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Iranian Journal of Allergy, Asthma, and Immunology: A Bibliometric and Altmetric Analysis from 2005 to 2022

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ABSTRACT

This study aimed to present a bibliometric and altmetric Analyses of the Iranian Journal of Allergy, Asthma, and Immunology (IJAAI).

The citation performance and altmetric data were extracted from Scopus and Altmetric Explorer, respectively. Analyses were done using SPSS 26, Microsoft Excel, VOSviewer, and CiteSpace.

The results of the bibliometric analysis revealed that IJAAI had experienced respectable growth. Among the total citations, 4746 citations belong to the first decade (2005-2014) and 3,035 citations belong to the second (2015-2022). The findings demonstrated the significance of IJAAI among Iranian researchers. Pourpak, Z (66; 6.57%) is the top-producing author in IJAAI. The examination of research institutions reveals that the Tehran University of Medical Sciences (TUMS) is ranked first. The most highly cited article in IJAAI over the past 18 years is a review article which has received 138 citations. IJAAI is ranked first at the citing source and journal level, with the most citations (249 citations) to IJAAI. Iran has collaborated with 13 other countries. Overall, the analysis of co-occurred keywords indicates that IJAAI authors have used the following three high-frequency and important keywords: Asthma (162), Inflammation (48), and Multiple sclerosis (40). Co-citation analysis results demonstrated that a total of 6,718 sources were cited in this journal. The results of the altmetric analysis show that IJAAI has a reasonably low presence across various social media platforms, including Twitter, Facebook, Wikipedia, Mendeley, news and blogs.

This study aids researchers in exploring and identifying emerging trends in the fields of allergy, asthma, and immunology.

Keywords: Allergy and immunology; Asthma; Altmetrics; Bibliometrics

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INTRODUCTION

The Iranian Journal of Allergy, Asthma and Immunology (IJAAI) is the first specialized English-language journal in the fields of allergy, asthma and immunology that is published in Iran. This journal was established in 2000 and is now indexed in more than 15 international highly-prestigious databases, such as Clarivate Analytics Web of Science Core Collection, PubMed, Scopus (since 2005), Embase and DOAJ.[1] IJAAI is the official publication of the Iranian Society of Asthma and Allergy (ISAA), supported by the Immunology, Asthma and Allergy Research Institute (IAARI) and published by TUMS. According to its statement of objectives and scope notes, IJAAI aims to publish original articles, selected reviews, case-based reviews and other articles of special interest related to the field of allergy, asthma and immunology. Currently, this journal is ranked 23rd percentile and 154th among all academic journals in the field of Immunology and Allergy indexed in Scopus. IJAAI has a Cite Score of 2.1, meaning that articles published in it between 2018 and 2021 received an average of 2.1 citations in 2021.[2] The Source Normalized Impact per Paper (SNIP) of this journal is 0.391. SNIP is a field-normalized evaluation of the journal's impact[3] and indicates that IJAAI articles received 0.391 citations specifically from journals in the field of immunology and allergy. Moreover, the Scimago Journal and Country Rank (SJR) of IJAAI is 0.345, representing the average number of citations received by IJAAI articles over the past three years. SJR evaluates the scientific impact of a journal, considering both the number of citations received by the journal and the prestige of the journals from which those citations come.[4] The impact factor of this journal in 2021 was 1.570.

In 2022, IJAAI celebrated its 18th anniversary in scopus. A common practice among journals is to celebrate their anniversary by publishing a comprehemsive review of the journal, a special issue or an editorial.[1,5] Allergy, Pediatric Allergy and Immunology (PAI), Clinical and Translational Allergy (CTA)),[6] the Journal of Consumer Research,[7] Journal of Advertising,[8] Global Finance Journal,[3] Journal of Public Policy and Marketing[9] and Journal of Artificial Societies and Social Simulation[10] were among such journals. On the other hand, scientific journals are the main channels for promoting knowledge and advancing science, which makes the "evaluation of scientific journals" an important aspect of the reliability of their published content.[11] A comprehensive analysis of the journal's articles has not been conducted thus far in the 18-year history of IJAAI.

Traditionally, "peer review" has been a common method for determining the quality of scientific work, but since the 1990s, quantitative evaluation measures, such as bibliometrics or scientometrics have gained increasing importance in this regard. Currently, bibliometrics has become a key component of esearch quality assessment due to its ability to produce practical results quickly and easy access to bibliographic databases (such as Scopus, Web of Science, etc.).[12,13] Bibliometrics is a statistical analysis of written items, associated most with journal articles. It provides quantitative analysis based on citing and cited works. Times cited, journal impact factors and the H-index are all based on these metrics. Through bibliometrics, information on various research parameters (such as the number of authors, country of origin and organizational affiliations, budget resources, research subjects and focus, and citation indices for quantifying the research) are obtained.[14] Bibliometric analysis can also identify the development in a research area or changes made in a specific journal.[15,16] In addition to bibliometric analysis, Altmetrics is a tool that measures the volume and nature of online attention to research findings[17-19] and thus complements some traditional citation-based metrics such as Impact Factor and H-index.[20,21] This includes news coverage, social media activity, and other data, like views and downloads. Both of these methods were used in the present study.

In general, various factors such as co-international co-authorship,[22-24] impact factor of journals, and collaboration networks[25-27] are involved in the citation rate of a journal. Therefore, the evaluation of these cases can be influential in improving the quality of articles, scientific indicators of IJAAI, and the citations received by its articles.

Considering the points mentioned above, this study was conducted to analyze the bibliometric and Altmetric performance of IJAAI. This study provides a comprehensive picture of the journal by presenting the publication trends, authorship patterns, citation structure, and highly-cited articles. Potential authors

and readers of the journal will be able to determine which publications and influential authors they should consider when they decide to design a research project. Additionally, this is the first study to provide an overall perspective on the scientific performance of IJAAI from 2005 to 2022. Therefore, based on this approach, the current bibliometric overview strongly prepares suitable solutions for the scientific growth of the journal. In addition, as no such study has been done on this publication so far, this study offers insights that may serve as a roadmap for the editorial board.

MATERIALS AND METHODS

This study used bibliometric and altmetric analysis techniques as presented in Table 1

Table 1. An overview of the research techniques

Approach	Technique	Tool	Bibliographic Attribute	Timespan
Bibliometrics Analysis	Citation Analysis	Excel and Statistical Package for Social Science (SPSS)	Publication Years Citations Citing Sources Authors Institutes Countries	2005-2022
	Co-authorship Analysis	VOSviewer	Countries	
	Co-occurrence Analysis		Keywords	
	Co-citation Analysis		Cited References Cited Authors	
	Visualizing the emerging trends	CiteSpace	Citations	
Altmetrics Analysis	Alternative metrics	Altmetric Explorer	Mentions	
		Dimensions	Citations	

Bibliometric Analysis

Bibliometrics comprises a set of tools applying quantitative approaches to bibliographic data.[28] The main goal of bibliometric analysis is to express qualitative aspects of a scientific agent, thus transforming an intangible quantity, such as scientific quality, into something that is tangible and meaningful.[29] The bibliometric methodology is often divided into two types of analyses: performance analysis and scientific mapping.[30] The former focuses on the productivity of individuals, institutions and countries, while the latter deals with the dominant themes emerged in a scientific field. This study combines both analyses to provide a comprehensive picture of the journal's progress over the past 18 years. To analyze the performance, this investigation uses metrics such as publication counts and citations per year to depict the journal's growth in terms of its productivity and visibility. This study employs a wide range of tools, such as co-occurrence of keywords, co-authorship, etc., to conduct a retrospective analysis of IJAAI. Additionally, to understand the dynamics of the relationships among contributors to this journal, co-authorship analysis was performed at individual and national levels for producing authors, countries and institutions.

The time frame of the present study covers 18 years, from the beginning of 2005 (Since IJAAI's being indexed in Scopus) to the end of 2022. Therefore, this study follows the standard protocol adopted by researchers for collecting documents from the Scopus database for making bibliometric analysis.[31,32] Scopus is commonly considered as a large, structured and well-organized citation database,[33] making it a preferred database for data extraction. Accordingly, in January 2023, the following syntax was used to extract the relevant documents of IJAAI from Scopus for analysis:

SRCTITLE ("Iranian Journal of Allergy, Asthma, and Immunology") AND PUBYEAR > 2004 AND PUBYEAR < 2023.

The search result included bibliographic data for 1004 IJAAI documents that were extracted from Scopus. The strongest bibliometric and altmetric techniques and software packages, such as SPSS 26, Microsoft Excel, VOSviewer, and CiteSpace, were used for data analysis. Bibliometric techniques include important techniques such as citation analysis, co-authorship, co-occurrence, and co-citation.[34] Analysis of the frequency distribution of documents and citations received by the journal, identification of the most-cited documents in the journal, determination of sources citing the journal's publications, and identification of the most productive and influential authors, universities, and countries were among the main analyses performed using the citation analysis. Then, network visualization of co-authorship of countries, co-occurrence of keywords, and co-citation of sources and authors was performed using a bibliometric software named VOSviewer.[35] Finally, to illustrate the emerging trends of IJAAI over time, CiteSpace software was employed.[36]

Altmetrics Analysis

Altmetrics, a short-written term of Alternative Metrics refers to alternative indicators.[37,38] Altmetrics is considered as one of the most common alternative indicators for tracking back the social impact of research articles. The Altmetric Attention Score (AAS) is calculated as a weighted approximation based on an automated algorithm that considers multiple sources such as online social media to calculate a combined score.[26] Data sources for Altmetrics include among others Twitter, Facebook (mentions on public pages only), Google+, Wikipedia, Mainstream news outlets, Scientific blogs, Policy documents, Patents, Post-publication peer reviews (Faculty of 1000 Prime, PubPeer), Weibo, Reddit, Pinterest, YouTube, online reference managers, Mendeley, and Sites Running Stack Exchange (Q&A).[18,39]

Altmetric LLP is one of the most important providers of Altmetrics data, with more than 41 million articles. This database collects information about the impact of articles mentioned on various social media and assigns an Altmetric score to the article based on the distribution of social network scores.[21,40,41] The Altmetric score reflects an immediate feedback on the research findings through measuring public and scholarly interest.[42] This indicator shows how scientific output has been shared, marked, recommended, read, saved, quoted, liked and used socially. Although altmetrics is considered at the article level, it can also be used for individuals, organizations, countries, and journals.[43,44] Therefore, in this study, Altmetric Explorer, one of the services provided by Altmetric LLP, was employed to examine the presence of IJAAI articles in various social media and collect the altmetric attention scores of highly mentioned papers. To this end, in January 2023, the Altmetric Database (Altmetric LLP, London, UK) was searched using the title of the Iranian Journal of Allergy, Asthma, and Immunology (ISSN: 1735-1502). Figure 1 presents a page of an IJAAI article in Altmetric LLP.

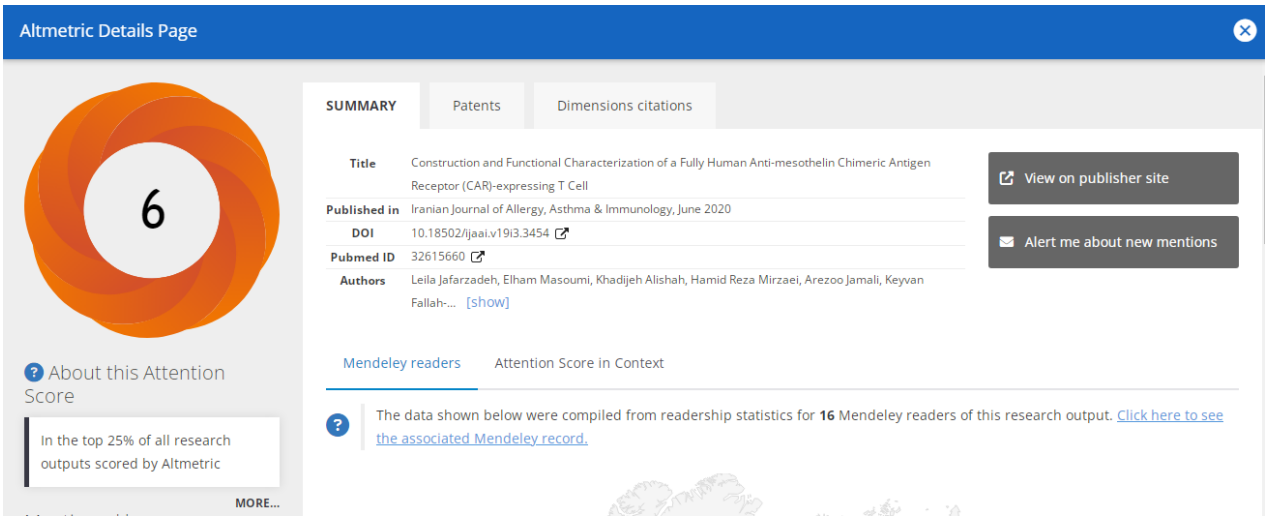

Figure 1. Altmetric indicators of one of IJAAI papers in the Altmetric Institute.

Finally, after extracting the Altmetric scores of IJAAI articles, the top ten highly mentioned articles were identified. Furthermore, the citation performance of these highly mentioned articles was measured in the Scopus citation database. Moreover, this study applied the Dimensions Citation Database to measure the citation performance of these articles. Dimensions was created by a London-based technology firm Digital Science (www.dimensions.ai/) (operated by the Holtzbrinck Publishing Group, which also has a majority share in the publisher of *Nature*). This product goes beyond traditional bibliometric data and links publications to relevant funding, financial agencies, patents and clinical trials. Finally, the number of downloads extracted from the journal's website.

RESULTS

Publication Evolution and Citation Structure of the IJAAI

IJAAI published 1004 documents, including 894 articles, 60 reviews, 37 letters, 9 erratum, 2 editorials, 1 short survey, and 1 retracted document from 2005 to the time of data collection in 2022. Therefore, the analysis includes all 1004 IJAAI documents. Figure 2 shows the trends of IJAAI publications and received citations by year. As observed, the number of IJAAI publications increased from 32 in 2005 to 87 in 2020 and 64 in 2022. The publication slope is 0.78, indicating a growing trend. As shown in Figure 2, the journal has grown in the second half, and the number of its scientific output has increased. In the first nine years, there were 345 documents, while in the second half, there were 659 documents.

The number of citations has decreased from 330 citations in 2005 to only 13 in 2022. The citation slope is -0.13, indicating that the growth of citations has not been constant and the trend of receiving citations is decreasing. The number of citations received has consistently decreased since 2015.

In Table 2, the citation structure of IJAAI documents is presented. The total number of received citations for these documents from the beginning of 2005 to the end of 2022 was 7781 citations. Among the total citations, 4746 citations belong to the first decade (2005-2014), and 3,035 citations belong to the second 8-year period (2015-2022). The average number of citations per document is 7.75, and the average number of citations per year is 432.27. Notably, 0.09% of IJAAI publications (only one article) received more than 100 citations and about 54.58% of the publications received at least one citation. 15.23% did not receive any citations.

Leading Authors, Institutes and Countries in the Journal

In the past 18 years, various authors, research institutions and countries have contributed to IJAAI publications. Table 3 shows the specifications of the top-producing and influential authors, institutions and countries. The examination of the top-producing authors indicates that Pourpak, Z (66; 6.57%) is the top-producing author in IJAAI. Moin, M (50; 4.98%) and Rezaei, N (41; 4.08%) are ranked second and third, respectively. The examination of institutions reveals that Tehran University of Medical Sciences (TUMS) (335; 33.36%), Shahid Beheshti University of Medical Sciences (SBUMS) (134; 13.34%), and Immunology, Asthma and Allergy Research Institute (IAARI) (109; 10.85%) are the top-producing institutions in IJAAI, respectively. These three institutions have contributed to approximately 57% of the journal's publications. Therefore, the TUMS is ranked first. In addition, three other top institutions are also affiliated with the TUMS, as demonstrated in Table 3. In terms of countries, it was found that Iran (777), China (69) and Turkey (42) are the top-producing countries in IJAAI publications, respectively.

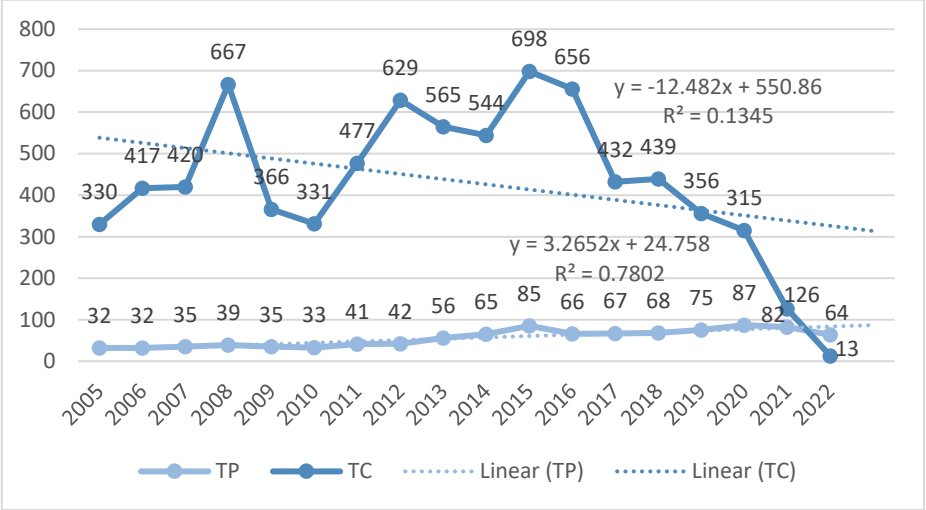

Figure 2. Distribution of publications and citations in IJAAI by year from 2005 to 2022.

Table 2. Annual citation structure of IJAAI.

Year	≥100	≥50	≥40	≥30	≥20	≥10	≥1	0	TP	TC	CPP
2005	0	0	0	3	2	6	18	3	32	330	10.31
2006	0	1	1	0	3	13	12	2	32	417	13.03
2007	0	0	1	1	3	14	15	1	35	420	12
2008	1	0	1	4	5	12	11	5	39	667	17.10
2009	0	0	0	1	5	7	22	0	35	366	10.45
2010	0	0	0	1	4	8	20	0	33	331	10.03
2011	0	0	0	4	4	14	16	3	41	477	11.63
2012	0	1	1	2	7	16	15	0	42	629	14.97
2013	0	0	0	1	4	23	28	0	56	565	10.08
2014	0	0	0	1	4	16	42	2	65	544	8.36
2015	0	0	1	0	5	25	46	8	85	698	8.21
2016	0	1	1	2	4	17	39	2	66	656	9.93
2017	0	0	0	0	2	16	45	4	67	432	6.44
2018	0	0	0	1	5	8	47	7	68	439	6.41
2019	0	0	0	0	2	8	54	11	75	356	4.74
2020	0	0	0	0	2	7	54	24	87	315	3.62
2021	0	0	0	0	0	1	53	28	82	126	1.53
2022	0	0	0	0	0	0	11	53	64	13	0.20
Total	1	3	6	21	61	211	548	153	1004	7781	-
%	0.09	0.29	0.59	2.09	6.07	21.01	54.58	15.23	100.00	-	-

Source: Own elaboration based on Scopus; ≥100, ≥50, ≥40, ≥30, ≥20, ≥10, ≥1 = number of papers with equal or more than 100, 50, 40, 30, 20, 10 and 1 citations; TP = Total papers; TC: Total citations; CPP: Citation per paper

Table 3. Top ten most productive and influential authors, institutes, and countries

N	Author	TP (%)	N	Institute	TP (%)	N	Country	TP (%)
1	Pourpak, Z.	66 (6.57)	1	Tehran University of Medical Sciences	335 (33.36)	1	Iran	777(77.39)
2	Moin, M.	50 (4.98)	2	Shahid Beheshti University of Medical Sciences	134 (13.34)	2	China	69 (6.87)
3	Rezaei, N.	41 (4.08)	3	Immunology, Asthma and Allergy Research Institute (TUMS)	109 (10.85)	3	Turkey	42 (4.18)
4	Movahedi, M.	35 (3.48)	4	Children's Medical Center (TUMS)	102 (10.15)	4	United Kingdom	30 (2.98)
5	Aghamohammadi,A	34 (3.38)	5	School of Medicine (TUMS)	98 (9.76)	5	United States	28 (2.78)
6	Fazlollahi, M.R.	30 (2.98)	6	Iran University of Medical Sciences	74 (7.37)	6	Netherlands	17 (1.69)
7	Gharagozlou, M.	26 (2.58)	7	Tarbiat Modares University	70 (6.97)	7	Germany	14 (1.39)
8	Bemanian, M.H.	23 (2.29)	8	Mashhad University of Medical Sciences	60 (5.97)	8	Italy	14 (1.39)
9	Mirshafiey, A.	21 (2.09)	9	Shiraz University of Medical Sciences	51 (5.07)	9	Sweden	14 (1.39)
10	Nabavi, M.	21 (2.09)	10	Baqiyatallah University of Medical Sciences	47 (4.68)	10	Australia	10 (0.99)

N= Number; TP = Total papers

Highly-cited Papers in the IJAAI

Table 4 presents 20 documents with the highest number of citations in IJAAI and their specifications, such as the number of received citations, title, author(s), year of publication, document type, average citations per article and average citations per year. The most highly cited article in IJAAI over the past 18 years is a review article entitled "*The role of reactive oxygen species in immunopathogenesis of rheumatoid arthritis*," which has received 138 citations.[45] This article, written by Mirshafiey A. and Mohsenzadegan M. and published in IJAAI in 2008, focuses on the role of reactive oxygen species in immunopathogenesis. The average citation per article is 0.13, and the average citation per year is 7.66. The second-ranked most highly cited article, with 60 citations, is also a review article entitled "*The immunopathogenic role of reactive oxygen species in Alzheimer disease*" authored by Mohsenzadegan M. and Mirshafiey A.[46] This article was published in 2012. also discusses the immunopathogenic role of reactive oxygen species in Alzheimer disease. It should be noted that among the 20 highly cited documents, six were reviews and the rest were research articles. In addition, all of these highly cited articles were co-authored by the collaboration of researchers. On the other hand, a higher number of authors (multi-authored papers) would lead to a higher number of citations.

Sources Citing IJAAI

One of the important, interesting and practical analyses for journals is the analysis of sources citing its documents. A total of 7220 documents were cited 1004 documents published in IJAAI. Table 5 provides the highly-citing authors, journals, institutions and countries cited IJAAI publications. At the author level, Rezaei, N. (118; 1.63%), Aghamohammadi, A. (114; 1.57%), and Abolhassani, H. (75; 1.03%) are the top three citing authors. IJAAI is ranked first at the source and journal level, meaning that this journal has the most citations (249 citations) to itself. *Frontiers In Immunology*, with 113 citations, and *International Journal of Molecular Sciences*, with 86 citations, are ranked second and third, respectively. At the institution level, the highest number of citations to IJAAI documents belongs to TUMS, SBUMS, and Mashhad University of Medical Sciences, respectively. Finally, the examination at the country level indicated that Iran (1927), China (1347), and the United States (976) are the top three countries citing IJAAI publications, respectively.

Table 4. Top 10 highly-cited papers in IJAAI based on Scopus

Rank	Authors	Year	Title	Total Citation
1	Mirshafiey A., Mohsenzadegan M.	2008	The role of reactive oxygen species in immunopathogenesis of rheumatoid arthritis	138
2	Mohsenzadegan M., Mirshafiey A.	2012	The immunopathogenic role of reactive oxygen species in Alzheimer disease	60
3	Kianmehr M., Ghorani V., Boskabady M.H.	2016	Animal model of asthma, various methods and measured parameters, a methodological review	58
4	Hassan Z.M., Ebtekar M., Ghanei M., Taghikhani M., Daloii M.R.N., Ghazanfari T.	2006	Immunobiological consequences of sulfur mustard contamination	56
5	Trajkov D., Mirkovska-Stojkovikj J., Arsov T., Petlichkovski A., Strezova A., Efinska-Mladenovska O., Sandevska E., Gogusev J., Spiroski M.	2008	Association of cytokine gene polymorphisms with bronchial asthma in Macedonians	48
6	Hosseini-Farahabadi S., Tavakkol-Afshari J., Rafatpanah H., Farid-Hosseini R., Daluei M.K.	2007	Association between the polymorphisms of IL-4 gene promoter (-590C>T), IL-13 coding region (R130q) and IL-16 gene promoter (-295T>C) and allergic asthma	47
7	Paiman S.A., Siadati A., Mamishi S., Tabatabaie P., Khotaee G.	2006	Disseminated Mycobacterium bovis infection after BCG vaccination	47
8	Farrokhi S., Gheybi M.K., Movahed A., Tahmasebi R., Iranpour D., Fatemi A., Etemadan R., Gooya M., Zandi S., Ashourinejad H., Alavizadeh S., Khoddami S.	2015	Common aeroallergens in patients with asthma and allergic rhinitis living in southwestern part of Iran: Based on skin prick test reactivity	46
9	Varmaghani M., Farzadfar F., Sharifi F., Rashidain A., Moin M., Moradi-Lakeh M., Rahimzadeh S., Moghaddam S.S., Kebriaeezadeh A.	2016	Prevalence of Asthma, COPD, and Chronic Bronchitis in Iran: A Systematic Review and Meta-analysis	44
10	Amirghofran Z.	2012	Herbal medicines for immunosuppression	42

Table 5. Sources that cited the IJAAI.

N	Author	TP (%)	Journal	TP (%)	Institute	TP (%)	Country	TP (%)
1	Rezaei, N.	118 (1.63)	Iranian Journal of Allergy Asthma and Immunology	249 (3.44)	Tehran University of Medical Sciences	661 (9.15)	Iran	1927 (26.68)
2	Aghamohammadi,A.	114 (1.57)	Frontiers In Immunology	113 (1.56)	Shahid Beheshti University of Medical Sciences	291 (4.03)	China	1347 (18.65)
3	Abolhassani, H.	75 (1.03)	International Journal of Molecular Sciences	86 (1.19)	Mashhad University of Medical Sciences	247 (3.42)	United States	976 (13.51)
4	Azizi, G.	59 (0.81)	International Immunopharmacology	77 (1.06)	Children's Medical Center (TUMS)	214 (2.96)	India	352 (4.87)
5	Pourpak, Z.	53 (0.73)	Plos One	64 (0.88)	School of Medicine (TUMS)	193 (2.67)	Italy	339 (4.69)
6	Ghanei, M.	50 (0.69)	Scientific Reports	52 (0.72)	Iran University of Medical Sciences	183 (2.53)	United Kingdom	292 (4.04)
7	Mirshafiey, A.	50 (0.69)	Allergologia Et Immunopathologia	49 (0.67)	Tabriz University of Medical Sciences	178 (2.46)	Germany	245 (3.39)
8	Boskabady, M.H.	49 (0.67)	Journal of Clinical Immunology	44 (0.60)	Research Center for Immunodeficiencies (TUMS)	138 (1.91)	Turkey	213 (2.95)
9	Mahmoudi, M.	46 (0.63)	Nutrients	38 (0.52)	Baqiyatallah University of Medical Sciences	135 (1.86)	Brazil	207 (2.86)
10	Yazdani, R.	43 (0.59)	Expert Review of Clinical Immunology	34 (0.47)	Tarbiat Modares University	125 (1.73)	Canada	204 (2.82)

N= Number; TP = Total papers

Co-authorship Map of Countries

Figure 3 shows the co-authorship network of contributing countries in IJAAI. In total, 59 countries have collaborated with this journal over the past 18 years. A threshold of 5 was considered for drawing the map of country collaborations, meaning that countries with at least five collaborated documents in IJAAI were included in the map. Two countries were excluded from the map because they had no collaboration with other countries. Finally, 21 countries were placed in eight clusters. According to Figure 3, the first cluster (in red) includes five countries: The United States, North Macedonia, Mexico, France and Egypt. The second cluster (in green) includes four countries: China, India, Japan and Serbia. The third cluster (in blue) includes four countries: Iran, Germany, Spain and Sweden. The fourth cluster (in yellow) includes three countries: The Netherlands, Pakistan and Turkey. The fifth cluster (in purple) includes two countries: The United Kingdom and Australia. Finally, Canada, Italy, and Malaysia are in the sixth, seventh and eighth clusters, respectively.

In Figure 3, the size of the circles represents the number of links (collaborations) a country has with other countries. The co-authorship map of countries shows that Iran had the most collaborations in the network of collaborating countries in IJAAI. According to the map, Iran has collaborated with 13 other countries. In addition, the highest collaborations have occurred between Iran and the United Kingdom (link strength = 46). The thickness of the lines represents the level of collaboration between countries; therefore, the thicker the lines are, the greater the level of collaboration is.

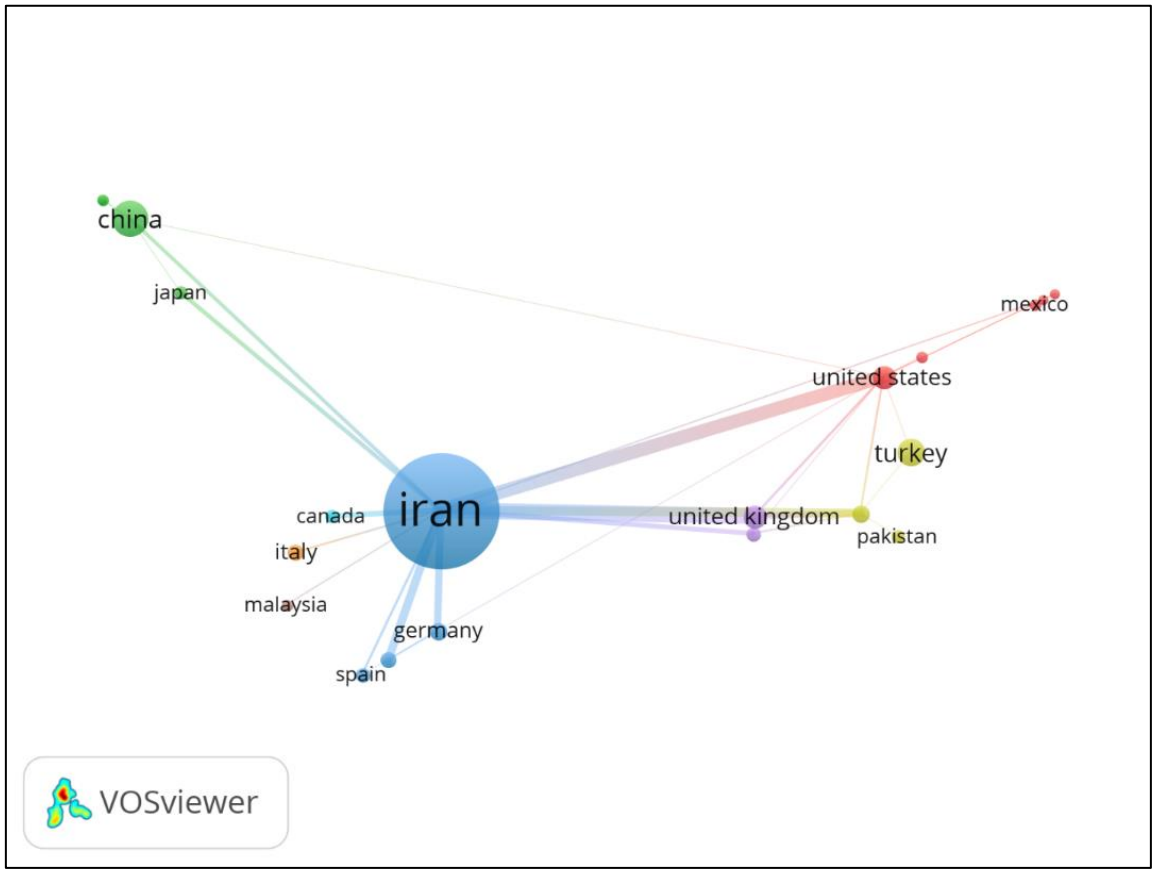

Figure 3. Co-authorship map of highly-productive countries in the IJAAI

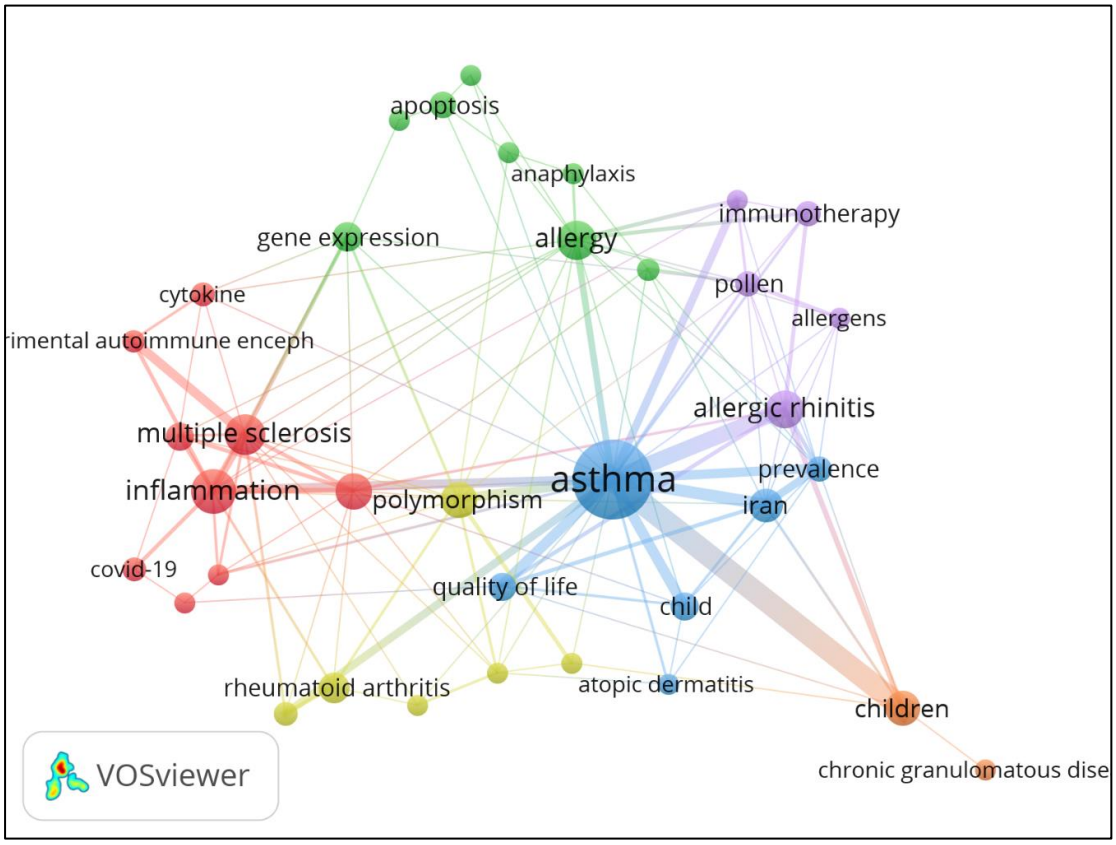

Figure 4. Co-occurrence map of highly-frequent author-assigned keywords of articles published in the IJAAI

Co-occurrence Map of IJAAI Author-assigned Keywords

Examining the keywords of articles published in IJAAI can provide useful information for IJAAI authors, readers and managers. Therefore, co-occurrence analysis was applied to identify and better understand the most frequent keywords. In the co-occurrence maps, the most frequent keywords are analyzed. For this purpose, a threshold of ten was considered and keywords with a frequency of ten or more were selected. According to Figure 4, a total of 36 highly-frequent keywords were placed in six clusters. The first cluster (in red) includes nine keywords: autoimmunity, common variable immunodeficiency, COVID-19, cytokine, cytokines, experimental autoimmune encephalomyelitis, inflammation, microRNAs, and multiple sclerosis. The second cluster (in green) includes eight keywords: allergy, anaphylaxis, apoptosis, breast cancer, flow cytometry, gene expression, hypersensitivity, and sulfur mustard. The third cluster (in blue) includes six keywords: asthma, atopic dermatitis, child, Iran, prevalence, and quality of life. The fourth cluster (in yellow) also includes six keywords: interferon-gamma, polymorphism, regulatory T cells, rheumatoid arthritis, single nucleotide polymorphism, and tuberculosis. The fifth cluster (in purple) includes five keywords: allergens, allergic rhinitis, immunotherapy, pollen, and rhinitis. Finally, the sixth one (in orange) includes the keywords children and chronic granulomatous disease.

Overall, the analysis of keywords indicates that IJAAI authors have used the following ten highly-frequenct and important keywords: Asthma (162), Inflammation (48), Multiple sclerosis (40), Allergy (38), Allergic rhinitis (36), Cytokines (31), Polymorphism (31), Children (29), Iran (27), and Rheumatoid arthritis (22). In addition, the highest co-occurrence of keywords has been observed between Asthma (total link strength=110) and children (total link strength=27).

Figure 5 indicates the co-occurrence network of keywords over time. This network is consistent with the conceptual clusters in the previous figure. According to the map legend, the keywords highlighted in light green and yellow are the ones that have become more prevalent since 2014 (the second decade of the journal). The keywords with darker colors were more common

before 2014 (the journal's first decade). Overall, the timeline map of highly-frequenct keywords indicates that in recent years, articles with keywords such as COVID-19, microRNAs, immunotherapy, inflammation, and rheumatoid arthritis have dominated the journal. These keywords are highlighted in yellow on the map, and articles on these topics belong to the last five years, after 2018. In the middle years of this period, particularly in 2016, keywords such as experimental autoimmune encephalomyelitis, gene expression, and anaphylaxis are highlighted (in light green) as the dominant keywords.

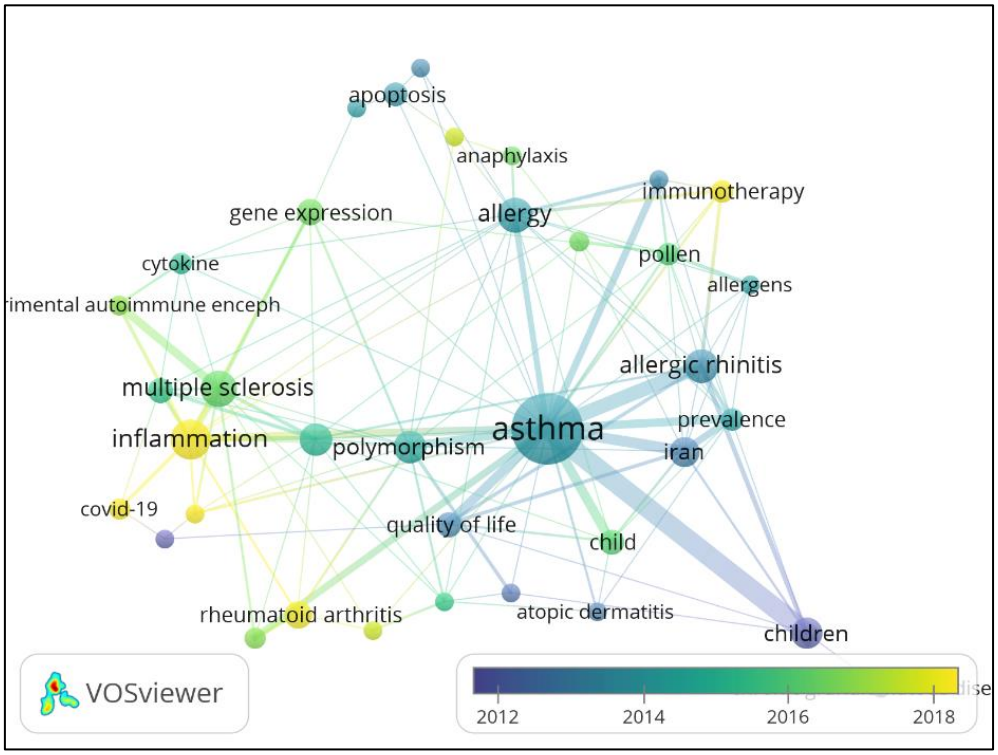

Figure 5. Co-occurrence map of time-based highly-frequent author-assigned keywords

Co-citation Map of Sources Cited by IJAAI Documents

Co-citation analysis was employed to investigate the references of IJAAI publications over the last 18 years. The results demonstrated that a total of 6,718 sources were cited in this journal.

Among these cited sources, 229, 115, 74, 48, and 36 sources were cited at least 20, 40, 60, 80, and 100 times, respectively. To draw the map of the most cited sources, a threshold of 100 was considered. Therefore, 36 sources with 100 or more citations were placed in three clusters. In co-citation maps, the larger the circle size is, the more citations it represents. As shown in Figure 6, the Journal of Allergy and Clinical Immunology (JACI) has the largest circle size among all sources, which means that IJAAI authors use articles from the JACI more often to write their articles. Since the JACI is one of the most important and reputable journals in the field of allergy and immunology, this is a logical result. According to the received citations, the top sources that IJAAI authors have selected for citing in their articles in the last 18 years are the JACI (791), Journal of Immunology (685), Blood (375), Allergy (371), Plos One (331), IJAAI (286), Clinical & Experimental Allergy (239), American Journal of Respiratory and Critical Care Medicine (236), Nature (233), The New England Journal of Medicine (229), The Lancet (224), Journal of Experimental Medicine (203), Science (192), etc.

This map has three colors, each representing a cluster of cited journals. In co-citation maps, when journals are placed in the same cluster, they are cited together more often. The first and largest cluster is highlighted in red and includes 17 journals, such as Journal of Immunology (685), Blood (375), Plos One (331), Nature (233), and Science (192). The second cluster, highlighted in green, includes 12 journals such as the JACI (791), Allergy

(371), Clinical & Experimental Iranian Journal of Allergy, Asthma and Immunology (286), Allergy (239), and American Journal of Respiratory and Critical Care Medicine (236), and Chest (168). Finally, the third cluster, highlighted in blue, includes seven journals such as The New England Journal of Medicine (229), The Lancet (224), Journal of Clinical Immunology (167), Tissue Antigens (164), Clinical and Experimental Immunology (153), Vaccine (114), and Clinical Immunology (116).

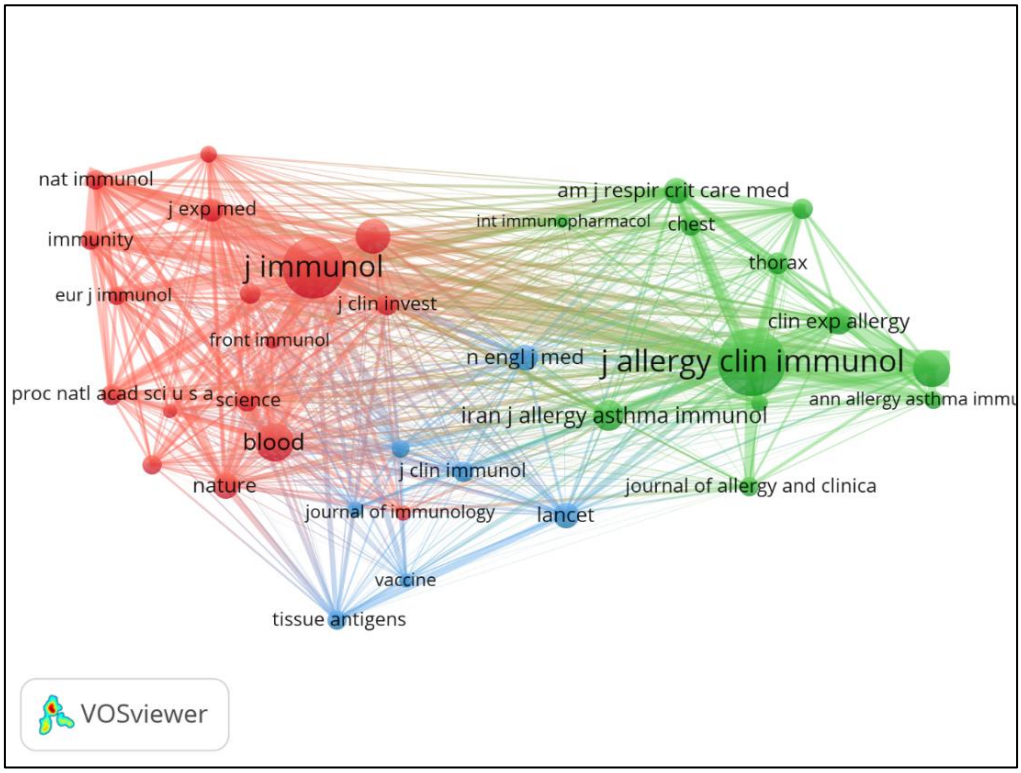

Figure 6. Co-citation map of sources cited in the IJAAI.

Authors' co-citation Map Cited in IJAAI Documents

When analyzing the references of a journal's articles, analyzing the cited authors is also important as it indicates which authors of citing journals have used articles of cited authors. The analysis of IJAAI publications' references indicated that 67,134 authors were cited in the articles of this journal. Among the cited authors, 161, 22, and 4 authors were cited at least 20, 50, and 100 times, respectively. Therefore, the authors who received at least 100 citations were included in the map. The results indicated that IJAAI authors had cited Aghamohammadi's articles more often in writing their articles.

Visualizing the Emerging Trends of IJAAI

CiteSpace software was applied to visualize the emerging trends of IJAAI over time. Emerging trends can be identified based on articles with the highest citation bursts in recent years. Figure 7 indicates a list of five articles with high citation bursts. As demonstrated in this figure, the citation burst of an article belongs to the last two years. This citation burst began in 2020 and continued until 2022. The mentioned article represents the emerging trends in IJAAI.

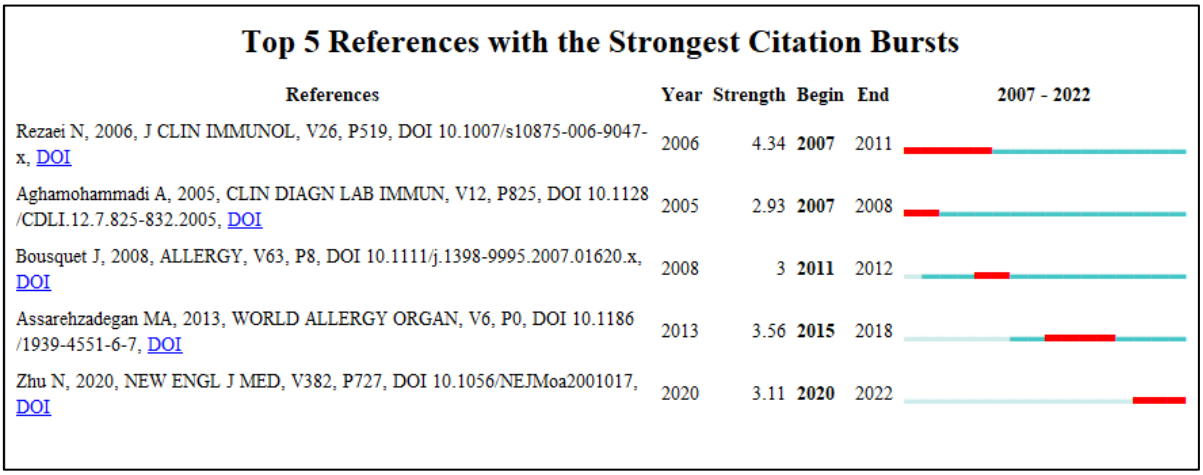

Figure 7. Top five articles with the most significant citation bursts

These articles have addressed topics including coronavirus, immunology, asthma, and allergies. The article by Na Zhu titled as "*A Novel Coronavirus from Patients with Pneumonia in China, 2019*" refers to the coronavirus and pneumonia.[47] This article was published in 2020 and received much attention from the scientific community in the same year. The article by Nima Rezaei titled as "*Frequency and clinical manifestations of patients with primary immunodeficiency disorders in Iran: update from the Iranian Primary Immunodeficiency Registry(2006)*" attracted much attention a year after its publication.[48] This article discusses the clinical manifestations of patients with primary immunodeficiency disorders in Iran. In general, all of these articles refer to emerging and interesting topics in IJAAI and are likely to be of great interest to researchers in the future.

Altmetric Analysis of IJAAI Documents

First, the most viewed articles in IJAAI were examined. These articles are listed in Table 6. This table ranks the top ten downloaded articles in IJAAI among articles published between 2005 and 2022. The total number of downloads (TD) of IJAAI articles, year of publication, and author are also listed in this table. The article "*Animal Model of Asthma, Various Methods and Measured Parameters: A Methodological Review*" ranks first with 3536 downloads.[49] This article was published by Majid Kianmehr et al. in 2016. The article by Masoud Aliyali et al. (2010) entitled "*Effects of N-Acetylcysteine on Asthma Exacerbation"* with 3479 downloads, and the article by Zahra Amirghofran (2012) titled "*Herbal Medicines for Immunosuppression*" with 3088 downloads rank second and third, respectively.[50,51]

In addition, the presence of IJAAI articles in various social media, such as Twitter, Facebook, Blogs, News, Wikipedia, Mendeley, etc., has been reported. According to the altmetric database, out of 1004 documents published in IJAAI, 606 (60.35%) were not mentioned in any social media. A total of 398 documents (39.64%) have been shared at least once on social media and have an altmetric attention score in the time of this investigation. Table 7 presents the characteristics of the top ten IJAAI articles with the highest altmetric attention scores and their most important altmetric indicators. According to Table 7, the research by Shishehbor F. et al. entitled as "*Quercetin effectively quells peanut-induced anaphylactic reactions in the peanut sensitized rats*" has the highest altmetric attention score and ranks first (45).[52] This article, published in 2010 and has been shared and mentioned twice by News outlets, 195 times by Twitter, and 19 times by Facebook pages. This article has 34 readers in Mendeley, 15 Dimensions Citations, and 19 Scopus Citations.

Table 6. Most frequently downloaded IJAAI articles since 2016

R	TD	Year	Authors	Title
1	3536	2016	Majid Kianmehr, Vahideh Ghorani and Mohammad Hossein Boskabady	Animal Model of Asthma, Various Methods and Measured Parameters: A Methodological Review
2	3479	2010	Masoud Aliyali, Ali Poorhasan Amiri, Ali Sharifpoor and Fatemeh Zalli	Effects of N-Acetylcysteine on Asthma Exacerbation
3	3088	2012	Zahra Amirghofran	Herbal Medicines for Immunosuppression
4	2782	2012	Aylin Ozgen Alpaydin 1, Mine Bora, Arzu Yorgancioglu, Aysin Sakar Coskun, Pinar Celik	Asthma Control Test and Asthma Quality of Life Questionnaire Association in Adults
5	2414	2007	Sedigheh Ebrahimi, Bahador Sarkari	Comparative Efficacy of Dexamethasone versus Hydrocortisone in Severe Acute Pediatric Asthma
6	2229	2016	Mehdi Varmaghani, Farshad Farzadfar, Farshad Sharifi, Arash Rashidian, Mostafa Moin, Maziar Moradi-Lakeh, Shadi Rahimzadeh, Sahar Saeedi Moghaddam and Abbas Kebriaeezadeh	Prevalence of Asthma, COPD, and Chronic Bronchitis in Iran: A Systematic Review and Meta-analysis
7	2113	2015	Sayed Mehran Marashian, Esmaeil Mortaz, Hamid Reza Jamaati, Mostafa Alavi-Moghaddam, Arda Kiani, Atefeh Abedini, Johan Garssen, Ian M Adcock and Ali Akbar Velayati	Role of Innate Lymphoid Cells in Lung Disease
8	1987	2016	Sama Bitarafan, Aliakbar Saboor-Yaraghi, Mohammad-Ali Sahraian, Danesh Soltani, Shahriar Nafissi, Mansoureh Togha, Nahid Beladi Moghadam, Tina Roostaei, Niyaz Mohammadzadeh Honarvar and Mohammad-Hossein Harirchian	Effect of Vitamin A Supplementation on Fatigue and Depression in Multiple Sclerosis Patients: A Double-blind Placebo-controlled Clinical Trial
9	1962	2020	Ali Esmaeili Vardanjani, Siamak Moayedi and Mohamad Golitaleb	COVID-19 Pandemic Hemoperfusion Therapy Versus Plasma Exchange Therapy in Intensive Care
10	1770	2016	Gholamreza Azizi, Shahin Khadem Azarian, Sepideh Nazeri, Ali Mosayebian, Saleh Ghiasy, Ghazal Sadri, Ali Mohebi, Nikoo Hossein Khan Nazer, Sanaz Afraei and Abbas Mirshafiey	Monogenic Auto-inï¬,ammatory Syndromes: A Review of the Literature

R: Rank; TD: Total downloads

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Table 7. Altmetrics score of the top ten highly-mentioned publications in the IJAAI.

Rank	First Author, Year, Title	Altmetric Score	News outlets	Blogs	Policy source	Tweeters	Face book pages	Wiki pedia page	Mendeley	Dimensions Citation	Scopus Citation	Rank
1	Shishehbor F. (2010). Quercetin effectively quells peanut-induced anaphylactic reactions in the peanut sensitized rats		2	0	0	195	19	0	34	15	19	3
2	Alizadeh, Z. (2021). A Pilot Study on Controlling Coronavirus Disease 2019 (COVID-19) Inflammation Using Melatonin Supplement		2	0	0	66	0	0	28	0	10	4
3	Mansourabadi, A. (2020). Intravenous Immunoglobulin Therapy in Myocarditis		2	0	0	2	0	0	12	1	1	7
4	Roostaei, T. (2015). Impact of Melatonin on Motor, Cognitive and Neuroimaging Indices in Patients with Multiple Sclerosis		0	1	0	3	0	0	100	0	19	3
5	Haidari, F. (2014). Comparison of Essential Fatty Acid Intakes and Serum Levels of Inflammatory Factors between Asthmatic and Healthy Adults: A Case- Control Study		0	0	0	21	0	0	36	0	8	5
6	Azizi, G. (2014). Effects of Imatinib Mesylate in Mouse Models of Multiple Sclerosis and In vitro Determinants		0	1	0	1	0	0	32	0	22	1

Table 7. Continued...

7	Yousefi Saqqezi, S. (2021). Combined Training Improves the Expression Profile of Inflammation-associated Antimicrobial Peptides, MicroRNAs, and TLR-4 in Patients with Multiple Sclerosis		1	0	0	3	0	0	22	0	2	6
7	Hormati, A. (2021). Production of SARS-CoV-2 Antibodies and Emergence of the Clinical Symptoms of COVID-19		1	0	0	3	0	0	44	0	2	6
8	Chirumbolo, S. (2011). Quercetin as a potential anti-allergic drug: which perspectives?		0	0	0	18	1	0	29	17	20	2
8	Fetyan, S. (2022). Lipopolysaccharide Responsive Beige-like Anchor Protein Deficiency in a Patient with Autoimmune Lymphoproliferative Syndrome-like Disease Phenotype: A Case Report and Literature Review		1	0	0	2	0	0	3	0	0	8

DISCUSSION

Bibliometric studies of any kind provide extensive information about global publication productivity, research trends over the years, the status of contributing countries, and citation data. Altmetric analyses reveal the individual impact of scientific items via the Internet and various online social media platforms. This study examined the status of IJAAI as a highly reputable journal in Iran in the field of allergy, asthma, and immunology using bibliometric and altmetric analyses. The results showed that the publication trend of IJAAI was somewhat developing, along with some hardship. The highest number of documents were published in 2020, which on one hand suggests ongoing scientific development in the field of allergy, asthma, and immunology, and on the other hand, it seems to be due to the emergence of COVID-19. In this period of time, there was a significant increase in the publication of articles in many scientific journals, too. Then, from 2020, the number of articles had a decreasing trend. The number of papers in the journal's second half was higher than that in the first half, which indicates that the journal has gradually become more international and been recognized by the scientific community more than in the first half. The trend of citations received by the journal was utterly downward and the journal experienced the lowest citation rate in the last 18 years, with only 13 citations in 2022. It seems that the journal is going through a natural process and needs more time pass to be cited. The citations in the first half of the journal were also higher than in the second half, which is a warning for IJAAI officials because it indicates that the number of users and citing articles for IJAAI is potentially decreasing.

In general, different factors are involved in the citation rate of a journal. Co-authorship is one of the indicators of receiving citations. In many studies, the relationship between co-authorship and the better quality of scientific works,[22] the relationship between international co-authorship and the impact factor of individual journals,[23] the relationship between co-authorship and productivity of active agents,[24] and the relationship between scientific collaboration and citation rates[25-27] have been confirmed. On the other hand, Ibáñez et al. (2012) demonstrated that international collaboration results in documents with higher citation rates than nationally and institutionally collaborated documents.[53] A possible explanation of this fact is that a large number of international and national collaborations spring from projects that need the participation of many researchers affiliated to different institutions, whereas most institutional collaborations usually involve authors from the same research group, that is normally involve fewer authors. So, works with international collaborations would have more citations than national and institutional documents. Therefore, considering the cases mentioned above, encouraging authors to collaborate can be influential in improving the quality of articles, scientific indicators of IJAAI, and the citations received by its articles. Three countries, including Iran, China and Turkey have the most contributions. In calculations based on GDP, these three countries were ranked as the first three ones. Despite the relatively low and moderate GDP of these countries, the high number of articles produced under geographic influence may explain this result. This part of result is aligned to study by Kocyigit and Akyol (2021) that mentioned that Turkey, China, South Korea, Japan and Italy were the five most productive countries.[54]

A total of 77.39% of IJAAI documents are from Iran. All the top 20 institutions, led by the TUMS, are Iranian. Most of the authors are also Iranian; among them, Pourpak, Z. is the most prolific author in IJAAI. These factors influence the number of citations received, as Ibáñez et al. (2012) found that journal articles had higher citations per document and citations per year than conference papers. [53] Therefore, accepting international-level and original articles in each issue of the journal can also be placed on the agenda of IJAAI officials to increase received citations. A review article entitled "*The role of reactive oxygen species in immunopathogenesis of rheumatoid arthritis*" is the most cited article published in IJAAI in the last 18 years. Most of the top 20 cited papers are original articles. Although more than three-quarters of the papers were original research articles, reviews reached a higher value in terms of average citation per article.

Analysis of the citing sources of the journal's documents revealed that, at the author level, Rezaei, N had the most citations among the authors. IJAAI ranks first at the level of citing resources and journals, which means that this journal has had the most citations to the itself known as self-citation. Chorus and Waltman (2016) believe that self-citation of journals may result from increased misconduct in science, but they explain

that there are many ogical reasons for self-citation of journals.[55] On the other hand, editors of high-impact journals tend to accept papers with more self-citation rates, as their authors have considered the relevant issues and topics of great interest to the readership. Interestingly, articles with more self-citations also receive more citations, confirming their heavy relationship with the journal and its readership.[56] While some studies have criticized the self-citation of journals in higher rates due to its potential role in inflating the impact factor,[57] this may indicate convergence in research interests between the author/authors and the journal at hand. Therefore, the self-citation of the journal is a valuable indicator in determining the suitability of an article for the journal and its readership and helping the article achieve greater visibility and impact. High-impact journals benefit more from self-citation, as their editors accept that articles of more relevant meet the information needs of their readers. Given these points, it is recommended that a balance be made between the number of self-citations and the number of citations to other journals and citing resources in IJAAI.

At the country and institution levels, the highest citations to IJAAI documents belong to Iran and the TUMS, respectively. Three other top institutions were also affiliated to the TUMS, indicating TUMS's high impact on IJAAI. Iran has had the most collaboration in the network of participating countries in IJAAI, well demonstrated by analyzing the international network of national collaborations, which showed that Iranian researchers are familiar with IJAAI; however, the number of international collaborations versus national collaborations should increase. Interestingly, the Iran-United Kingdom collaboration cluster was the thickest, indicating that the collaboration occured mainly between Iran and the United Kingdom, which is somewhat consistent with the retrieved publications from the database. The United Kingdom ranked fourth in the number of publications in the journal after Turkey. It is noteable that in the United Kingdom, allergy specialists are scarce and general practitioners provide most of the allergy care.[58]

Asthma, inflammation and multiple sclerosis are the three most frequent and important keywords used by IJAAI authors. In addition, the highest co-occurrence of keywords occurred between the terms asthma and children. The analysis of co-citations of cited sources indicated that IJAAI authors mostly use articles from the Journal of JACI. This journal is one of the most important and reputable journals in the field of allergy and immunology. In addition, most of these cited journals are well-known, reputable, high quality and have a significantly high impact factors. Therefore, it can be concluded that IJAAI authors have employed high-quality and reputable sources in their articles.

In examining newly-emerging and interesting hot topics in IJAAI, the results demonstrated that the article by Na Zhu entitled "*A Novel Coronavirus from Patients with Pneumonia in China, 2019*" refers to coronavirus and pneumonia. This article was published in 2020 and received much attention from the scientific community in the same year. Moreover, the article by Nima Rezaei entitled "*Frequency and clinical manifestations of patients with primary immunodeficiency disorders in Iran: update from the Iranian Primary Immunodeficiency Registry*[48]" which refers to the clinical manifestations of patients with primary immunodeficiency disorders in Iran received much attention one year after its publication. In most cases, emerging topics will likely be of much interest in the future.

The article by Majid Kianmehr et al. entitled "*Animal Model of Asthma, Various Methods and Measured Parameters: A Methodological Review*" was the most viewed in IJAAI [49] as it had the highest downloads. It is important to note that downloads and clicks indicate interest and attention but do not indicate the actual user groups and real use of information; therefore, the potential background remains unclear in this regard.[59] Therefore, some downloads may even reach a dead end because no one exactly knows what happens with the downloaded documents or information after clicking on the links at hand. Therefore, the presence of IJAAI articles in various online social media was examined to overcome this limitation. It should be noted that altmetrics, such as citation-based bibliometrics, does not reflect the quality of research output, but only measures online attention to publications shared in social media. The results of altmetrics analysis indicated that the article by Shishehbor F. et al. entitled "*Quercetin effectively quells peanut-induced anaphylactic reactions in the peanut sensitized rats*" had the highest altmetric attention score.[52] A total of 60.35% of all IJAAI publications were not mentioned in any social media. Only 39.64% of the publications were shared at least once on social media and had an altmetric attention score. For a reputable specialized journal, this is a low rate. As Ortega (2017) pointed out, this may be due to the unfamiliarity of authors and readers with social

media, the unawareness of their role in disseminating scientific information, and the non-inclusion of altmetric indicators on the journal's website. These results are consistent with those reported by other literatures.[20,40,60-62] In a 2017 study on Twitter accounts and online attention, Ortega suggested that the presence and activity of a journal or an editor on social media is a key factor in helping disseminate journal productions socially.[60] The subject matter of published articles plays a key role, as Holmberg and Vainio reported in 2018, depending on the platform, personal connection to the research topic, and interesting topics in terms of research novelty, all have often been cited as some reasons for increasing online attention.[63]

In the case of IJAAI, the limited presence of articles in social media is likely due to the journal's specialized and specific nature and the difficulties people have in understanding these types of research. A specific article or topic receives a high altmetric score or online attention due to the popularity of the topic at hand among non-professional members, such as the public. Therefore, it is recommended to create social media accounts to the journal to facilitate the dissemination of its research output among non-academic audiences and readers. Authors should also report the practical or clinical implications of their research findings and their impact on the general public in an easy-to-understand and accessible way and mention accurately the limitations of their results. In this way, the easy-understandable translation of knowledge by experts can be better articulated and research results can be directed toward practical applications.

Iranian Journal of Allergy, Asthma, and Immunology is 18 years old. In celebration of its 18th anniversary, this analytical bibliographic study presents over 1000 documents from this journal. A wide range of techniques, including among others bibliometric and altmetric analyses were applied for this purpose. The growth of scientific publications, alongside a decrease in received citations proves that attention to the quality of contents and the quantity of journal publications is essential for more growth in citation rates. The quality of IJAAI publications is relatively high as many of the journal's publications are cited by high-ranking indexed journals. Moreover, presence on online scientific social media strengthened visibility. The policymakers of this journal should target potential populations of this field to increase readership and citations of the journal.

Furthermore, IJAAI can flourish through international collaborations and the greater participation of its authors because Iran and Iranian institutions currently play an active role in IJAAI publications. In conclusion, since IJAAI is an important ISI-indexed journal in the field of asthma, allergy, and immunology, this study provides an excellent and helpful reference for researchers and stakeholders interested in conducting research in these areas. In other words, this bibliometric analysis serve as a roadmap for IJAAI officials. This study can help researchers to compare and determine new trends and scientific landscape in the allergy, asthma, and immunology field. Also, it allows them to conduct bibliometric studies for other journals through empirical methods and compare the results obtained with our results.

STATEMENT OF ETHICS

This study was approved by the ethics committee of Iran University of Medical Sciences, Tehran, Iran (No:IR.IUMS.REC.1401.676).

FUNDING

This study was approved by Student Research Committee of Iran University of Medical Sciences (Approval number: 24080).

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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Not applicable.

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