

Analysis of the Status of Articles Indexed in the Field of Infertility Treatment Published by Iranian Scholars: A Citation Analysis Approach versus Altmetrics Indicators

Shohreh SeyyedHosseini

Ph.D, Knowledge and Information Science,
Department of Medical Library and
Information Science, Bushehr University of
Medical Sciences, Bushehr, Iran.

s.seyyedhosseini@bpums.ac.ir

tanin64@gmail.com

ORCID iD:

<https://orcid.org/0000-0002-9281-7936>

Mahdieh Shahneh

BSc, Medical Library and Information Science,
Department of Medical Library and Information
Science, Student Research and Technology
Committee, Bushehr University of Medical
Sciences, Bushehr, Iran.

m.shahneh@bpums.ac.ir

shehnehmahdieh@gmail.com

ORCID iD: <https://orcid.org/0009-0004-7667-6864>

Arezoo Abjameh

BSc, Medical Library and Information Science,
Department of Medical Library and
Information Science, Student Research and
Technology Committee, Bushehr University of
Medical Sciences, Bushehr, Iran.

a.abjameh@bpums.ac.ir

arezooabjameh@gmail.com

ORCID iD:

<https://orcid.org/0009-0003-5723-430x>

Reza BasirianJahromi

Associate Prof., Knowledge and Information
Science, Department of Medical Library and
Information Science, Bushehr University of
Medical Sciences, Bushehr, Iran.

Corresponding Author: r.bairiyan@bpums.ac.ir

rezabj@gmail.com

ORCID iD:

<https://orcid.org/0000-0002-8170-5728>

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Abstract

The current study examines the status of scientific outputs on infertility treatment indexed in PubMed and evaluates these outputs on social media using altmetric indicators from 2015 to 2024. This research was conducted using a descriptive-analytical approach. To assess the status of scientific articles on infertility treatment using citation analysis, articles indexed in PubMed from 2015 to 2024 were collected, and their citation counts on Google Scholar were extracted. Subsequently, the effectiveness of these articles in social networks was considered using the altmetrics approach. In this section, the attention given to the papers was measured using the Altmetrics Bookmarklet. Finally, the data were analyzed using SPSS software. Of 1,204 articles retrieved from the PubMed database, 493 documents (42%) were mentioned in social media. During this period, attention to these articles has grown, with fluctuations, averaging 21.24 citations per article. Additionally, in the referenced articles by Iranian researchers, Mendeley accounted for the largest share with 482 articles (77.97%). Master's students had the highest share of referencing articles on Mendeley (38.10%). The United States accounted for 31.7% of the tweets related to articles by Iranian researchers, holding the largest share of retweets on platform X. The subject areas of medicine had the highest share of references on Mendeley at 18.3%. Furthermore, the correlation coefficient between the citation index and the Altmetric score was 0.27 and significant ($P < 0.05$).

Considering the positive role of social media in increasing the visibility and citation of scientific articles in the infertility treatment, showed that less than half of the articles by Iranian scholars in the infertility treatment have received attention on social media, it can be concluded that it is essential for researchers, academic institutions, and organizations supporting researchers to actively engage on various social media platforms to enhance the visibility of their publications and, consequently, increase the citation of these resources.

Keywords: Infertility, PubMed, Altmetric, Mendeley, X, citation analysis, Articles, Iranian Scholars.

Introduction

Today, researchers are increasingly seeking to publish their scientific outputs for public access and for those who genuinely need information (Willinsky, 2006). One of the most common types of scientific outputs is the article, which is generally evaluated by citations from other researchers (BasirianJahromi, Arfaenia, Seyyed Hosseini, Torabi, Sangari & Khosravi, 2022). Many governmental and non-governmental organizations extensively use citation analysis to assess scientific findings and inform decisions about professional advancement (Azer & Azer, 2019). However, there is no doubt that the use of citation analysis in conventional ways has its limitations; among these is that analyzing citation data is very time-consuming and slow. Additionally, citation analyses are limited to measuring the impact of publications from the author's perspective. In other words, citation metrics are more suitable for evaluating theoretical publications than for applied research by researchers (Khosravi, BasirianJahromi, Amouri & SeyyedHosseini, 2019).

Advancements in information and communication technology, particularly the expansion of the Internet and social media, have significantly accelerated the dissemination of science to diverse audiences (Trueger, Thoma, Hsu, Sullivan, Peters & Lin, 2015). The limitations of citation analysis led to the introduction of a new term in 2010: altmetrics, or alternative metrics. This term is used to assess the articles' social and scientific impact regardless of the number of citations they receive. Altmetrics also evaluate and measure scientific results based on overall performance in online tools and related fields (BasirianJahromi et al, 2022). These tools include online sharing platforms (X, Facebook, Reddit, news articles, Google Plus, blog posts, YouTube, Mendeley), academic social networks (ResearchGate), online citation management (CiteULike, Zotero, and Mendeley), storage tools (Mendeley, CiteULike, and X), comments, blog posts, published comments on articles, Facebook comments, conference organization websites, and social usage statistics (Facebook and YouTube). The altmetrics score indicates the volume of reactions or feedback an article receives from public and scientific domains (SeyyedHosseini & BasirianJahromi, 2021).

In summary, altmetrics and bibliometrics are both methods for measuring the impact and reach of academic research, but they differ in their focus and the types of data they analyze. Bibliometrics refers to the quantitative analysis of academic literature, primarily using traditional metrics such as citation counts, impact factors, and the h-index to assess the influence and reach of publications over time within scholarly databases. It relies heavily on established citation indexes and is typically used to evaluate the performance of researchers, journals, or institutions. Altmetrics, on the other hand, encompass a broader range of metrics that include non-traditional indicators of research impact. It looks at online engagements such as social media shares, blog posts, news mentions, and downloads from platforms like ResearchGate or

institutional repositories. Altmetrics aim to capture immediate impact and public engagement beyond the academic community, reflecting how research influences various audiences and conversations in real-time.

One of the significant areas of concern for health policymakers, where monitoring scientific outputs can significantly aid in planning and developing a roadmap for community health, is infertility. Infertility is recognized as the inability to conceive (Akhondi et al, 2013). If a woman has not become pregnant after one year of regular sexual intercourse without contraception, the couple may be considered infertile.¹ Treating infertility is a stressful process that often impacts the mental and social well-being of women. This process affects their psychological state and influences their success in parenting (Hamzehgardeshi, Elyasi, Moosazadeh, Ahmadi, Ahmadian & Ansari, 2021). Over the past three decades, significant advancements in medical science have led to improvements in infertility treatment. These remarkable advancements have also resulted in a reduction in sexually transmitted diseases and an increase in overall public health (Zarinara, Zeraati, Kamali, Mohammad, Shahnazari & Akhondi, 2016).

On the other hand, infertility has a profound impact on the emotional, psychological, economic, and social issues faced by individuals and families. This issue is so stressful that it ranks fourth among stressors, following the death of a mother, the death of a father, and spousal infidelity (Hossein Rashidi, Malek Afzali, Haqullahi, Abedini & Eslami, 2017). Consequently, examining scientific outputs in infertility treatment, with an emphasis on articles on social networks, alongside assessing the effectiveness of these publications in scientific databases, is important for specialists in this field and the general public.

Therefore, the present study aims to utilize altmetric data to report the relationship of altmetric indicators in the articles of Iranian researchers in the field of infertility treatment from 2014 to 2023 in the PubMed database, along with their traditional bibliometric citation counts, to provide insights into the altmetric method as an impact indicator of research compared to traditional citation metrics, especially in specialized fields like infertility treatment. Understanding this relationship may help researchers and academic institutions assess the effectiveness of their work in reaching and influencing academic and public audiences. Additionally, this study, focusing on Iranian researchers, aims to clarify regional trends in infertility treatment research and its publication, contributing to the global discourse on reproductive health.

Materials and Methods

This research is applied and descriptive-analytical, using bibliometric methods and the Altmetrics Bookmarklet tool. The Altmetrics Bookmarklet was employed to assess the effectiveness of articles on infertility treatment, given their credibility and significance. The extensive use of previous altmetrics research in this field suggests the importance and credibility of this tool. The study measured downloads, attention, and mentions of the examined articles on various online platforms, including social media, news media, and blogs. The Altmetrics Bookmarklet collects data on the journal article score by tracking posts, tweets, and other online activities related to the research articles, and provides a score based on the information gathered from these sources. The Altmetric bookmarklet is a powerful tool for researchers, institutions, and other stakeholders to understand and communicate the impact of research in the contemporary digital landscape. It has several advantages, including enhanced visibility, broad research insights, a user-friendly interface, comprehensive coverage, and real-time tracking.

The research population comprised scientific articles on infertility treatment indexed in PubMed from 2015 to 2024, and the database was used to gather data due to its significance in the medical field. To gather data, the PubMed database was used due to its importance among researchers in the medical field. In consultation with specialists in obstetrics and gynecology and after reviewing scientific articles in this field, commonly used keywords related to infertility treatment were identified. The following search strategy was used in PubMed on January 1, 2025.

((Childlessness[Title/Abstract] OR Barrenness [Title/Abstract] OR "Reduced fertility"[Title/Abstract] OR "Impaired fecundity"[Title/Abstract] OR "Reproductive dysfunction"[Title/Abstract] OR "Reproductive Sterility"[Title/Abstract] OR Sterility [Title/Abstract] OR "Sub Fertility"[Title/Abstract] OR Subfertility[Title/Abstract] OR infertility[Title/Abstract]) AND (Treatment*[Title/Abstract] OR therap*[Title/Abstract] OR remed*[Title/Abstract] OR cure[Title/Abstract] OR therapeutic[Title/Abstract] OR treat*[Title/Abstract])) AND (Iran[Affiliation])

Using this search strategy, 1,172 articles by Iranian researchers on infertility treatment were retrieved from PubMed. Each article was retrieved and examined using the "altmetric it" plugin, which was previously installed to view its details. Additionally, citation counts for articles in this field were extracted from the Google Scholar citation search engine, as this database indexes many Persian-language journals that may have cited the articles mentioned. Finally, the data obtained were analyzed using SPSS version 26. Correlation between the Altmetric scores of the articles and their citation counts was assessed using the Kolmogorov-Smirnov test; because the data were non-normal, the Spearman correlation test was used.

Results

The level of attention to Iranian researchers' articles in the field of infertility treatment on social networks

The results of the examination of attention to Iranian researchers' articles on social networks in the field of infertility treatment are illustrated in Figure 1.

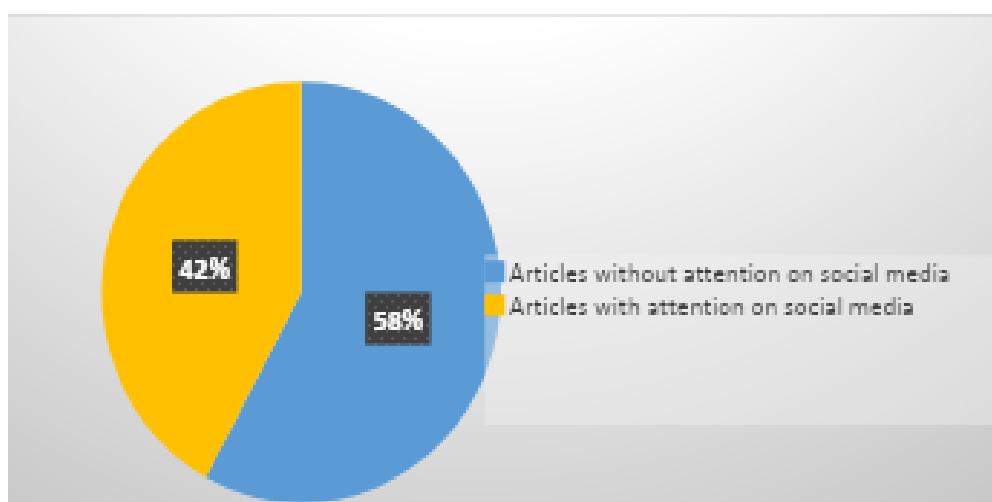


Figure 1: Iranian articles with/without attention on social media in the field of infertility treatment

As Figure 1 shows, of 1,204 articles by Iranian researchers on infertility treatment retrieved from the PubMed database, 493 (42 percent) were mentioned on social networks. While 679

articles (58 percent) were not mentioned on social networks.

According to Table 1, an analysis of Iranian researchers' articles on infertility treatment on social media from 2015 to 2024 shows that the total number of articles with an Altmetric score is 493. Among these, 29 articles are from 2015, 29 from 2016, 40 from 2017, 37 from 2018, 45 from 2019, 46 from 2020, 54 from 2021, 66 from 2022, 80 from 2023, and 67 from 2024. The average citation count for articles during the years 2015 to 2024 is 21.24, with an average of 52.36 citations for 2015, 36.10 for 2016, 30.41 for 2017, 43.98 for 2018, 33.43 for 2019, 34.45 for 2020, 26.18 for 2021, 19.71 for 2022, 8.66 for 2023, and finally, 3.71 for 2024. Additionally, according to the statistics presented in Table 1, the number of articles by Iranian researchers on infertility treatment on social media has increased from 2015 to 2024, although it has also fluctuated. The average Altmetric score for each year was 7.69, with 17 for 2015, 2.93 for 2016, 4.10 for 2017, 5.70 for 2018, 15.02 for 2019, 10.15 for 2020, 4.94 for 2021, 8.95 for 2022, 4.03 for 2023, and 7.70 for 2024.

Table 1

Status of the Iranian articles during 2015-2024 based on citations, and altmetrics score in the field of infertility treatment

Year	Number of articles	Sum of citations	Average of citations	Articles with altmetrics	Total altmetrics	Average of the altmetrics score
2015	69	3613	52.36	29	493	17
2016	62	2238	36.10	29	85	2.93
2017	75	2281	30.41	40	164	4.10
2018	91	4002	43.98	37	211	5.70
2019	103	3443	33.43	45	676	15.02
2020	109	3755	34.45	46	467	10.15
2021	142	3717	26.18	54	267	4.94
2022	156	3075	19.71	66	591	8.95
2023	181	1567	8.66	80	322	4.03
2024	184	683	3.71	67	516	7.70
2015-2024	1172	28374	24.21	493	3792	7.69

Social networks publish articles by Iranian researchers in the field of infertility treatment

The results of the study on social networks publishing articles by Iranian researchers in the field of infertility treatment, indexed in the PubMed database, are illustrated in Figure 2.

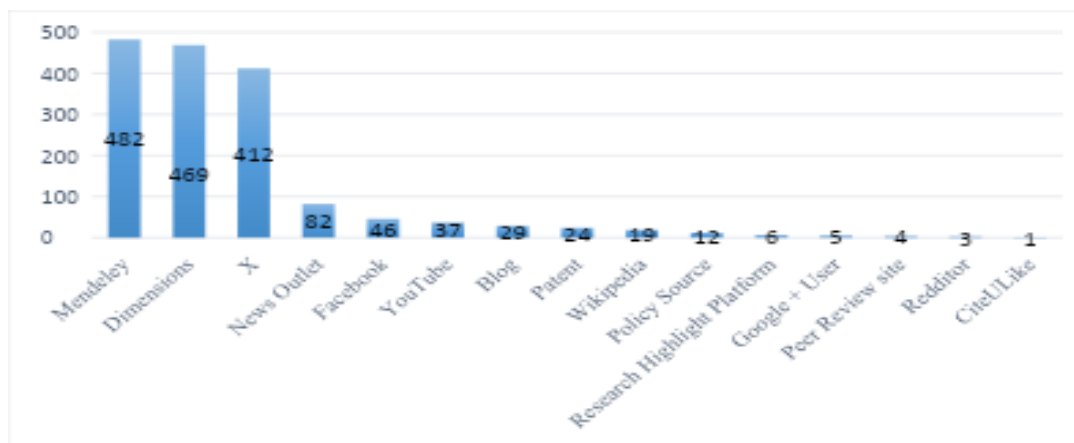


Figure 2: The most widely-used social networks in the field of infertility treatment

According to Figure 2, examining social networks referencing articles by Iranian researchers in the field of infertility treatment, Mendeley had the highest share among all tools; 482 articles (97.77 percent) were referenced 23,439 times in Mendeley. Following Mendeley, the social network Dimensions was next, with 469 articles by Iranian researchers in infertility treatment (95.13 percent) shared 11,046 times. After Dimensions, X had 412 articles by Iranian researchers on infertility treatment (83.57 percent), shared 1,571 times, and had 8,262,923 followers. Following X, News Outlet had 82 articles (16.63 percent) and 297 shares, Facebook had 46 articles (9.33 percent) and 70 shares, YouTube had 37 articles (7.51 percent) and 81 shares, blogs had 29 articles (5.88 percent) and 33 shares, patents had 24 articles (4.87 percent) and 37 shares, Wikipedia had 19 articles (3.85 percent) and 40 shares, Policy Source had 12 articles (2.43 percent) and 12 shares, Research Highlight Platform had 6 articles (1.22 percent) and 8 shares, Google Plus had 5 articles (1.01 percent) and 5 shares, Peer Review Site had 4 articles (0.81 percent) and 4 shares, Reddit had 3 articles (0.61 percent) and 3 shares, and the YouLike site had 1 article (0.20 percent) and 1 share, which were other significant social networks that referenced the articles of Iranian researchers in the field of infertility treatment.

The distribution of posts of Iranian researchers in the field of infertility treatment on X based on the countries of the posters and the roles of the posters in the community

The geographical distribution of posts in the Altmetric Explorer database, based on the available information in the profiles of the posters and the geographical tags of the posts, indicate that in 72.86% of the citations of Iranian researchers' articles in the field of infertility treatment, it was not possible to determine their geographical location due to incomplete information in the profiles of the posters on X. Overall, 7.31% of all posters of Iranian researchers' articles related to infertility treatment are from the United States; therefore, the United States accounts for the highest percentage of postings of these articles. Following the United States, the countries ranked next in terms of the volume of Iranian researchers' articles posted in the field of infertility treatment are the United Kingdom with 3.42% and Japan with 2.14%. Iran ranks fourteenth with 0.27%. The distribution of scientific article postings in the field of infertility treatment on X, based on the posters' roles in the community, is presented in Table 2.

Table 2

Distribution of Iranian researcher's posts in the field of infertility treatment on X

Rank	Tweeters	Number of Tweets	Percentage of Tweets
1	Member of the public	1133	75.79
2	Science communicators (journalists, bloggers, editors)	170	11.37
3	Practitioners (doctors, other healthcare professionals)	122	8.16
4	Scientist	70	4.68

The findings in Table 2 indicate that 75.79% of all posts by Iranian researchers on X about infertility treatment are made by ordinary individuals (non-specialists). Therefore, ordinary individuals (non-specialists) have the largest share of posts by these researchers on this social network. Following them, in order, are science communicators (journalists, bloggers, editors) with 11.37%, health professionals (doctors, other health-related occupations) with 8.16%, and scientists with 4.68%, ranking next in terms of the volume of posts by Iranian researchers in the field of infertility treatment on this social network.

Distribution of citations of Iranian researchers' articles in the field of infertility treatment in Mendeley by citing countries and the roles of the citing individuals in the community

The geographical distribution of citations of Iranian researchers' articles in the field of infertility treatment in Mendeley is presented based on the information available in the profiles of the submitters indicate that in 99.29% of the citations of Iranian researchers' articles in the field of infertility treatment, it was impossible to determine the geographical location of the Mendeley referents due to incomplete information in the referents' profiles. Overall, the citations that included the country name in the referents' profiles accounted for 0.17% of all referents of Iranian researchers' articles in this field, which pertains to the Islamic Republic of Iran; therefore, the Islamic Republic of Iran has the highest percentage of citations in this field on Mendeley. Following the Islamic Republic of Iran, Turkey, with 0.13%, and the United States, with 0.10%, rank next in citation volume for Iranian researchers' articles on Mendeley in the field of infertility treatment.

The findings in Table 3 indicate that 10.38% of all referrers of articles by Iranian researchers in the field of infertility treatment on Mendeley are master's degree students. Therefore, master's students had the largest share of mentions of articles on Mendeley. Following them, undergraduate students account for 10.17%, and PhD students represent 7.03%, ranking next in terms of the number of article referrals by Iranian researchers in the field of infertility treatment on Mendeley. Additionally, in 59.08% of Mendeley referrals, it was impossible to identify the referrers' roles due to incomplete information in the senders' profiles.

Table 3

Distribution of citations of Iranian researchers' articles in the field of infertility treatment on Mendeley by citing countries

Rank	Readers by professional status	Number of readers	Percentage of readers	Rank	Readers by professional status	Number of readers	Percentage of readers
1	Unknown/other/unspecified	11881	59.08	7	Postgraduate Student	458	2.28
2	Master Student	2088	10.38	8	Lecturer	173	0.86
3	Bachelor Student	2046	10.17	9	Associate Professor	99	0.49
4	Ph.D. Student	1413	7.03	10	Professor	52	0.26
5	Researcher	1281	6.37	11	Senior Lecturer	49	0.24
6	Doctoral Student	556	2.76	12	Librarian	14	0.07

Distribution of article referrals by Iranian researchers in the field of infertility treatment on Mendeley by topic

The findings in Table 4 indicate that 18.30% of the total citations for articles by Iranian researchers in the field of infertility treatment on Mendeley pertain to the medicine and dentistry thematic area. Therefore, researchers and professionals working in this thematic area have the largest share of citations for articles by Iranian researchers in the field of infertility treatment on Mendeley. Following this, the thematic areas of biochemistry, genetics, and molecular biology rank next, with 7.808%, while nursing and health professions follow in terms of the volume of citations for articles by Iranian researchers on Mendeley in the field of infertility treatment. Additionally, in 55.871% of Mendeley citations, it was impossible to identify the thematic areas of the citing authors due to incomplete information in the submitters' profiles.

Table 4

Distribution of article referrals by Iranian researchers in the field of infertility treatment on Mendeley by topic

Rank	Readers by discipline	Number of Readers	Percentage of Readers	Rank	Readers by discipline	Number of Readers	Percentage of Readers
1	Unknown/other/unspecified	11134	55.871	15	Chemistry	40	0.201
2	Medical & dentistry	3647	18.301	16	Sports & Recreations	34	0.171
3	Biochemistry, Genetics & Molecular Biology	1556	7.808	17	Business, Management & Accounting	33	0.166
4	Business, Management & Accounting	1178	5.911	18	Arts and Humanities	30	0.151
5	Agricultural & Biological Sci.	790	3.964	19	Environmental Sci.	25	0.125
6	Pharmacology, Toxicology & Pharmaceutical Sci.	425	2.133	20	Mathematics	13	0.065

Rank	Readers by discipline	Number of Readers	Percentage of Readers	Rank	Readers by discipline	Number of Readers	Percentage of Readers
7	Psychology	395	1.982	21	Material Sci.	13	0.065
8	Immunology and Microbiology	129	0.647	22	Linguistics	10	0.050
9	Social Sci.	126	0.632	23	Chemical Engineering	8	0.040
10	Veterinary Sci. & Veterinary Medicine	101	0.507	24	Energy	4	0.020
11	Engineering	92	0.462	25	Earth & Planetary Sci.	4	0.020
12	Computer Sci.	47	0.236	26	Philosophy	3	0.015
13	Neurosciences	44	0.221	27	Physics & Astronomy	2	0.010
14	Economics, Econometrics & Finance	43	0.216	28	Decision Sci.	2	0.010

The relationship between the effectiveness of articles by Iranian researchers in the field of infertility treatment on social networks (based on the Altmetric index) and the quality of the articles (based on the citation index)

To assess the correlation between article Altmetric scores and citation counts, the Kolmogorov-Smirnov test was first conducted, as shown in Table 5.

Table 5

The Kolmogorov- Smirnov test for the normality/abnormality of the indicators

Indices	Mean	Std. Deviatin	Z	P	Result
Altmetrics Score	3.24	17.53	0.43	0.0001	Abnormal
Citation Index	24.21	39.26	0.27	0.0001	Abnormal

As shown in Table 6, the calculated z-value from the Kolmogorov-Smirnov test for the Altmetric score and citation index is not significant ($P > 0.05$). Therefore, the Altmetric score and citation index are not normally distributed, and non-parametric analyses (e.g., Spearman's correlation coefficient) should be used to assess their correlation.

Table 6

The relationship between Altmetric index the citation index in the field of infertility treatment

Indices	N	R	P
Altmetrics Score & Citation Index	1172	0.27	0.0001

As shown in the table above, the correlation coefficient between the citation index and the Altmetric score is 0.27 and is significant ($P < 0.05$). A Spearman correlation coefficient of 0.27 reflects a positive association between the citation index and the Altmetric score.

Discussion

Altmetrics is a relatively new method for assessing the effectiveness of articles and research

across various fields, and it has recently garnered the attention of researchers. Altmetrics have a strong relation with communication theories. For example:

Altmetrics as a form of scholarly communication analysis: Altmetrics essentially analyze various forms of communication surrounding research outputs online. This includes social media mentions, news coverage, blog posts, policy document citations, and more. Understanding the dynamics of these communication channels and their influence requires insights from communication theories.

Exploring the "Why" Behind Altmetrics: Just as there's a need to understand the motivations and processes behind traditional citations in scholarly communication, there's a similar need to explore the "why" behind different altmetric indicators. For instance, why are some articles heavily tweeted but rarely cited in policy documents?

Communication Theory Models Applied to Altmetrics: Scholars are exploring how communication theories can provide frameworks for understanding altmetrics data. For example:

- **Media Richness Theory:** This theory, which examines the effectiveness of different communication media based on their richness (e.g., immediacy, number of cues), can be applied to analyze the types of information being conveyed through various altmetric sources and their impact on understanding and engagement.
- **Social Impact Theory:** This theory, which focuses on factors such as strength, immediacy, and number to explain how influence is exerted, can be used to understand the persuasive nature of communication about research on social media and other platforms, potentially influencing the uptake or awareness of research.
- **Cultivation Theory:** The cultivation hypothesis suggests that heavy media consumption can shape perceptions of reality. In the context of altmetrics, this could relate to how consistent exposure to research mentions in news or social media might influence public understanding or attitudes toward science.

Identifying Communication Patterns and Audiences: Altmetrics allow for the identification of different audiences and communication patterns for scholarly work, depending on the platform. Research shows that audiences for science vary across disciplines and communication channels, highlighting the need for tailored communication strategies based on understanding the specific publics involved. In essence, altmetrics, by capturing and quantifying various forms of online interaction with research, provide rich datasets that can be analyzed through the lens of communication theories to gain deeper insights into how scholarly work is disseminated, perceived, and impacts different publics. This intersection helps us move beyond simply counting mentions to understanding the meaning and implications of these digital traces.

One area where the effectiveness of research has not yet been measured using altmetrics is fertility treatment, a significant challenge in Iran. New solutions and treatments for fertility can lead to improvements and increases in childbirth, which is a crucial issue for modern society. According to data from the Altmetrics Institute, an analysis of articles by Iranian researchers on infertility treatment published in the PubMed database from 2015 to 2024 shows that less than half (42 percent) have received attention on social media. It indicates a relatively limited use of social media by researchers, resulting in insufficient attention from article authors to creating scientific profiles on social media and, consequently, a lack of attention to their articles (Erfanmanesh, 2017). One possible reason for researchers' reluctance to share their articles on social media could be the changing algorithms of these platforms. Studies have shown that

social media networks prioritize engaging content, such as videos and advertisements, over scientific or academic articles, making it more difficult for specialized or less visually appealing content to be seen (Araujo, Nascimento, Gonzalez & Costa, 2018).

Additionally, users' preference for short content may lead fewer researchers to share their longer scientific articles on social media (Francke & Hammarfelt, 2022). Another reason could be the researchers' lack of a proper understanding of knowledge translation (the expression of specialized science in simple, understandable language for the general public) on searchable social media. Furthermore, various altmetrics tools, including the one used in this study (the Altmetrics Institute website), only cover a specific portion of the web and evaluate that segment (Costas, Zahedi & Wouters, 2015; Erfanmanesh, 2017). Therefore, these factors can be considered reasons for the limited attention to Iranian articles on infertility treatment on social media; however, a definitive conclusion in this regard requires further studies.

An analysis of articles by Iranian researchers in the field of infertility treatment from 2015 to 2024 showed that both the number of articles and citations increased during this period. The rise in citation rates may be related to the increasing number of references cited in articles in recent years. A study conducted in 2021 indicated that, across various subject areas such as computer science, linguistics, and health, as the number of published journal articles increases, the density of cited sources in those articles also rises (Dai, Chen, Wan, Liu, Gong & Wang, 2021). The decline in citations since 2020 may be due to various factors, including the widespread COVID-19 pandemic that year, which led researchers to focus more on COVID-19 and reduce attention to infertility research. Another factor may relate to the nature of citation behavior, meaning that the shorter a paper's lifespan, the less likely it is to receive citations. Additionally, an examination of the number of articles with Altmetric scores by Iranian researchers in this field indicates an improvement in researchers' familiarity with social media, as evidenced by fluctuations in this trend over the years. This phenomenon has been confirmed in previous studies (Erfanmanesh, 2017; Floyd, Wiley, Boyd & Roth, 2021; SeyyedHosseini Yazdankhahfard, Azargoon & BasirianJahromi, 2024).

An analysis of different types of social networks indicates that platforms such as Mendeley, Dimensions, X (formerly Twitter), News Outlet, Facebook, YouTube, blogs, patents, Wikipedia, Policy Source, Research Highlight Platform, Google Plus, Peer Review, Reddit, and YouLike are tools for sharing articles by Iranian researchers in the field of infertility treatment. Among these, Mendeley, Dimensions, and X have the highest usage statistics and are more widely used than other social media platforms. The significance of these three platforms in sharing scientific articles has also been noted in previous research (Costas et al., 2015; Erfanmanesh, 2017; Hassan & Gillani, 2016; Nuredini & Peters, 2016; Kolahi & Khazaei, 2016; Dixon & Baker, 2020; SeyyedHosseini, Khosravi, Assadi, Jokar & Jahromi, 2021; SeyyedHosseini et al, 2024). This trend is likely related to the popularity and higher acceptance of these three social networks among audiences.

By examining the posts of Iranian researchers in the field of infertility treatment on X, it was confirmed that posts were sent by interested researchers, scientific journals, and educational institutions (in addition to the authors of the research outputs) (Vainio & Holmberg, 2017, Haustein & Costas, 2020; Seyyedhosseini et al., 2021). Previous research acknowledged the greater share of the two countries, the United States and the United Kingdom, in posting scientific articles on X (Vainio & Holmberg, 2017; Fang, Costas & Wouters, 2022). The findings also indicated that Iran, with only four tweets, accounted for 0.27% and ranked

fourteenth; perhaps the main reason is the limited access of Iranian researchers to X due to the platform being filtered in Iran (Maleki, 2014). Additionally, the findings revealed that ordinary individuals (75.79%) accounted for the largest share of articles tweeted by Iranian researchers on infertility treatment. This high share could be attributed, on the one hand, to the significant number of users who identify as ordinary users on Twitter, regardless of their education level, and, on the other hand, to ordinary individuals' interest in following research on infertility treatment.

Among the citations in which the country name was listed in the profiles of the citing individuals, Iran, Turkey, and the United States ranked highest. The findings also indicated that students had the largest share of citing articles by researchers in this field on Mendeley. This result may reflect the interest of students-alongside the researchers themselves-in studying and sharing scientific articles by Iranian researchers in infertility treatment. Other studies also show that students account for a significant share of citations to researchers' articles in the Mendeley reference management tool (Khwaja & Eddy, 2015; Ariyanti & Fitriana, 2020).

A thematic analysis of articles by Iranian researchers on infertility treatment with the highest citation rates on Mendeley revealed that the medical and dental fields received the most citations. Previous researchers have identified the medical and dental fields as one of the areas with the highest presence on social media (Costas et al., 2015; Kolahi & Khazaei, 2016; Smailhodzic, Hooijsma, Boonstra & Langley, 2016; Vainio & Holmberg, 2017; Andersen & Haustein, 2017; Connell, Weyand & Barnes, 2022). It may be related to the short half-life of articles in these fields. Additionally, considering that researchers in the medical and dental fields are continuously seeking new treatment methods, they have a greater interest in publishing their research through social media (Connell et al., 2022); especially since this way, research in these fields reaches the general public.

Ultimately, based on the results of the present study, a significant moderate relationship was observed between the Altmetric score and the number of citations of articles by Iranian researchers in the field of infertility treatment. Some previous studies have also reported a significant statistical relationship between Altmetric indicators and the number of citations received by research articles (Bar-Ilan, 2014, Costas et al., 2015, Esmailpour-Bandboni, Batooli, Ramezani, Ranjbar-Pirmousa & Ramezani, 2016, Syamili & Rekha, 2017, Thelwall & Nevill, 2018, Ravikumar & Khonglam, 2018, Erfanmanesh, 2018, Dixon & Baker, 2020, Floyd et al, 2021, Hassan, Nasr, Abdelrahman & Hassan, 2024, Venkatesh & Bk, 2024, Orimi et al, 2024). Therefore, it can be said that social media positively impacts the introduction, communication, and collaboration among researchers, as well as the management of their scientific outputs. It can be argued that publishing research articles in social web environments increases their visibility and exposes them to a broader audience, which in turn affects future citation rates and, through more citations, increases the quality performance indicators of the relevant journals.

Conclusion

Altmetrics examine online attention and user engagement with scientific articles and can complement traditional metrics. The Altmetric score reflects the online mentions of articles in social media, blogs, and other social networks. This score can indicate a paper's popularity and influence on online platforms, particularly in social and news networks. Various studies, including the present one, have shown that articles that receive more attention on social media also gather more citations. In other words, online attention can translate into increased citations

in scientific databases. This trend has been observed in various research fields in recent years.

As a supplementary tool for assessing the scientific impact of articles, altmetrics can help identify papers that may receive future citations. It provides insights into the papers' social and public influence on researchers and academic institutions. Overall, the relationship between the altmetric index and the citation index indicates that online attention to scientific articles can predict future citations. It underscores the importance of using altmetrics as a complementary approach to evaluating the effectiveness of research across various subject areas in the digital age. Therefore, researchers, academic institutions, and organizations supporting researchers should be aware of the benefits of disseminating research findings on social media, as well as of sharing their articles in organizational and subject-specific databases, thereby increasing the visibility of their publications through these channels. Health policymakers should provide more specific strategies to improve researchers' digital presence (e.g., by leveraging science influencers or local platforms).

Limitations

Like other studies, this research also has its limitations. First, due to the nature of the study and the method used to conduct it, it has not been possible to control for confounding variables, including journal quality or institutional affiliation. Second, relying exclusively on the citations provided in Google Scholar, which may include incomplete or duplicate data for each article, can introduce potential biases when estimating the number of citations for each article. Third, thematic differences in the field of infertility (including whether articles focusing on novel fertility methods have attracted more attention) have not been taken into account.

Endnote

1. <https://www.who.int/news-room/fact-sheets/detail/infertility>

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