22	Earth & Planetary Sci.	17(0.14)
10	Computer Sci.	161(1.29)	23	Energy	6(0.05)
11	Social Sci.	156(1.25)		Decision Sci.	3(0.025)
12	Pharmacology, Toxicology & Pharmaceutical Sci.	127(1.02)	24	Design	3(0.025)
13	Veterinary Sci. & Veterinary Medicine	58(0.46)	25	Linguistics	2(0.015)
				Philosophy	2(0.015)
14	Immunology and Microbiology	50(0.40)	26	Unknown/Unspecified/Other	2695(21.58)

They concluded that citation numbers and altmetrics scores demonstrated special guidance to assess the impact of nuclear medicine investigations. Although, according to Baek et al., there was no overlap between the top 50 most-cited articles and the top 50 altmetric articles. Furthermore, Kim et al. measured the altmetrics attention score (AAS) for the top 100 papers in the field of neuroimaging [8]. Their findings indicated that the AAS for the population was in the range of 145–1467. The majority of articles were original articles that originated from the United States. But in this study, we collected and characterized published articles associated with nuclear medicine in the Web of Science database from 2010 to 2019. The lack of adequate journals' attention, especially in developing countries, to receive and allocate digital object markers for scholarly articles cause inaccessibility to all articles. Furthermore, only 21% of nuclear medicine publications have altmetrics scores. This document shows that scientific communities are unaware of either how to use social media or how important it is to share their articles on social networks.

Another impressive point is that authors cannot translate their knowledge, expressing specific science in simple and understandable language, to the general public. Consequently, they have not efficient scientific profiles on social networks.

A review of the previous studies demonstrated that Twitter and Mendeley are the most widely used and more popular than others. It is likely related to the m popularity and acceptance of these two social networks among scholars. Therefore, tweets can estimate highly cited articles, especially within the earliest days of publication. Social media could lead to an increase in the visibility of the papers, and consequently, improve the citations received by the articles [9].

Moreover, the number of nuclear medicine articles with the altmetrics index from 2010 to 2019 indicated

an improvement in the acceptance rate and application of social networks.

The evaluation of the geological distribution of the tweet of the nuclear medicine era showed that the majority of tweets (25.18%) in this field originated in the United States. This result is compatible with previous studies in many fields of studies, including medicine, nursing, and radiology that got the most attention on Twitter originated in the USA and the UK. The extend of the scientific community, availability of funds for research, and perhaps the more tendency to widely disseminate their findings lead to account for the high proportion of scientific publications arising in the USA [7, 9-11].

Researchers, Ph.D., and MS students have had a prominent and outstanding contribution to referred articles by Mendeley, an academic bibliographical tool. This may be attributed to the students' interest in reviewing and sharing scientific papers in the nuclear medicine field [12-14].

According to the results of the statistical analysis, there was a substantial relationship between the altmetrics score and the average number of citations for nuclear medicine articles. Some previous research has reported a considerable statistical relationship between altmetrics scores and the higher number of citations [12, 15-18]. Remembering the fact that the determination of citations for articles takes time to have an influence on the assessment of studies. It is proposed that researchers and authors pay more attention to sharing their findings by altmetrics tools including the social web. Immediate and easy accessibility of altmetrics makes us evaluate the social impact of academic research readily.

Therefore, social media have positive effects on introducing, communicating, and collaboration between researchers and other enthusiasts for acquiring information in a particular field, as well as the evaluation of their scientific products. The publication of research papers in the social web environment improves the visibility of these documents and exposes them to a wider audience, and subsequently augments the number of citations for the articles effectively in the future. Additionally, this approach will increase the impact factor of relevant journals. Future altmetrics studies in nuclear medicine should identify any correlation between high journal impact factor and citation counts with altmetrics scores.

This study has some potential limitations. First, we limited our analysis to articles published in nuclear medicine in the title box of WoS. So, some highly influential papers that were originally indexed in the other citation databases, such as Scopus, may have been excluded from our list. Second, we used only data supplied by Altmetric.com for assessing the papers. Other tools such as PlumX, Crossref Event Data, Article-Level Metrics-PLoS provide alternative metrics that use different online sources and algorithms, which may offer different results.

Limitations

Several inherent limitations of our research should be mentioned: (1) we only searched WOS with some keywords only in the title of the journal articles. So, we may have missed some articles on nuclear medicine by this approach; (2) the authors only evaluated articles with altmetric hits. Thus, papers without altmetrics scores, were not included in the study warring better comprehensive designed work in the future.

CONCLUSION

We can conclude that there is a positive correlation between the altmetrics index and the high number of citations in the articles related to the nuclear medicine field. Therefore, the authors have to pay more attention to social activities (such as creating and updating their profiles on social media) for wider dissemination and proper evaluation of their scientific publications.

REFERENCES

1. Willinsky J, Principle A. The Access principle: The case for open access to research and scholarship. Cambridge, MA: MIT Press; 2006.
2. Eyre-Walker A, Stoletzki N. The assessment of science: the relative merits of post-publication review, the impact factor, and the number of citations. PLoS Biol. 2013;11:e1001675.
3. Trueger NS, Thoma B, Hsu CH, Sullivan D, Peters L, Lin M. The altmetric score: a new measure for article-level dissemination and impact. Ann Emerg Med. 2015 Nov;66(5):549-53.
4. Citrome L. Moving forward with article level metrics: introducing altmetrics. Int J Clin Pract. 2015; 69:811-21.
5. Priem J, Groth P, Taraborelli D. The altmetrics collection. PLoS One. 2012; 7(11):e48753.
6. Konkiel S. Altmetrics: A 21st century solution to determining research quality. Online Searcher 2013;37(4).
7. Baek S, Yoon DY, Lim KJ, Hong JH, Moon JY, Seo YL, Yun EJ. Top-cited articles versus top Altmetric articles in nuclear medicine: a comparative bibliometric analysis. Acta Radiol. 2020 Oct;61(10):1343-1349.
8. Kim ES, Yoon DY, Kim HJ, Lee K, Kim Y, Bae JS, Lee JH. The most mentioned neuroimaging articles in online media: a bibliometric analysis of the top 100 articles with the highest Altmetric Attention Scores. Acta Radiol. 2019 Dec;60(12):1680-1686.
9. Eysenbach G. Can tweets predict citations? Metrics of social impact based on Twitter and correlation with traditional metrics of scientific impact. JMIR Bioinform Biotech. 2011;13:e12.

10. Kelly JC, Glynn RW, O'Briain DE, Felle P, McCabe JP. The 100 classic papers of orthopaedic surgery: a bibliometric analysis. J Bone Joint Surg Br. 2010 Oct;92(10):1338-43.

11. Yoon DY, Yun EJ, Ku YJ, Baek S, Lim KJ, Seo YL, Yie M. Citation classics in radiology journals: the 100 top-cited articles, 1945–2012. AJR Am J Roentgenol. 2013 Sep;201(3):471-81.

12. Delli K, Livas C, Spijkervet FK, Vissink A. Measuring the social impact of dental research: An insight into the most influential articles on the Web. Oral Dis. 2017 Nov;23(8):1155-1161.

13. Syamili C, Rekha RV. Do altmetric correlate with citation?: A study based on PLOS ONE journal. COLLNET J Scientometr Inform Manag. 2017;11:103-17.

14. Haustein S, Larivière V, Thelwall M, Amyot D, Peters I. Tweets vs. Mendeley readers: How do these two social media metrics differ? Inform Technol. 2014;56(5):207-215.

15. Thelwall M. Early Mendeley readers correlate with later citation counts. Scientometrics. 2018;115:1231-40.

16. Waltman L, Costas R. F1000 Recommendations as a potential new data source for research evaluation: A comparison with citations. J Assoc Inf Sci Technol. 2014;65:433-45.

17. Thelwall M, Haustein S, Larivière V, Sugimoto CR. Do altmetrics work? Twitter and ten other social web services. PLoS One. 2013; 8:e64841.

18. Maggio LA, Leroux TC, Meyer HS, Artino Jr AR. MedEd: exploring the relationship between altmetrics and traditional measures of dissemination in health professions education. Perspect Med Educ. 2018 Aug;7(4):239-247.