

Bibliometric study of *BioImpacts* using a technological impact approach

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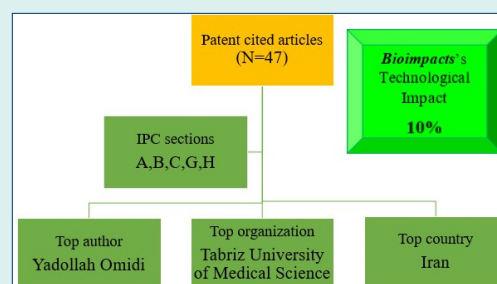
Abstract

Introduction: The number of citations received by articles is a key indicator of a journal's quality and effectiveness within its field. This, in turn, influences the ability to secure funding for ongoing publication, establishing a suitable policy for its promotion, and helping researchers selecting an appropriate journal to publish their findings or find information they require. Meanwhile, one way to measure a journal's technological impact is to examine the patent citations attached to its articles. This study aims to evaluate the technological impact of *BioImpacts* (BI) by examining the patents' citations to its articles.

Methods: This descriptive study was conducted using the bibliometric method with a technological impact approach. The published *BI* belonged to the years 2011-2023. Data were extracted using the Lens and Espacenet databases. Descriptive statistics and Excel software were applied for data analysis.

Results: The results revealed that *BI* had a 10% technological impact. Original research contributed to most of the cited articles (27). American patents were the most impacted by *BI*'s articles. Moreover, human necessities (A) and chemistry and metallurgy (C) were two main technological sections influenced by *BI*'s articles. The most active and influential country was Iran and the most active and influential organization was Tabriz University of Medical Sciences.

Conclusion: Based on the present research findings, the technological impact of *BI* is considerable; so, it is important to present information about this issue on the journal's website and adopt appropriate policies for further development of *BI* in this field.



Introduction

With the growing number of scientific journals, stakeholders such as publishers, readers, policymakers and evaluators have been increasingly interested in the journal's quality ratings and rankings. An essential tool for securing funding to keep publishing a journal is to know its quality and ranking. These two items are employed by researchers to select an appropriate journal to publish their findings or find information they require. Furthermore, promotion points are granted based on the impact and performance of academic researchers and the rankings of universities are developed using this information.¹⁻⁴

Citation is one of the main criteria for evaluating the quality of a journal and its articles.⁵ Citation indices, which

present the journal's impact on science and technology, and the contributions made by individuals, organizations, and nations, are derived from the citations of scientific and technical works.^{4,6-8}

Narin et al was the first one who used patent citations on non-patent literature (NPL) as an indicator of the impact of science on technology.⁹ Since then, many researchers have investigated the impact of science on technology in various fields, including nanotechnology,¹⁰ energy,¹¹ biomedicine,¹² social sciences and humanities,¹³ parasitology¹⁴ etc. In these studies, patents and scientific articles were technology and science indicators, respectively.

The patent's references form prior art, which aids in determining if the application satisfies the novelty criteria



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for patentability.¹⁵ Patents and NPL like books, scientific papers, technical documents, and congress articles, are all cited.¹⁶ Scientific journal articles make up around 48-90% of NPL,^{9,6-20} and the rate of patent citations to scientific articles in different fields is about 4–15%.^{12,14,21}

Bibliometric method is utilized to investigate the influence of science on technology. Numerous factors have so far been examined, including the number of citations to scientific articles, features of scientific documents, individuals, citing nations, impacted technological areas, and journal's impact factor.²²

BioImpacts (BI), published by Tabriz University of Medical Sciences (TUOMS) in English since 2011. This journal focuses on articles in the fields of pharmaceutical and biomedical sciences.²³ As one of the top journals approved by Iran's Ministry of Health and Medical Education, BI is indexed in the Web of Science (WoS), Scopus, and Medline. According to Zahedi et al, BI is cited by the United States Patent and Trademark Office (USPTO) patents and received three citations until 2018.²⁴ Given that Zahedi's analysis was published several years ago and that BI is still published, more up-to-date and comprehensive data are required to assess its impact on technological development. To our knowledge, no further research has been done in this area. Thus, the present research aims to perform a bibliometric study of BI using a technological impact approach by examining the patent citations to its articles.

Materials and Methods

The bibliometric method was applied to conduct this descriptive analysis using a technological impact approach based on patent citations to the articles published in BI. The Lens database was used to identify articles cited in the patents. This database offers search and analysis capabilities for more than 268 million scientific documents and 153 million patents. Moreover, it provides information on both past and future references to scientific documents and patents. The Medline/PubMed database, which indexes BI, acts as one of the data sources for Lens scientific literature.²⁵

Using the scientific documents app of the Lens database, BI's articles from the first year of publication (2011) until the end of 2023 were extracted by searching for the journal's title. The retrieved documents were narrowed down to those cited by the patents. The procedure for selecting the retrieved articles is depicted in Fig. 1.

The articles' bibliographic data, such as title, name of author(s), publication year, author's affiliation, and number of citations, as well as the bibliographic data of the citing patents like the application number, name of inventor(s), name of applicant(s), publication year and subject area based on the International Patent Classification (IPC)²⁶ scheme were extracted and recorded in the designated checklist^[1]. While multiple authors

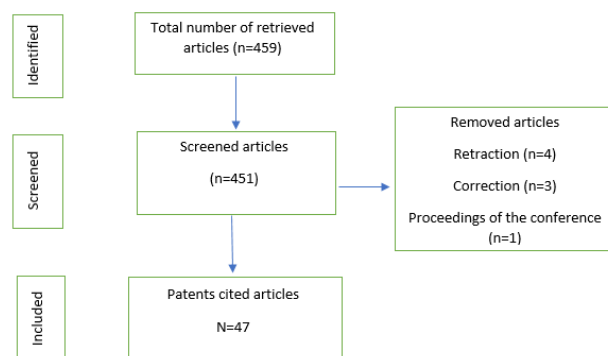


Fig. 1. A flow diagram of the procedure for selecting the retrieved articles for examination.

contributed to each article, the contributions of each author and the collaborating authors' organizations and nations were considered the same and equal to 1. Participation in producing at least three articles identified the most prolific authors, organizations, and countries, and the number of similarly productive variables determined the number of top-cited authors, organizations, and countries.

In order to obtain comprehensive bibliographic data, we utilized the Espacenet database to retrieve the complete names of patent applicants because the Lens database occasionally provided only abbreviated information. This database contains information on over 140 million patent documents in more than 100 countries.²⁷

The requested data were retrieved on January 20, 2024, and then analyzed using descriptive statistical analysis and the Excel software.

Results

From the total of 451 articles published in BI, 47 (10.4%) were cited by 168 patents. The total and average citations received by the articles was 169 and 3.6, respectively.

The articles included four types: original research, review, editorial, and hypothesis. The highest number (27) belonged to original research, and review articles received most of the citations^[2] (Fig. 2).

Eight articles received more citations than the average. The article by Nokhodchi et al obtained the maximum number of citations (44), followed by Srinivasan Shanmugam's article with 30 citations as the second most cited (Table 1).

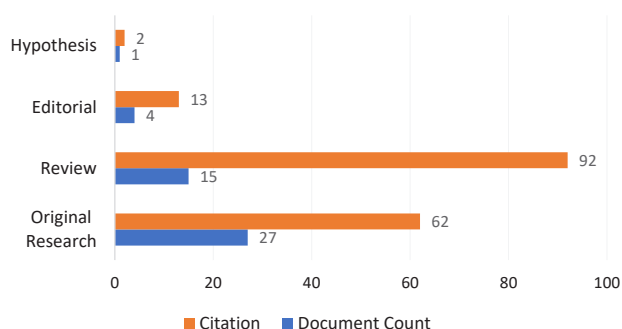
The articles were published with the participation of 159 authors. Seven authors contributed to the publication of at least three articles. Yadollah Omid and Jaleh Barar were the most active, contributing to the publication of 12 and 11 articles, respectively (Table 2).

Ali Nokhodchi received 48 citations out of the seven most cited authors, and Kofi Asare-Addo, Pryia Patel, and Shaista Raja received 44 citations (Table 2).

Of the 43 organizations that contributed to producing articles, four organizations produced three or more articles. Contributing to producing 24 papers and having

Table 1. Five highly cited articles by patents in BI

Title	Author(s)	Doc type	Citation	
			N	%
The Role of Oral Controlled Release Matrix Tablets in Drug Delivery Systems ²⁸	Ali Nokhodchi et al	Review	44	26
Granulation techniques and technologies: recent progresses ²⁹	Srinivasan Shanmugam	Review	30	17.8
Cytotoxic Impacts of Linear and Branched Polyethylenimine Nanostructures in A431 Cells ³⁰	Vala Kafil, Yadollah Omid	Original Research	13	7.7
Heavy Chain Only Antibodies: A New Paradigm in Personalized HER2 + Breast Cancer Therapy ³¹	Seyed Moein Moghimi et al.	Editorial	7	4.14
Role of Lactobacillus plantarum MTCC1325 in membrane-bound transport ATPases system in Alzheimer's disease-induced rat brain ³²	Nimgampalle Mallikarjuna et al	Original Research	6	3.6

**Fig. 2.** Type, count, and citation of cited documents

gained 52 citations, TUOMS was determined to be the most productive and the most influential organization (Table 2).

Four countries contributed to producing at least three articles. The most productive country was Iran (31 articles), followed by the United States standing at the second rank (10 articles). Also, Iran and the United Kingdom were the most cited countries, with 63 and 51 citations, respectively (Table 2).

The citing (including granted and application) patents for *BI*'s articles were released from 2013 to 2023. Most of them (36 patents) belonged to 2020 (Fig. 3).

Ten patent offices were involved in the registration of the citing patents. The USPTO and the World Intellectual Property Organization (WIPO) were two principal patent offices with 104 and 32 patents registered, respectively (Fig. 4).

The citing patents were filed by inventors and applicants from 27 and 26 countries, respectively. The most significant number of patents (76) belonged to the USA, followed by Germany and China being ranked second and third, respectively (Fig. 5).

Articles by Iranian authors were cited by inventors and applicants from 19 and 16 countries, respectively. Of them, American inventors and applicants contributed to producing 12 and 13 of the total number of patents (Fig. 6).

The citing patents were categorized into five sections: A, B, C, G, and H, as well as 19 IPC classes. Sections A61 (medical or veterinary science; hygiene), C07 (organic chemistry), and C12 (biochemistry; beer; spirits; wine;

vinegar; microbiology; enzymology; mutation or genetic engineering) were the three main categories with the frequency of 497, 94 and 71, respectively (Table 3).

Discussion

This study assessed the technological impact of *BI* using patent citations. The findings showed that patents cite 10% of the articles. Other studies have shown that patents cite 4-15% of scientific articles.¹⁴ For example, according to the Ke survey, approximately 4% of biomedical articles were cited by the US patents.¹² A study by Garrido-Cardenas et al. showed that patents cited 15% of the articles published in parasitology journals.¹⁴ Hence, *BI* has an appropriate technological impact.

Reviews had the most citations of any type. Given that 80% of the citations for reviews came from the articles of Nokhodchi et al.²⁸ and Shanmugam,²⁹ it can be said that the citations of review articles are influenced mainly by the citations of these two articles, with the remaining 13 review articles receiving a relatively small percentage of the citations. Therefore, it cannot be stated that the type of article affects the quantity of citations received.

Guerrero-Bote et al reported that original papers account for the most significant percentage of articles cited in patents,²¹ which agrees with our findings.

The number of cited articles and citations obtained differs significantly from the contribution of active and influential authors. The findings indicated the first four influential authors have a few articles overall, and their influence is derived from the impact of a single review article. From a technological viewpoint, it can be stated that the five influential authors have no direct impact because the reviews are the outcome of reviewing other researchers' publications. It is also necessary to examine the number of citations that active authors receive concerning the type of article to assess their technological effect. Determining the authors' technological H-index might also be helpful in this regard.

TUOMS has been ranked first in terms of activity and impact. Our review revealed that TUOMS authors produce a significant quantity of *BI*'s articles. A better understanding of its contribution to the technological impact of *BI* can be obtained by calculating the ratio of its

Table 2. Active and influential authors, organizations and countries

Variable		Document		Citation		
		N	%	N	%	
Author	Active	Yadollah Omid	12	25.3	35	20.7
		Jaleh Barar	11	23.4	16	9.5
		Abolfazl Barzegari	5	10.6	5	3
		Jaber Dehghani	4	8.5	6	3.6
		Marziyeh Fathi	3	6.4	6	3.6
		Mohammad A Rafi	3	6.4	4	2.4
		Mohammad-Reza Rashidi	3	6.4	8	4.7
		Ali Nokhodchi	2	4.3	48	28.4
	Influential	Kofi Asare-Addo	1	2.1	44	26
		Pryia Patel	1	2.1	44	26
		Shaista Raja	1	2.1	44	26
		Yadollah Omid	12	25.3	35	20.7
		Srinivasan Shanmugam	1	2.1	30	17.8
		Jaleh Barar	11	23.4	16	9.5
Organization	Active	Tabriz University of Medical Sciences	24	51.1	52	30.8
		Tehran University of Medical Sciences	4	8.5	8	4.7
		University of Tabriz	3	6.4	5	3
		Thomas Jefferson University	3	6.4	4	2.4
		Tabriz University of Medical Sciences	24	51.1	52	30.8
	Influential	The University of Kent	2	4.3	48	28.4
		University of Huddersfield	1	2.1	44	26
		Hanmi Pharm. Co., Ltd.	1	2.1	30	17.8
		Iran	31	66	63	37.3
		United States	10	21.3	17	10.1
Country	Active	India	4	8.5	11	6.5
		United Kingdom	3	6.4	51	30.2
		Iran	31	66	63	37.3
	Influential	United Kingdom	3	6.4	51	30.2
		South Korea	1	2.1	30	17.8
		United States	10	21.3	17	10.1

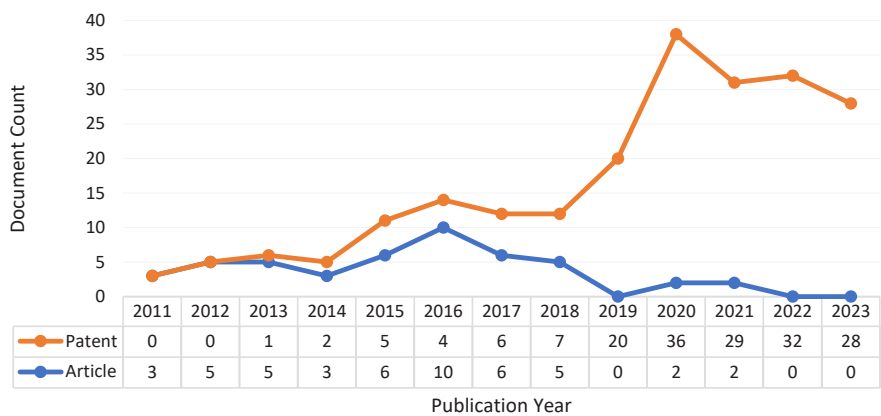


Fig. 3. Publication year of citing patents and BI's cited articles.

cited articles to its total articles in *BI*. After TUOMS, Tehran University of Medical Sciences has been ranked second in technical activity and the average number of citations to its articles is close to

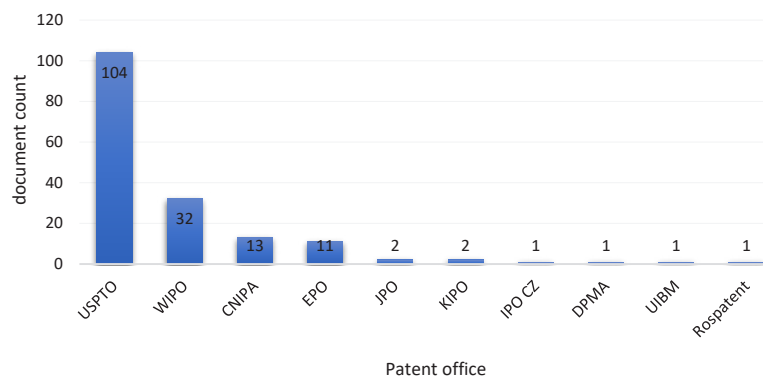


Fig. 4. Patent offices for citing patents.

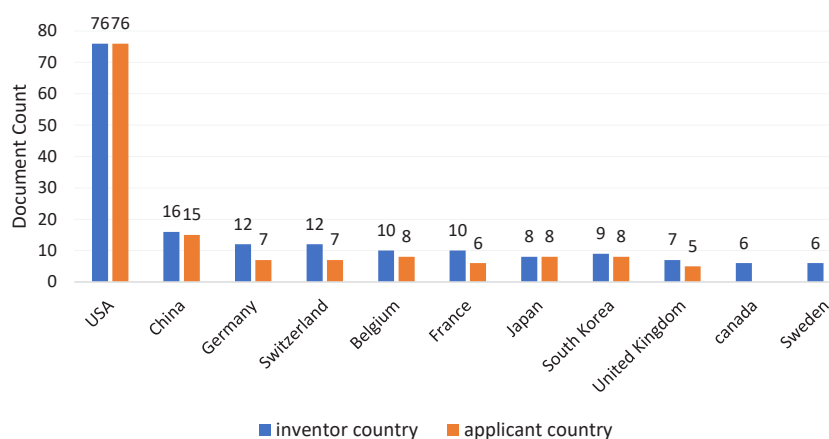


Fig. 5. Top ten inventor and applicant countries.

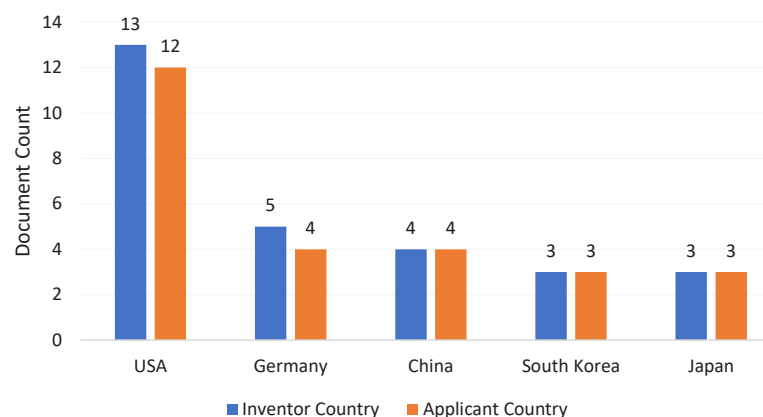


Fig. 6. Top five countries citing inventors and applicants to Iranian articles.

TUOMS. In terms of influential organizations, except TUOMS, three other universities with the most significant impact are influenced by a single review article and do not directly affect technology. So, it could be more beneficial to ascertain the universities' technological H-index.

Active and influential countries have the same issues as active and influential organizations. In the present research, the author's affiliation determines the shares of each organization and country. All organizations and countries where the author has multiple affiliations in an article are assigned one share. A more precise allocation

can be found by assigning a relative contribution to each author's organization and country.

According to the patent publication year, the first citation is two years after the article's publication date, and the last citations are in 2021. This could be due to the 18-month interval between filing an application and publishing it. Finardi notes that the time interval between the publication of an article and the receipt of the first citation from a patent is three to four years,³³ which is consistent with our analysis result (about two years).

Most of patents citing *BI*'s articles are filed in the

Table 3. IPC classes of citing patents

Section	Class	N
A: Human Necessities	A01: Agriculture; Forestry; Animal Husbandry; Hunting; Trapping; Fishing	6
	A23: Foods or Foodstuffs; Treatment Thereof, not Covered by Other Classes	12
	A61: Medical or Veterinary Science; Hygiene	497
B: Performing Operations; Transporting	B01: Physical or Chemical Processes or Apparatus in General	8
	B28: Working Cement, Clay, or Stone	2
	B29: Working of Plastics; Working of Substances in a Plastics State in General	7
	C01: Inorganic Chemistry	2
	C04: Cements; Concrete; Artificial Stone; Ceramics; Refractories	6
	C07: Organic Chemistry	94
C: Chemistry; Metallurgy	C08: Organic Macromolecular Compounds; Their Preparation or Chemical Working-up; Compositions Based Thereon	28
	C09: Dyes; Paints; Polishes; Natural Resins; Adhesives; Compositions not Otherwise Provided for; Applications of Materials not Otherwise Provided for	7
	C11: Animal or Vegetable Oils, Fats, Fatty Substances or Waxes; Fatty Acids Therefrom; Detergents; Candles	4
	C12: Biochemistry; Beer; Spirits; Wine; Vinegar; Microbiology; Enzymology; Mutation or Genetic Engineering	71
	G01: Measuring; Testing	15
	G06: Computing; Calculating or Counting	1
G: Physics	G09: Educating; Cryptography; Display; Advertising; Seals	1
	G10: Musical Instruments; Acoustics	1
	G16: Information and Communication Technology [ICT] Specially Adapted for Specific Application Fields	1
H: Electricity	H01: Electric Elements	8

USPTO. As reported by Zahedi et al, *BI* received only three citations from the US patents before November 2018.²⁴ Re-examining the patents citing *BI*'s articles revealed that these articles received 11 US patent citations until 2018, which differed from the findings of Zahedi et al significantly.

The number of patent offices and inventor and applicant countries demonstrates the geographical scope of *BI*'s articles' technological influence. The USPTO and the USA hold the most significant proportion in this regard. The number of patent citation from various countries and patent offices to non-patent sources is dictated by the patent office's policy and its obligation to refer to prior art. Previous research has demonstrated that US patents are more scientifically founded than those from other countries.^{10,34,35} Most of patents registered in any country's patent office are owned by its inventors and applicants; hence, *BI*'s articles have the most significant impact on American patents.

Typically, each country's science and technology are in sync and can have the greatest impact on each other within that geographical area. Since prior art is not specified in the patent filed in Iran's Intellectual Property Office, it was impossible to investigate the impact of *BI*'s articles on relevant technology in Iran.

Zahedi et al reported that up to November 2018, section of chemistry and metallurgy (C) was the only technological area impacted by *BI*'s articles.²⁴ The present study results revealed that five technological sections were impacted, with human necessities (A) and chemistry and metallurgy

(C) sections ranked the highest. Re-examination results showed that *BI*'s articles from patents in Section C gained three citations up to the end of 2018, which agrees with the findings of Zahedi et al. Additionally, contrary to the conclusions of Zahedi et al, the citations through the end of 2018 are from sections A, B, and C.

Conclusion

The present research used the index of patents' citations to scientific articles to examine the technological impact of *BI*. It was revealed that *BI* has an appropriate technological impact, and the impact of *BI*'s articles is geographically distributed, indicating its significant visibility and accessibility. Therefore, *BI* can serve as a valuable information resource for academic and industry researchers working in linked technological domains and as a venue for disseminating their findings. To demonstrate *BI*'s technological prestige and contribution to technological advancement, information about its technological impact must be included on the journal's website, and suitable policies must be adopted to secure its continued growth. Considering that *BI* is multidisciplinary, it is suggested to analyze how different types of articles affect the journal's technological impact based on the specific subject area. It is also advisable to undertake a study to evaluate the technological standing of journals in the same subject categories to assess *BI*'s place relative to them. Finally, it is recommended to investigate the technological H-index of the authors.

Research Highlights

What is the current knowledge?

- BI's articles are cited by the USPTO patents in the section C (chemistry and metallurgy).

What is new here?

- The ten patent offices' patents, mainly the USPTO and the WIPO, are impacted by BI's articles in five technological sections. Human necessities (A) and chemistry and metallurgy (C) have the highest rank. BI's articles have the most significant impact on American patents.

Authors' Contribution

Conceptualization: Leila Mirzapour.

Data curation: Leila Mirzapour.

Formal analysis: Leila Mirzapour.

Investigation: Fatemeh Sheikhshoeai.

Methodology: Leila Mirzapour.

Supervision: Fatemeh Sheikhshoeai.

Visualization: Leila Mirzapour.

Writing-original draft: Leila Mirzapour.

Writing-review and editing: Fatemeh Sheikhshoeai, Leila Mirzapour.

Competing Interests

The authors declared no conflicts of interest.

Ethical Statement

Not applicable.

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Endnotes

^[1] IPC has eight sections, including Human Necessities (A); Performing Operations, Transporting (B); Chemistry, Metallurgy (C); Textiles, Paper (D); Fixed constructions (E); Mechanical engineering, Lighting, Heating, Weapon, Blasting (F); Physics (G); Electricity (H).

^[2] In this study, four short communications are included in the category of original research and two perspective articles are included in the review category.

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