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Original Article

A Bibliometric Study of Articles Published in the International Journal of Medical Laboratory

Ismael Mostafavi [1*] Ph.D., Somaye Dehghani-Sanij [2] M.Sc.

[1] Department of Information Science and Knowledge Studies, Yazd University, Yazd, Iran
[2] Department of Medical Library and Information Science, School of Health Management and Information Sciences, Iran University of Medical Sciences, Tehran, Iran

A B S T R A C T

Introduction: This study undertakes the first bibliometrics analysis of the past 10 years of the International Journal of Medical Laboratory (IJML), covering the articles published from 2014 to 2023. The study's focus is to describe the characteristics of scientific outputs by analyzing the performance and conceptual trends of IJML.

Materials and Methods: This applied study examines all articles published in the IJML journal through all its 32 issues by 2023. Keywords and authors' scientific collaboration network analysis were performed through bibliometrics and social network analysis, using Microsoft Excel, VOSviewer, and statistical software.

Results: 288 articles were published in the IJML journal, by 1315 authors from 116 universities and research institutes from 2014-2023. "Polymerase chain reaction (PCR) technique", "Bacteria," and "Neoplasms" were the most valuable body of information identified based on the keyword visualization and density maps. There was no significant relationship between title length and abstract views or fulltext downloads (p = 0.514, p = 0.362, respectively). However, a significant correlation exists between abstract views and fulltext downloads (p = 0.0001). Statistical correlation coefficients for the top 50 organizations show a strong positive correlation among the number of authors, submissions, and acceptances (p = 0.0001).

Conclusion: The paper identified the leading trends of the IJML journal in terms of papers, authors, institutions, and keywords. There was a moderate variety according to the distribution and scope of the contents published. Analyzing the journal's trends and current research helps policymakers foster innovation and collaboration in medical laboratory science research.

***Corresponding Author:** Department of Information Science and Knowledge Studies, Yazd University, Yazd, Iran. **PO. Box:** 8915818411, **Tel:** +983531233658, **Email:** mostafavi@yazd.ac.ir

Introduction

In today's rapidly advancing medical field, the crucial role of medical laboratory science in healthcare is undeniable [1]. In other words, medical laboratory science bridges the gap between clinical medicine and scientific investigation [2]. Its pivotal role is precisely and systematically analyzing biological specimens, including blood, urine, tissues, and other bodily fluids. Rigorous analysis of bodily fluids not only facilitates disease diagnosis and treatment but also underpins routine preventive medicine. Digital publishing, in particular, allows for rapid dissemination and accessibility. Moreover, Journals can publish research on cutting-edge lab techniques and technologies [3].

Since its launch in 2014, the International Journal of Medical Laboratory (IJML) has enhanced its accessibility through online full-text access, and emphasized the importance of peer review, ensuring that published articles maintain high academic standards. While it benefits from focused specialization and diverse topics, IJML also covers a broad range of topics within medical laboratory science, including diagnostic techniques, laboratory technology, molecular biology, and clinical applications, making it relevant to researchers and practitioners. The IJML's scope on practical and clinical applications of laboratory science tries to cover all aspects of medical laboratory and medical basic sciences, biochemistry, biotechnology, genetics, hematology, microbiology, immunology, parasitological, and mycology ensures that its research findings are directly relevant to medical practice [4].

Bibliometric analysis has emerged as a critical tool for enhancing the visibility and credibility of scientific journals. Researchers can identify influential articles and emerging fields by examining citation counts and patterns. Additionally, analyzing collaboration networks reveals the interconnectedness of researchers and institutions, highlighting the flow of knowledge and the formation of scientific communities [5].

Regular bibliometric analysis is beneficial and essential for journals aspiring to be indexed in prestigious international scientific databases [6]. The necessity of this practice lies in several key areas, such as demonstrating research impact and quality, identifying key research areas and trends, enhancing editorial and review processes, and enhancing visibility and accessibility. These factors collectively enhance a journal's profile, making it more competitive for inclusion in prestigious scientific databases. Through regular and rigorous bibliometric evaluations, journals can continuously improve and align themselves with the high standards required for global recognition and indexing [7]. To enhance the quality of the journal, it is essential to conduct such a study, as the future direction is contingent upon the findings.

The IJML represents a rich data source for such studies, yet comprehensive bibliometric analyses of this journal are sparse. By focusing on the IJML, this study aims to fill this gap and provide a detailed examination of research topics and collaboration networks over the past decade. The significance of this analysis lies in its ability to map the progression and shifts in medical laboratory

science research, offering a clear depiction of the journal's contributions to the field.

Materials and Methods

Performance analysis and science mapping are the main techniques of bibliometric analysis. While descriptive metrics patterns performance analysis, mapping techniques are required to reveal intellectual, conceptual, and social structures among research constituents [8]. Likewise, content analysis of all articles published in the IJML journal was performed, indicating descriptive characteristics of scientific outputs, co-word analysis, and clustering of keywords. Therefore, a quantitative approach via analytical-descriptive methods furthers this applied research.

Performance analysis

The journal performance analysis was based on bibliographic and citation data. Bibliographic data includes the total number of published articles, the total number of participating authors, sole-authored publications, co-authored publications, the number of active years of journal publication, and publication patterns from various dimensions such as the pattern of authorship, institutions, and countries. In the citation analysis section, citation data includes the total number of citations, the average citation per article, and the H index of the journal.

Conceptual analysis

Co-occurrence and citation analysis were used to map the conceptual content of the journal. Clustering and illustration of frequent words were performed to map the keywords in the content published by the IJML and the social network interactions of authors.

Data source

The journal's website (http://ijml.ssu.ac.ir) was used to search for articles published in the IJML. Only published articles from 2014 to 2023 were included, and rejected or unpublished manuscripts were excluded. Census sampling was done using the tools embedded in the article reporting section via the journal's information management system. Then, the desired data was downloaded as an Excel spreadsheet document [9].

Data curation

Published article information, including authors' name, article title, publication year, keywords, and affiliations were recorded for bibliometric analysis, then cleaning and pre-processing of data were applied, including but not limited to the following steps:

• Vocabulary standardization (Word ramification and unifications, abbreviations, acronyms, spellings, and stop words management)

• If the names of departments, institutions, and countries were part of the statistical population of the research were not included in the descriptive data.

• The keyword "COVID-19" was differentiated from "viral infections" due to the importance of the period corresponding to the post-Covid-19 era.

Statistical analysis

Microsoft Excel software (Version 2021) was used for data collection and pre-processing. Publication number, publication year, publication country, and the topic of the articles. The co-word matrix preparation was provided using RavarPreMap software (Version 1.2). Bradford's law was used to select the cut point threshold building co-occurrence matrix. Then, using VOSViewer software (Version 1.6.16, Leiden

University, Leiden, Netherland), the keywords co-occurrence network and authors' social network were mapped. Furthermore, the Spearman correlation test via the Statistical Package for the Social Sciences software (SPSS, Version 22) was used for further data analysis.

Results

Performance analysis of IJML

This section presents the findings from the analysis of publications. By 2023, IJML has published 288 articles forming 32 issues, all of which meet the inclusion criteria for this research. The total number of citations received is 658, with 481 citations for articles published in the last five years (Table 1). Figure 1 illustrates the productivity per active publication year and the stability of citations for IJML articles, based on author and citation metrics. Out of a total of 1315 authors, 0.05 percent of non-Iranian authors contributed to IJML publications. The most cited publications were by Momtaz H (2015), Rostaei Rad N (2016), and Kamalabadi M (2018), with 45, 19, and 17 citations, respectively. The average citation rate for all selected articles is 2.28, resulting in an H-index of 9 (Accessed date: 20 August 2024) (Table 2).

Table 1. IJML performance analysis from 2014 to 2023

Journal-related statistics	Results	Article-related statistics	Results
Number of volumes analyzed	10	Documents per authors	0.22
Published articles	288	Authors per document	4.56
Average time to review (days)	172	Views	533168
Average time to publish (days)	75	Average view per article	1851.2
Total authors	1315	Downloads	216695
Sole-authored articles	6	Average download per article	752.4
Co-authored articles	282	Total citation	658
Iranian authors	1251	Average citations per document	2.28
Non-Iranian authors	64	Authors' keywords	910

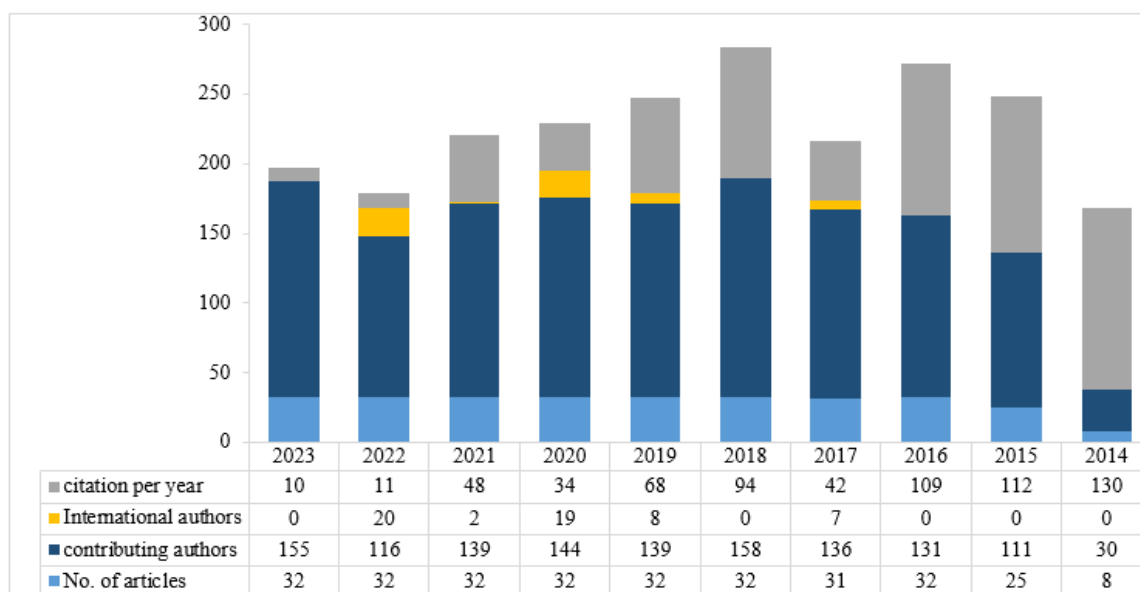|	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014
citation per year	10	11	48	34	68	94	42	109	112	130
International authors	0	20	2	19	8	0	7	0	0	0
contributing authors	155	116	139	144	139	158	136	131	111	30
No. of articles	32	32	32	32	32	32	31	32	25	8

Fig. 1. Productivity and citations for IJML by active publication year, 2014-2023

Table 2. Top ten most cited articles in IJML from 2014 to 2023 according to Google Scholar

Authors	Title	Year	citation	Reference
Momtaz, H.	Determining the prevalence and detection of the most prevalent virulence genes in *Acinetobacter baumannii* isolated from hospital infections.	2015	45	[10]
Rostaei Rad, N.	The relationship between thyroid hormone levels and body iron status in Iranian hypothyroidism patients.	2016	19	[11]
Kamalabadi, M.	Anti-viral effect and mechanism of carvacrol on herpes simplex virus type 1.	2018	17	[12]
Pourmasumi, S.	The effect of vitamin E and selenium on sperm chromatin quality in couples with recurrent miscarriage.	2018	17	[13]
Dashti-R, MH.	Comparative effect of cinnamon essential oil, diclofenac, and morphine on acute and chronic pain in mice.	2016	13	[14]
Hosseini Pour, P.	Investigating class I, II, and III integrons in multidrug resistance in Pseudomonas aeruginosa isolated from hospital infections in Ahvaz.	2015	11	[15]
Razi, M.	The peep of nanotechnology in reproductive medicine: a mini-review.	2015	11	[16]
Gholaminejad, F.	Propolis Supplementation Effects on Semen Parameters, Oxidative Stress, Inflammatory Biomarkers, and Reproductive Hormones in Infertile Men with Asthenozoospermia; A Randomized Clinical Trial.	2019	10	[17]
Nayeri Chegeni, T.	Genotyping of Acanthamoeba Species Isolated from Keratitis Patients by PCR Sequencing Methods in Tehran, Iran.	2019	9	[18]
Ghahramani, R.	Anti-diabetic effect of Portulaca oleracea (purslane) seeds in alloxan-induced diabetic rats.	2016	9	[19]

Conceptual analysis of IJML

The keywords co-occurrence of articles published in IJML are visualized in Figure 2. A minimum threshold of 5 keywords out of 1150 was established, while 910 keywords met this criterion. Each node represents a concept tied to a keyword, and the edges connecting them indicate existing relationships. The node size corresponds to the keyword's weight, while the color signifies its cluster. As illustrated in Figure 2, the distance between keywords in the visualization reflects their conceptual relatedness; closer keywords indicate stronger connections. "Bacteria", "Polymerase chain reaction (PCR) technique", "Neoplasms", "Parasites", and "Reproductive medicine," were the most frequent keywords with occurrences of 29, 28, 21, 19, and 18, respectively.

Keyword density mapped in Figure 3, indicates each item density by color, ranging from blue to green to yellow. Keywords at the center, appear in brighter colors, showing more connected keywords and higher weights. Conversely, further keywords occur less frequently. Low-density areas, such as keywords related to niche techniques like "Wesern Blot", suggest less explored or emerging fields within the journal. Total link strength scores are shown in Figure 4. High scores of total link strengths suggest well-integrated keywords in the journal's landscape disposed of driving collaboration and thematic focus. Keywords like "PCR technique" (156), "bacteria" (150), "neoplasms" (122), "reproductive medicine" (104), "genes" (102), and "parasites" (94) had the highest total link stregths, reflecting their influential role connecting other keywords.
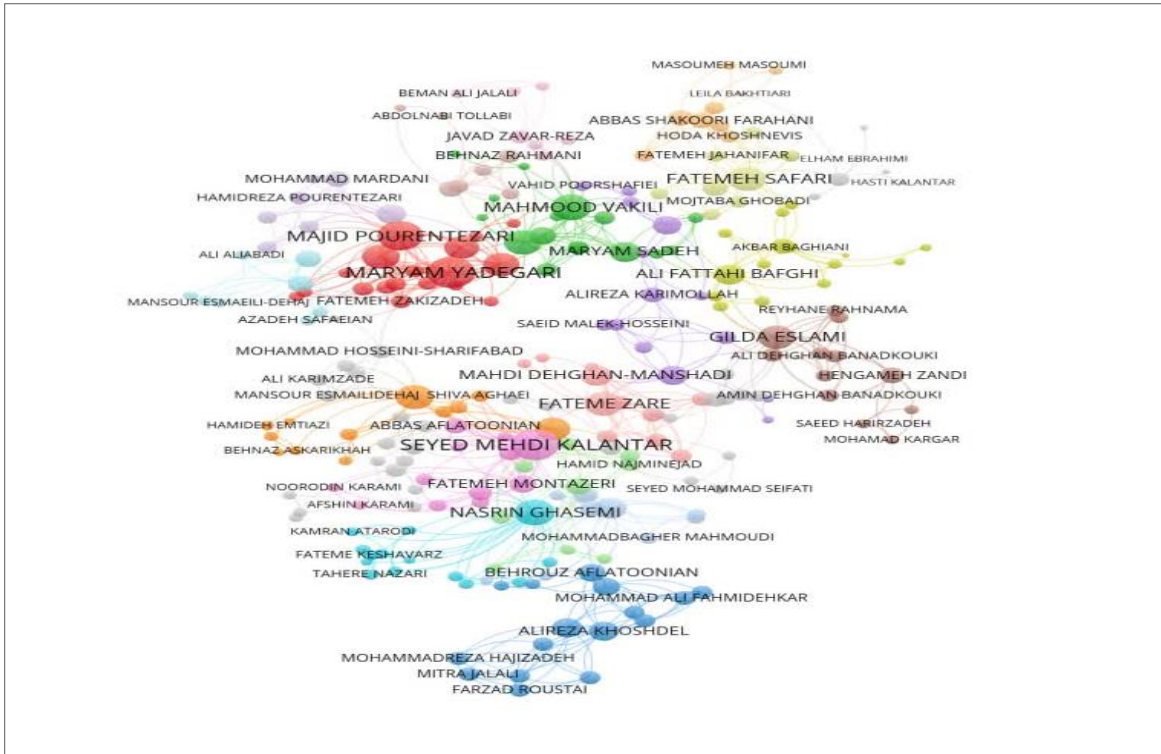
The authorship network revealed the research collaboration authored by 1315 contributors of IJML articles published from 2014 to 2023 (Fig. 5). The most prolific contributors are Mehdi Taheri Sarvtin with nine articles, followed by Hassan Mumtaz, Maryam Yadegari, and Mohadeseh Kamali with eight each. Nasrin Ghasemi, Seyed Mehdi Kalantar, and Seyedhossein Hekmatimoghadam each published seven articles, while Elham Bahreini and Fateme Zare published six. The network of authors who contributed to at least five articles consists of 24 nodes and 135 edges, indicating moderate connectivity. Table 3 presents the authorship network total link strength of IJML articles published from 2014 to 2023. The authors' influence increases as more connections to other authors exist in the network. Therefore, Seyed Mehdi Kalantar (70), Maryam Yadegari (68), and Majid Pourentezari (62) were identified as the most influential authors. Figure 6 maps the institutions affiliated with the IJML articles published by 2023. Shahid Sadoughi University of Medical Sciences (N = 95), as the publisher of IJML, was the most prolific institution affiliated with the IJML publications, followed by Azad Islamic University (N = 72), and Iran University of Medical Sciences (N = 29). Conversely, the least prolific institutions were Imam Khomeini Hospital Complex, Shahrekord University of Medical Sciences, and Shahrood University of Medical Sciences.

Fig. 2. Keywords co-occurrence of IJML articles from 2014 to 2023

Fig. 3. Keywords density analysis of IJML from 2014 to 2023

Fig. 4. Keywords total link strengths in IJML articles published from 2014 to 2023

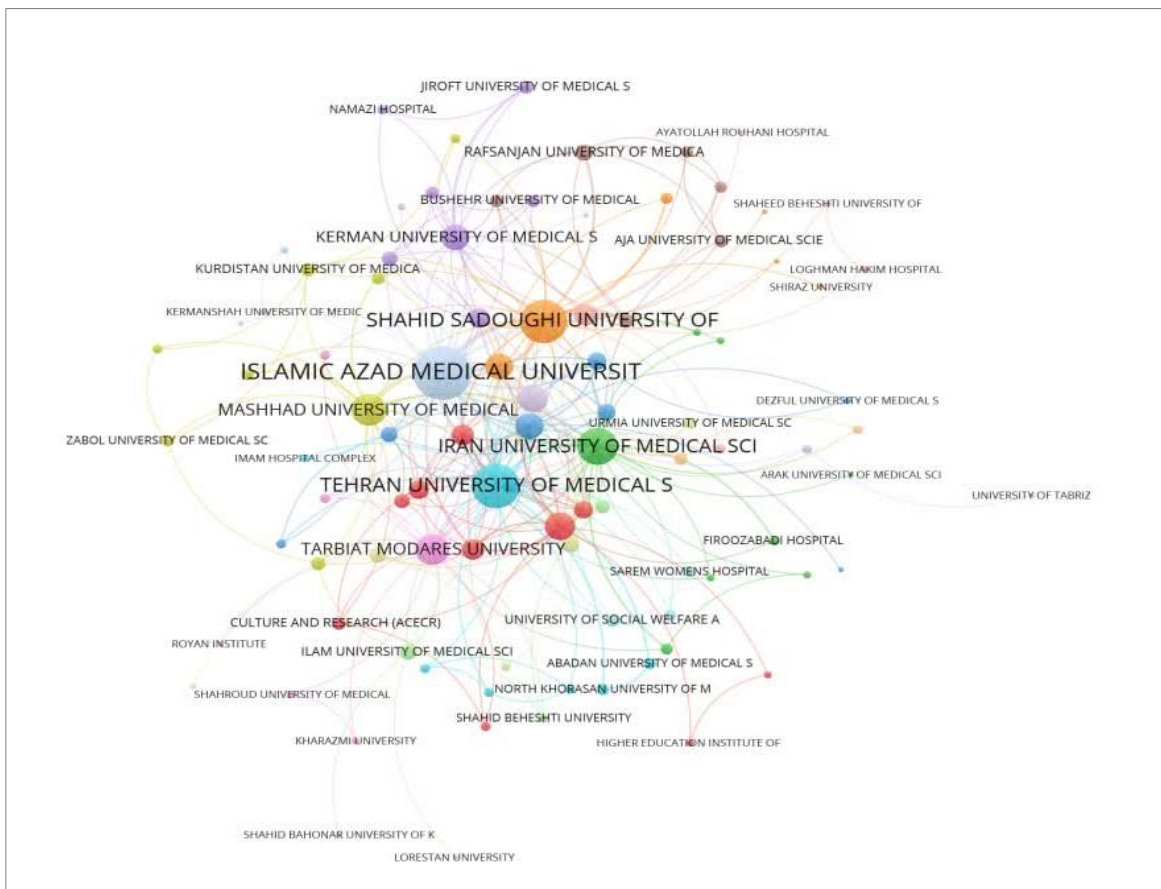**Fig. 5.** Authorship network of IJML articles published from 2014 to 2023

Fig. 6. Mapping author affiliations for IJML articles from 2014 to 2023

Table 3. Authorship network total link strength of IJML articles published from 2014 to 2023

No.	Author	Total link strength	No.	Author	Total link strength
1	Seyed Mehdi Kalantar	70	6	Seyyede Fatemeh Shams	50
2	Maryam Yadegari	68	7	Nasrin Ghasemi	46
3	Majid Pourentezari	62	8	Soodeh Namjoo	46
4	Mohammad Hadi Sadeghian	58	9	Fateme Zare	44
5	Farhad Zaker	52	10	Mahmood Vakili	44

Table 4. Total link strength scores of institutions affiliated with IJML articles published from 2014 to 2023

Rank	Academic and research institutions	Total link strength
1	Islamic Azad Medical University	178
2	Tehran University of Medical Sciences	126
3	Shahid Sadoughi University of Medical Sciences	116
4	Iran University of Medical Sciences	88
5	Mashhad University of Medical Sciences	64
6	Tarbiat Modares University	60
7	Shahid Beheshti University of Medical Sciences	48
8	University of Tehran	48
9	Ahvaz Jundishapur University of Medical Sciences	44
10	Isfahan University of Medical Sciences	44

Table 5. Descriptive statistics on co-authorships, submissions, and acceptances from the 50 universities with the most articles published in IJML from 2014 to 2023

Universities (N=50)	Min	Max	Median	Sum	Mean±SD	P-Value[*]
Co-authorships	5	170	12	1262	25.24±33.19	0.0001
Total submissions	1	60	4	338	6.76±9.58	0.0001
Accepted articles	0	46	3	235	4.70±7.18	0.0001

[*]Differences are statistically significant at $p < 0.05$.

Table 6. Descriptive statistics on title length, views, and downloads for IJML from 2014 to 2023

Variable	Min	Max	Median	Sum	Mean±SD
Title length	8	28	15	4369	15.17±3.81
Abstract views	291	6617	1653.5	533168	1851.27±1179.33
Fulltext downloads	104	3361	642.5	216695	752.41±513.26

Table 7. Spearman's rho correlation between title length, views, and downloads for IJML from 2014 to 2023

Spearman's Rho correlation		Title length	Abstract views	Fulltext downloads
Title length	Spearman's rho	-		
	p-value	-		
Abstract views	Spearman's rho	0.054	-	
	p-value	0.362	-	
Fulltext downloads	Spearman's rho	0.039	0.913	-
	p-value	0.514	0.0001	-

Institutions affiliated with countries other than Iran included India (N = 6), Nigeria (N = 5), Turkey (N = 3), and Australia (N = 1). Table 4 represents the total link strength scores of 1675 affiliations associated with IJML articles published from 2014 to 2023. In terms of affiliation network total link strength, Islamic Azad University (178), Tehran University of Medical Sciences (126), and Shahid Sadoughi University of Medical Sciences (116) were the most influential institutions. The affiliations of 1675 authors Were analyzed to pinpoint the key organizations and academic institutions cited in IJML articles. After manually reviewing these affiliations, data on organizations, universities, faculties, and departments were compiled. Table 4 displays the publication patterns of the academic and research institutions linked to the IJML articles.

Table 5 represents the descriptive statistics in terms of co-authorship, manuscript submission, and article acceptance associated with the top 50 institutions (universities) that published the most articles in the IJML journal by 2023. Spearman's rho correlation coefficients for the top 50 institutions showed a strong positive correlation for co-authorships, manuscript submission, and article acceptance (R = 0.888, 0.858, and 0.953, respectively). This indicates that as the number of co-authorships increases, so do the rates of submissions and acceptances. The significance value (p<0.05) further confirms that the relationships among these variables are statistically significant.

Descriptive statistics of all 288 articles' title length, the number of abstract views, and the number of full-text downloads of the articles published in the IJML journal in 2014-2023 are represented in Table 6. The average title length of the articles was found to be approximately 15 words, with a standard deviation of 3.8. In terms of abstract views, the mean number of views per article reached 1851.27, with a maximum of 6617 views observed for a particularly engaging piece. The standard deviation of 1179.33 highlights that while many articles garnered a modest number of views, a select few achieved significant visibility within the academic community. Regarding article full-text downloads, the average number of full-text downloads was slightly lower, at 752.41 downloads per article, indicating that while articles attract attention through abstract views, not all are converted into full-text downloads. The range of full-text downloads, with a maximum of 3257, suggests that certain articles resonate more strongly with the audience, leading to higher engagement.

As shown in Table 7, Spearman's rho correlation coefficient was calculated based on the number of words in the article titles (title length), the number of views, and the number of downloads of the articles published in the IJML journal in ten years. This correlation coefficient shows that there is no significant relationship between the article title length and the number of abstract views and full-text downloads (p = 0.514, p = 0.362, respectively). However, there is a significant correlation between article views and downloads (p = 0.0001).

Discussion

In today's rapidly evolving medical research and technology era, one can hardly imagine a healthcare system without the contributions of medical laboratory sciences. Similarly, the laboratory analysis of body fluids plays an essential role in diagnosing and treating disease and routine preventative medicine [1, 2, 3]. Additionally, journals can adapt to these changes by embracing digital transformation and staying abreast of technological advancements [21]. Therefore, in recent advancements in medical laboratory science, bibliometric studies provide quantitative insights into the research landscape of specific journals, enabling scholars to assess publication trends, authorship patterns, citation impacts, and thematic focuses [22].

In light of medical laboratory science's evolution, journals must adapt their scope, while bibliometrics guide decisions on expanding or narrowing focus areas, ensuring their alignment with the field's growth [7]. IJML established in 2014, has contributed to publishing scientific articles in medical laboratory science. The following discussion reviews prior bibliometric analyses of some similar journals, highlighting their methodologies, findings, and contributions to the understanding of scholarly output in this field.

A review of the related literature showed that few bibliometric studies have been conducted in the field of clinical and medical laboratory science journals. In 1999, Siebers studied the error rate of references in articles published in the New Zealand Journal of Medical Laboratory Science [23]. In 1994, Watson and Perrin studied the coverage by the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and MEDLINE of the literature in four allied health areas: medical technologies, medical records, radiologic technologies, and respiratory therapies [24].

Delwiche et al., analyzed citations from three widely-read journals in clinical laboratory science over three years. Applying Bradford's law in 2003, the researchers created three zones of journals: 13 in the first zone, 81 in the second, and 849 in the third and concluded that due to the broad scope of the field, no database can claim to cover it comprehensively, but rather their different strengths serve to complement one another [7]. Železnik, in a study, analyzed the Journal of Advanced Nursing over 40 years, focusing on publication trends, prolific authors, and institutions. It found a positive trend in literature production, with the United Kingdom leading in successful publications. Thematic analysis showed alignment with the journal's aims, emphasizing nursing research, practice, and education. The journal has seen a consistent increase in publications. Institutions from the United Kingdom were the most productive, and research themes align with the journal's goals, enhancing nursing knowledge and practice [25]. Zareivenovel et al. performed a bibliometric analysis of the Iranian Journal of Allergy, Asthma, and Immunology from 2005 to 2022. The most highly cited article in the Iranian Journal of Allergy, Asthma, and Immunology over the past 18 years was a review article that has received 138 citations. Iran has collaborated

with 13 other countries. Among the total citations, 4746 citations belong to the first decade (2005-2014), and 3,035 citations belong to the second (2015-2022) [21]. Li et al. summarize topical and frontier publications on exosomes in sepsis from 2004 to 2022 from the Web of Science. Most published articles were affiliated with China and the United States countries. Shanghai Jiao Tong University was the most prolific institution. Frontiers in Immunology was one of the journals with the highest number of papers. Ping Wang was the most productive author. "Mesenchymal stem cells derived exosomes," "microRNAs," "apoptosis," and "immunomodulatory therapy" are the current research hot spots and frontiers [26]. In line with the research methodology of previous studies [7, 23-26], the results of our study indicate that the most frequent keywords of articles published in the IJML journal include Bacteria, PCR, Neoplasms, Parasites, and Reproductive Medicine. The prevalence of keywords like "PCR technique" and "Bacteria" suggests a dominant focus on infectious diseases and diagnostics molecular techniques, which aligns with the journal's emphasis on practical applications in medical laboratory science. "Neoplasms" and "Reproductive Medicine" indicate a growing interest in cancer biology and fertility studies, showcasing the journal's relevance to current healthcare challenges. The network analysis shows strong connections between diverse fields, reflecting the journal's interdisciplinary approach. Notably, less frequent terms like "Western Blot" and "Bioinformatics" highlight potential areas for expansion, such as

exploring newer diagnostic techniques and computational biology.

The IJML article entitled: "Determining the prevalence and detection of the most prevalent virulence genes in *Acinetobacter baumannii* isolated from hospital infections" authored by Momtaz et al., published in 2014, received the most citations, revealing that *Acinetobacter baumannii* was isolated from 24.2% of clinical samples, with fimH being the most common virulence gene at 74% of samples. Given the high prevalence of *Acinetobacter baumannii* in hospital infections and the detection of key virulence genes, the authors emphasize the urgent need for molecular methods to identify this bacterium and develop infection control programs in hospitals [10]. The international collaboration score of authors was only 0.05% and involved contributors from Australia, Turkey, Nigeria, and India. Understanding authors' international collaboration patterns can offer valuable insights for the journal's policymakers to enhance such collaborations [28].

According to Table 5, while some institutions exhibit a high volume of submissions accompanied by equally high acceptance rates, others show a stark contrast with low acceptance rates despite a substantial number of submissions. The disparity may suggest potential differences in the quality of the research processes employed by the institutions. Also, the role of interdisciplinary collaborations within these institutions cannot be understated, as they are likely to contribute to both the quantity and quality of submissions. Institutions striving to enhance their academic reputation may be incentivized to support an increase in

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submissions, leading to greater acceptance as they seek to establish themselves as leading contributors in their field. It can be concluded that the robust interrelationship among the number of authors, submissions, and acceptances emphasizes the importance of collaborative research efforts in maximizing academic outputs [28, 29]. Future investigations could expand upon these findings to explore more nuanced factors influencing this dynamic, such as the impact of institutional funding, author experience, and submission strategies.

The statistical analysis of the correlation coefficient of title length, abstract views, and full-text downloads highlights the importance of examining other factors that may influence article visibility and engagement within academic publishing. While the length of article titles appears to lack a direct impact on their readership and download rates, it is essential to consider additional elements such as the content's relevance, the effectiveness of keywords used, and the timing of publication [30]. Observations also suggest that articles that address current trends or emerging topics may attract more views and downloads, regardless of title length [31]. Thus, while title length itself may not predict scholarly engagement, a multifaceted approach including an analysis of the subject matter, citation impact, and the role of social media in disseminating academic work could yield a more comprehensive understanding of the factors that drive article popularity within the international journal landscape [32].

To enhance its visibility and academic impact, IJML should consider adopting the following strategies:

1- Encourage submissions from researchers in underrepresented regions by promoting the journal at international conferences and collaborating with global institutions to strengthen international collaboration.

2- Leverage digital platforms and academic social media for broader dissemination, increasing article download and citation to optimize article visibility.

3- Streamline the peer review and publication timelines to improve editorial processes and attract high-quality submissions from leading researchers.

4- Prioritize thematic issues on cutting-edge areas such as artificial intelligence in diagnostics.

Conclusion

Ultimately, this bibliometric study will provide a retrospective view of the IJML's past decade and serve as a foundation for future research directions. The paper identified the leading trends of the IJML journal in terms of papers, authors, institutions, countries, and keywords. By understanding its historical trends and addressing existing gaps, IJML can enhance its reputation and play a more prominent role in shaping medical laboratory science research. Future bibliometric evaluations focusing on editorial board dynamics and researcher collaborative networks could provide additional insights for sustaining this progress.

Ethical Considerations
All ethical considerations were followed in compiling this work.

Conflict of Interest

Acknowledgments

Authors' Contributions

I.M: contributed to the design, implementation, and analysis of the results. S.D: contributed to the writing of the manuscript. All authors approved the final manuscript.

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