Exploring the Scientific Output and Impact of Universitas Muhammadiyah Surakarta: A Bibliometric Analysis

*1 Sheikh Abu Toha Md Saky, 2&3 Md. Nurul Isam

1Islamic Education, Muhammadiyah University of Surakarta, Indonesia
2Library and Information Science, International Islamic university Chittagong, Bangladesh
3PhD Research Scholar, Nanjing University, Nanjing, China

*Corresponding Author e-mail: g000224224@student.ums.ac.id

Abstract

This study uses bibliometric techniques to evaluate the scientific output of Universitas Muhammadiyah Surakarta (UMS), addressing a common challenge for regional universities: limited global visibility. Despite demonstrating strong research productivity, with 1,389 publications from 2004 to 2022, UMS's influence remains primarily regional, as evidenced by a high concentration of local citations. By analyzing citation metrics, co-authorship networks, and publication trends, this study sheds light on UMS's strengths and areas for development. The findings show that UMS excels in fields like public health and engineering, supported by partnerships with institutions in Malaysia and the UK. However, fields such as social sciences and education have lower international citation rates. This research highlights the need for UMS to pursue interdisciplinary collaborations, broaden its network beyond Southeast Asia, and aim for publication in high-impact journals to enhance its global presence. By providing strategic recommendations, this study contributes to knowledge on regional university research performance, suggesting future analyses that incorporate additional databases and multilingual data for a more comprehensive view of UMS's contributions to the global academic community.

Keywords: Bibliometrics, Scientific production, University performance, Collaboration networks, Citation analysis, Research performance assessment

How to Cite: Saky, S., & Isam, M. (2024). Exploring the Scientific Output and Impact of Universitas Muhammadiyah Surakarta: A Bibliometric Analysis. *Prisma Sains : Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram, 12*(4), 634-655. doi:https://doi.org/10.33394/j-ps.v12i4.12474

INTRODUCTION

In Indonesia, Universitas Muhammadiyah Surakarta (UMS) is a reputable institution of higher learning. For many years, the institution has been actively involved in intellectual and research endeavours, yielding a significant quantity of scientific output(Liauw, 2018; UMS, 2023). We want to do a bibliometric analysis of UMS's research output until 2022 in this project. Bibliometrics, the study of quantitative characteristics of literature, is used to assess the productivity and influence of a researcher or institution's research activities(Agarwal et al., 2016; Arias-Ciro, 2020; Bornmann & Leydesdorff, 2014; Cancino et al., 2017; Cucari et al., 2023; Das, 2015; Ellegaard & Wallin, 2015a; Guiling et al., 2022; Natakusumah, 2016; Okubo, 1997).

Data gathered from Scopus, used to analyze the scientific output of UMS. Several bibliometric indicators, including the number of publications, citations, and impact factor, used to examine the data. The study provides a thorough assessment of the research output and influence of UMS in many academic subjects. The study also pinpoint UMS's research

advantages and disadvantages as well as its place in the domestic and global research environment.

The research concentrates on the journal articles, conference papers, and book chapters that UMS has published. Additionally, it looks at how UMS researchers collaborate with their peers abroad and at home. The investigation also looks at the university's most prolific departments and research groups, as well as its most successful writers. The distribution of UMS publications by topic area and year will also be looked at in the research.

In recent years, bibliometric analysis has become an important method for evaluating the research output of academic institutions, yet many studies focus on large, globally recognized universities, often overlooking regionally impactful institutions like Universitas Muhammadiyah Surakarta (UMS) in Indonesia. While UMS contributes significantly to fields such as social sciences, engineering, and public health, it faces challenges in achieving international visibility, evidenced by a high proportion of local citations and limited global collaborations. This study addresses this gap by providing a focused bibliometric analysis of UMS's research from 2004 to 2022, assessing publication trends, citation metrics, and collaboration networks. By examining UMS's research impact, this study seeks to identify areas for improvement and offer insights for enhancing its global research presence, ultimately aiming to support UMS in achieving greater interdisciplinary engagement and international collaboration.

Lastly, The findings of this bibliometric study of UMS's scientific output helps academics and university administration better understand UMS's performance and impact in terms of research. Additionally, it assists the institution in determining its advantages and disadvantages so that future research initiatives may be planned properly. The study also provides helpful data for assessing the research output and influence of higher education institutions in Indonesia for decision-makers and funding organizations.

Objective

This study's goal is to do a bibliometric analysis of Universitas Muhammadiyah Surakarta's (UMS) scientific output in order to acquire a thorough grasp of the institution's research output and effect. Analyzing elements like the number of publications, citation counts, cooperation networks, and research domains are part of this. The goal of the research is to pinpoint the scientific output of UMS's strong and weak points as well as areas for improvement going forward. This study also used as a benchmark for the university's research output and as a strategic planning input.

Research questions of this study
1. What is the total number of publications and citations for Universitas Muhammadiyah Surakarta's (UMS) scientific output?
2. What are the most popular fields of study and publications venues for UMS researchers?
3. What are the most effective networks for cooperation among UMS researchers, and how have they changed over time?
4. What patterns can you see in the volume of regional and international citations for UMS publications?
5. How does the study assist UMS in enhancing the effectiveness and productivity of its research?

Significance of this study

The importance of this research is to shed light on Universitas Muhammadiyah Surakarta's scientific output (UMS). The goal of this study is to determine the research advantages, disadvantages, and strengths of UMS by examining the bibliometric data. This study also provides policymakers, researchers, and administrators at UMS ideas on how to boost networking and collaboration with other institutions and nations while also raising the quality and volume of scientific output. This research serves as a standard for UMS to use in

comparisons of its scientific accomplishments with those of other institutions, both locally and globally.

Related Work

Berger & Baker, and Ellegaard&Wallin, all suggest that bibliometric analysis is the quantitative study of bibliographic material(Berger & Baker, 2014; Ellegaard & Wallin, 2015b). Donthu et al. said that bibliometric analysis could be used to identify trends in a research field, while Berger & Baker mentioned that bibliometric analysis is the quantitative analysis of publications(Berger & Baker, 2014; Donthu et al., 2021; Ellegaard & Wallin, 2015b). Donthu et al. suggest that bibliometric analysis is a popular and rigorous method for exploring and analyzing large volumes of scientific data, and Ellegaard&Wallin indicate that the impact of bibliometric analysis has been increasing. Consequently, these papers suggest that bibliometric analysis is helpful for identifying trends in a research field. Additionally, Donthu et al. and Ellegaard&Wallin suggest that bibliometric analysis is a popular and rigorous method for exploring and analyzing large volumes of scientific data(Berger & Baker, 2014; Donthu et al., 2021; Ellegaard & Wallin, 2015b).

Bibliometric analysis can be useful for university research policy. Moed et al. found that bibliometric indicators can provide a "monitoring device" for university research management and science policy(Moed et al., 1985). Maharana&Sethi found that bibliometric analysis can be helpful for measuring a university's research output(Maharana & Sethi, 2013). Maharana also found that bibliometric analysis can be helpful for measuring a university's research output(Maharana, 2014).These papers suggest that bibliometric analysis can be helpful for measuring the research output of a university and for determining university research policy. However, none of the papers explicitly address the question, "Why does a university do bibliometric analysis?".

Nederhof et al. cover all 70 departments of one agricultural university and several veterinary departments of a second university(Nederhof et al., 1993). To extend the study into international comparison. Matsuura reported the bibliometric analysis of the IEEE Symposium on Security and Privacy (IEEE- SP)(Matsuura, 2005). Information for the analysis was gathered from Journal Citation Reports (JCR) and the Spanish Indice de Impacto de lasRevistasEspanolas de CienciasSociales (IN-RECS), Indice de Impacto de lasRevistasEspanolas de CienciasJuridicas (IN-REJS) and RevistasEspanolas de CienciasSociales y Humanidades (RESH). The contribution of Torres-Salinas et al. was to determine the adequacy of these ranking systems as bibliometric tools for describing the output in the Spanish journals of a university(Torres-Salinas et al., 2009). Garousi presents a bibliometric analysis of the Turkish software engineering (SE) community (researchers and institutions)(Garousi, 2015). Gan& Wang aim to map the intellectual structure of social media research in China from 2006 to 2013(Gan & Wang, 2015). Boshoff&Akanmu investigate the effect of using different data sources on the bibliometric profile of ObafemiAwolowo University in Nigeria, focusing on the Faculty of Pharmacy for the period 1990–2013(Boshoff & Akanmu, 2018a). It is significant to summarize the current research status and gaps and to propose future research directions in the field of university laboratory safety. A bibliometric analysis method was applied to gain an overall view of the developments, focus areas, and trends in this field of safety research Yang et al.(Yang et al., 2019). This stimulates us to examine using the WR as a reliable academic ranking for world universities. To test this hypothesis Shehattaet al. apply the WR results with two widely accepted indexes, i.e., the global university rankings and the bibliometrics(Shehatta et al., 2020). Other influential work includes the works by Krampen, and Pagell (Krampen, 2008; Pagell, 2014).

Van den Berghe et al. present the primary outcomes concerning the faculties of medicine, science, and pharmaceutical science at the three universities involved(Van den Berghe et al., 1998). Meera&Sahu aim to depict the University College of Medical Science's (UCMS) research performance in different areas or subfields of medical and health sciences(Meera &

Sahu, 2014). In an attempt to develop comprehensive, evidence-based methods for evaluation of the R&D performance of cross-disciplinary projects, a joint bibliometric analysis of patents and publications was performed for two industry-university-government collaborative projects aimed at commercialization: Hokkaido University Research & Business Park Project (2003-2007; 63 inventors; 176 patents; 853 papers), and Matching Program for Innovations in Future Drug Discovery and Medical Care – phase I (2006-2010; 46 inventors; 235 patents; 733 papers) (Gautam et al., 2014). Tripathi & Kumar provide an overview of the research output of Jawaharlal Nehru University, New Delhi, India, in terms of the number of publications contributed by faculty members and researchers(Tripathi & Kumar, 2015). Boshoff & Akanmu investigate the effect of using different data sources on the bibliometric profile of ObafemiAwolowo University in Nigeria, focusing on the Faculty of Pharmacy for the period 1990-20131990–2013(Boshoff & Akanmu, 2018b).Herrera et al. present a new method to analyze both emerging and established knowledge domains(Tibaná-Herrera et al., 2018). Background and Study Aim: The objective of (Tomanek and Lis, 2020) is to assess the development of scientific production and map thematic coverage of research in physical education(Tomanek & Lis, 2020). Shonhe seeks to provide a descriptive analysis of the research output about the Continuous Professional Development (CPD) of librarians(Shonhe, 2020). Topal et al. aim to analyze the articles bibliometrically conducted by researchers from Turkey and indexed in the SCI-E index of the Web of Science (WoS) database in the category of psychiatry(Topal et al., 2020). Grover et al. examine global research output (1656 records) on the "Impact of COVID-19 on Sleeping Disorders" based on publications indexed in the Scopus database(Grover et al., 2021).

The volume of papers, research hotspots and development trends, core authors, and the author of the perspective of the field of laboratory safety were systematically reviewed by bibliometrics and visual analysis to provide a valuable reference for related research. The volume of papers published in the field of laboratory safety has been increasing year by year in the past decade, becoming a hot spot in the scientific research field (Zhang et al., 2022). The Science Citation Index Expanded (SCIE) of Web of Science (WOS) was used to collect the top 100 most cited studies on UME and analyze the literature from different countries/regions, institutions, and journals (Chen et al., 2022). Solving these diseases has become the utmost concern worldwide, culminating in numerous studies. Gao et al. perform bibliometric analysis on the 100 most cited papers to identify research hot spots and trends in this field(Gao et al., 2022). Qin et al. predict the hotspots of IL-37 research quantitatively and qualitatively according to bibliometric analysis(Qin et al., 2022). Data on the COVID-19-related medical research subject of (Jose et al., 2022) from authors in Oman were sourced from the Scopus database(Jose et al., 2022). The present study aims to reveal the status and trends of anthracycline-induced cardiotoxicity during the past two decades by employing bibliometric software including R-bibliometric, VOSviewer, and CiteSpace (Y. Wang et al., 2022). The present bibliometric analysis of the articles published filed of TMD revealed that orofacialpain, bruxism, chronic pain, and myofascial pain are the most commonly used keywords by the authors (Al-Moraissi et al., 2023). The subject of Alıç and Hassa was to make a holistic analysis of scientific articles published on open fractures using bibliometric methods(Alıç & Hassa, 2022). The subject of Kang et al. was to conduct a bibliometric analysis of applications of herbal medicine for RA from 1991 to the present(Kang et al., 2022). To date, there has been no bibliometricanalysis to summarize the field. Lin et al. aim to conduct a bibliometric analysis of CMD to determine the current status and frontiers in this field(Lin et al., 2022).

METHOD

This study employed bibliometric techniques to assess the scientific output of Universitas Muhammadiyah Surakarta (UMS) from 2004 to 2022. Data was collected from the Scopus database(Baas et al., 2020; Pham-Duc et al., 2022), using the AF-ID identifier (AF-ID: "Universitas Muhammadiyah Surakarta" 60104396), yielding 1,389 documents after excluding

entries from 2023. Scopus was selected due to its comprehensive coverage of international research, though its exclusive use limits the inclusion of research outputs found in other databases like Web of Science or Google Scholar. Data analysis was conducted using Biblioshiny, a tool integrated with the R package, which facilitated data cleaning and visualization. Additionally, We used tools and software including MS Excel and Zotero. Key indicators included total publications, citations per document, and overall citation counts, providing a well-rounded assessment of UMS's research performance. Co-authorship network analysis was also performed to explore collaboration patterns within UMS and internationally. The selected timespan, 2004 to 2022, was chosen to capture recent trends and align with UMS's strategic focus on expanding research output and collaboration. Statistical methods included publication growth rates and citation trend analyses, with figures generated through Biblioshiny to identify key patterns and trends. The study provides insights into UMS's strengths, areas for improvement, and potential development opportunities.

RESULTS AND DISCUSSION

The scientific production of Universitas Muhammadiyah Surakarta (UMS) was analyzed using the data collected from various sources such as journals, books, etc. over the timespan of 2004 to 2022. Table 1 shows a total of 470 sources were used in the analysis, resulting in 1389 documents. The annual growth rate of UMS's scientific production was 34.55%.

Table 1. The Main Information of UMS scientific production during 2004-2022

Description	Results
Main Information About Data	
Timespan	2004:2022
Sources (Journals, Books, etc)	470
Documents	1389
Annual Growth Rate %	34.55
Document Average Age	3.7
Average citations per doc	18.9
References	39994
Document Contents	
Keywords Plus (ID)	6000
Author's Keywords (DE)	3620
Authors	
Authors	6720
Authors of single-authored docs	45
Authors Collaboration	
Single-authored docs	62
Co-Authors per Doc	23.7
International co-authorships %	28.87
Document Types	
Article	888
Book Chapter	11
Conference Paper	445
Data paper	6
Editorial	7
Erratum	4
Letter	1
Review	27

The average age of the documents was 3.7 years, and the average number of citations per document was 18.9. A total of 39994 references were used in these documents. The analysis of the document contents revealed that there were 6000 keywords plus (ID) and 3620 author's keywords (DE) used in the documents. The authors of these documents were 6720 in number, with 45 of them being single-authored. The analysis of the authors' collaboration revealed that there were 62 single-authored documents, with an average of 23.7 co-authors per document. The percentage of international co-authorships was 28.87%. The analysis of document types revealed that the majority of the documents were articles (888), followed by conference papers (445), and reviews (27). There were also 11 book chapters, 6 data papers, 7 editorials, 4 errata, and 1 letter. In summary, The data analysis of UMS scientific production showed that the university has a significant number of documents, with a high annual growth rate, and an average of 18.9 citations per document. The majority of the documents were articles, followed by conference papers, and reviews. The study also showed that UMS has a high percentage of international co-authorships and an average of 23.7 co-authors per document.

Annual production and citation

The table II shown illustrates Universitas Muhammadiyah Surakarta's (UMS) yearly output and citations from 2004 to 2022. Each year provides the number of publications (N) and the average number of citations per article (MeanTCperArt). Additionally, the mean number of citations per year and the number of citable years are supplied (MeanTCperYear and CitableYears, respectively).It can be seen from the statistics that UMS's scientific output has grown with time, with the largest number of publications in 2018 (142) and the lowest in 2009 (36). (2). The average number of citations per article changes as well, with the largest amount occurring in 2018 (101.86), and the lowest occurring in 2022. (0.94). The mean number of citations each year likewise fluctuates, with a peak in 2018 (20.37) and a low in 2009 (13.03). (0.21). From 2004 through 2022, the range of citable years is from 19 to 1.

Table 2. Annual production and citation over the period of 2004-2022

Year	N	MeanTCperArt	MeanTCperYear	CitableYears
2004	1	6.00	0.32	19
2005	2	10.50	0.58	18
2006	2	18.00	1.06	17
2007	2	14.50	0.91	16
2008	3	17.67	1.18	15
2009	2	3.00	0.21	14
2010	3	8.33	0.64	13
2011	8	10.25	0.85	12
2012	5	4.20	0.38	11
2013	17	7.71	0.77	10
2014	30	5.27	0.59	9
2015	24	5.38	0.67	8
2016	54	5.78	0.83	7
2017	61	5.43	0.90	6
2018	142	101.86	20.37	5
2019	272	2.51	0.63	4
2020	271	31.89	10.63	3
2021	281	3.30	1.65	2
2022	209	0.94	0.94	1

Top 10 most relevant Sources

Conference proceedings and journal articles comprise most of the top 10 UMS scientific output streams, according to the table III. AIP Conference Proceedings and Journal of Physics: Conference Series are the top two sources with 112 and 105 articles, respectively. International

Journal of Innovation, Creativity and Change and IOP Conference Series: Materials Science and Engineering include 51 and 48 articles, respectively. The majority of these top sources are in physics and materials science, except for Humanities and Social Sciences Reviews and the Universal Journal of Educational Research. UMS seems to be prominent in various subject disciplines in conference proceedings and journal publications.

Table 3. Top 10 most relevant Sources

Sources	Articles
Aip Conference Proceedings	112
Journal Of Physics: Conference Series	105
International Journal Of Innovation, Creativity and Change	51
IOP Conference Series: Materials Science and Engineering	48
Humanities and Social Sciences Reviews	38
Materials Science Forum	37
Universal Journal of Educational Research	28
IOP Conference Series: Earth and Environmental Science	26
Journal Of Medicinal and Chemical Sciences	21
International Journal of Pharmaceutical Research	20

The Materials Science Forum, Journal of Medicinal and Chemical Sciences, and International Journal of Pharmaceutical Research are additional specialized academic journals. This demonstrates that UMS has a large corpus of research in particular fields and that its publications cover them effectively. Additionally, the top source contains more than twice as many articles as the tenth source.

Most Cited Sources

Well-known and renowned publications like Lancet, PLOS ONE, and Nature are among the most often referenced sources of UMS scientific output. These journals are well-known among scientists and have a high impact factor. The Journal of Physics: Conference Series and Energy are also among the sources that are often mentioned, demonstrating that UMS places a high priority on physics and energy research. As seen table IV by the strong citation counts for Bio Resources Technology, BMC Public Health, and Journal of Volcanology and Geothermal Research, there is also a large presence in the domains of biotechnology, environmental science, and health. Overall, the most often referenced sources show the high calibre of UMS's research excellence and its influence in several sectors.

Table 4. Most Cited Sources (Journal)

Sources	Articles
Lancet	359
Plos One	129
Nature	90
Journal of Physics: Conference Series	73
Energy	63
Bioresour Technol	62
Procedia-Social and Behavioral Sciences	62
BMC Public Health	61
Fuel	54
J Volcanol Geotherm Res	54

AIP Conference Proceedings, IOP Conference Series: Materials Science and Engineering, and speciality publications like the Journal of Medicinal and Chemical Sciences

and the International Journal of Pharmaceutical Research are among the top 10 most referenced sources in addition to the journals already listed. Table IV presents that UMS researchers are well-represented in a number of specialized topics and actively engage in and contribute to academic conferences. Lastly, the results demonstrate the diversity and significance of UMS's scientific output, which focuses on high-calibre publications in respectable journals, conference proceedings, and specialized journals. The many citations for many of the sites on the list are evidence of the excellent quality of the research that UMS and its researchers are doing.

Source Dynamics

According to the figure 1, UMS scientific production has been rising since 2017, with a significant increase in articles published in AIP Conference Proceedings, Journal Of Physics: Conference Series, International Journal of Innovation, Creativity and Change, IOP Conference Series: Materials Science and Engineering, and Humanities and Social Sciences Reviews. AIP Conference Proceedings had 112 articles in 2022, followed by the Journal of Physics: Conference Series with 105. Note that these sources have no publications published before 2017, suggesting that UMS research has concentrated on these sources recently.
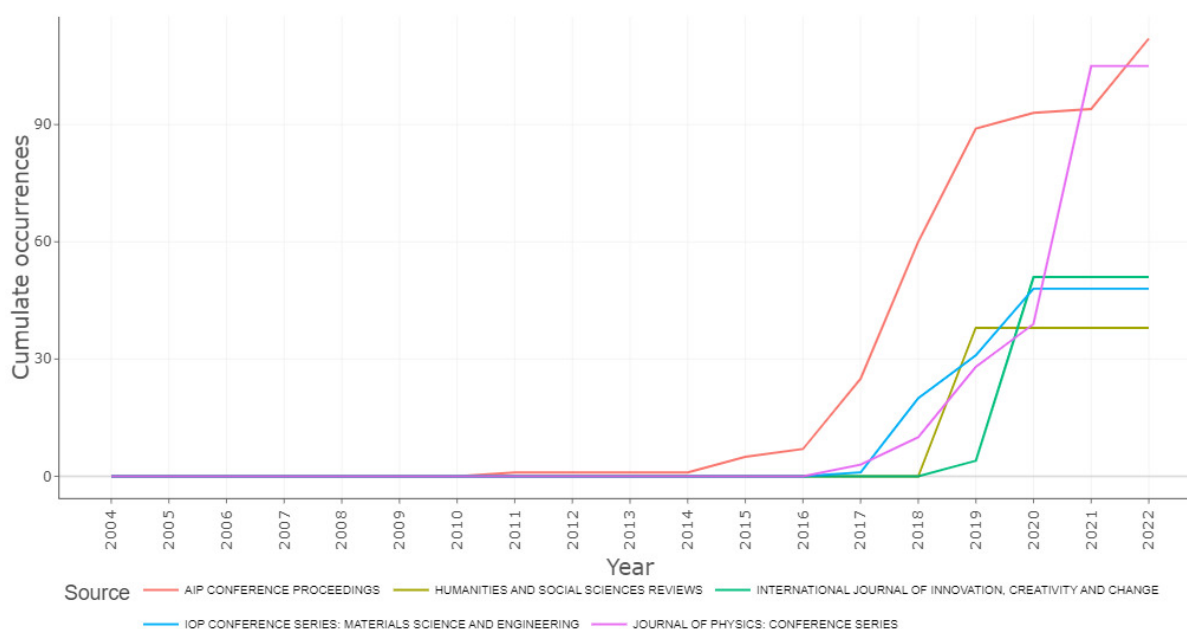

Figure 1. Source Dynamics

UMS has published several journal papers throughout the years. According to the figure 1, UMS has steadily produced more journal papers. With 112 and 105 publications, UMS publishes primarily in AIP Conference Proceedings and Journal of Physics: Conference Series. The third-most-published journal is the International Journal of Innovation, Creativity, and Change with 51 articles. UMS publishes 48 papers in IOP Conference Series: Materials Science and Engineering and 38 in Humanities and Social Sciences Reviews.AIP Conference Proceedings and Journal of Physics: Conference Series published most papers in 2020 and 2021. International Journal of Innovation, Creativity, and Change and IOP Conference Series: Materials Science and Engineering published largely in 2019 and 2020. This implies that UMS has submitted and accepted more papers to these journals recently.

Humanities and Social Sciences Reviews have consistently been published, showing UMS's dedication to multidisciplinary study. The figure 1 reveals that UMS is strong in physics and materials science and has produced more publications in these subjects recently. UMS publishes often in Humanities and Social Sciences Reviews, demonstrating its dedication to multidisciplinary research.

Most Cited Countries

According to the table V, the United States has the largest total number of citations (TC), 12,323, and an average number of citations per article of 513.46. With 1,843 TC and an average article citation of 2.22, Indonesia ranks second in the world. The third-highest TC, with a TC of 269 and an average article citation of 10.76, belongs to the United Kingdom. The TC and average article citations are lower for the remaining nations on the list, including Malaysia, Iran, Italy, Australia, the Netherlands, New Zealand, and India. This table V shows that, compared to other nations, the United States and Indonesia have the largest amount of involvement and influence in the scientific development of UMS.

Table 5. Most Cited Countries

Country	TC	Average Article Citations
Usa	12323	513.46
Indonesia	1843	2.22
United Kingdom	269	10.76
Malaysia	204	3.40
Iran	141	9.40
Italy	84	84.00
Australia	82	13.67
Netherlands	56	56.00
New Zealand	36	7.20
India	29	4.14

Most Global Cited Documents

The work "JAMES SL, 2018, LANCET" has the most citations overall with 5832, followed by "GBD 2017 CAUSES OF DEATH COLLABORATORS, 2018, LANCET," with 3451 citations, according to table VI analysis of the most widely referenced papers. The article "ABBAFATI C, 2020, LANCET" has 3339 total citations, which is also a lot. Table VI also reveals that "GBD 2017 CAUSES OF DEATH COLLABORATORS, 2018, LANCET" is the paper with the second-highest TC per year, at 575.17, after "JAMES SL, 2018, LANCET." The TC per year for the article "ABBAFATI C, 2020, LANCET" is likewise high at 834.75. The data also reveals that "GBD 2017 CAUSES OF DEATH COLLABORATORS, 2018, LANCET" is the paper with the lowest Normalized TC, at 33.88, while "JAMES SL, 2018, LANCET" is the one with the highest at 57.26.

With a high Normalized TC of 104.69, the paper "ABBAFATI C, 2020, LANCET" likewise has a high TC. The information in this table lists the UMS scientific output's most widely referenced publications. With 5832 total citations, an average of 972 citations per year, and a normalized TC of 57.26, the work "JAMES SL, 2018, LANCET" has the most citations overall. ABBAFATI C, 2020, LANCET, with 3339 citations, and "GBD 2017 CAUSES OF DEATH COLLABORATORS, 2018, LANCET" are two more noteworthy articles with large citation counts. With 1785 and 1554 citations, respectively, the articles "ROTH GA, 2020, J AM COLL CARDIOL" and "KYU HH, 2018, LANCET" are also highly cited.

Table 6. Top 25 Global Cited Documents

Paper	Total Citations	TC per Year	Normalized TC
JAMES SL, 2018, LANCET(James et al., 2018a)	5832	972.00	57.26
GBD 2017 CAUSES OF DEATH COLLABORATORS, 2018, LANCET(Roth et al., 2018a)	3451	575.17	33.88
ABBAFATI C, 2020, LANCET(Vos et al., 2020a)	3339	834.75	104.69

Paper	Total Citations	TC per Year	Normalized TC
STANAWAY JD, 2018, LANCET(Stanaway et al., 2018a)	2401	400.17	23.57
ABBAFATI C, 2020, LANCET-a(Murray, Aravkin, et al., 2020a)	1856	464.00	58.19
ROTH GA, 2020, J AM COLL CARDIOL(Roth et al., 2020)	1785	446.25	55.97
KYU HH, 2018, LANCET(Kyu et al., 2018a)	1554	259.00	15.26
DICKER D, 2018, LANCET(Dicker et al., 2018a)	515	85.83	5.06
ABBAFATI C, 2020, LANCET-a-b(H. Wang et al., 2020a)	407	101.75	12.76
LOZANO R, 2018, LANCET(Lozano et al., 2018)	253	42.17	2.48
REITSMA MB, 2021, LANCET(Reitsma et al., 2021)	227	75.67	68.81
ABBAFATI C, 2020, LANCET-a-b-c(Murray, Abbafati, et al., 2020)	185	46.25	5.80
LOZANO R, 2020, LANCET(Lozano et al., 2020)	175	43.75	5.49
BURSTEIN R, 2019, NATURE(Burstein et al., 2019)	97	19.40	38.69
HOSSAIN S, 2021, LIFE(Hossain et al., 2021)	84	28.00	25.46
KINYOKI DK, 2020, NATURE(Local Burden of Disease Child Growth Failure Collaborators, 2020)	80	20.00	2.51
FRANKLIN RC, 2020, INJURY PREV(Franklin et al., 2020)	73	18.25	2.29
JAMES SL, 2020, INJURY PREV(James et al., 2020)	69	17.25	2.16
AMRAN A, 2017, J FINANC REP ACCOUNT(Amran et al., 2017)	58	8.29	10.69
CORK MA, 2021, BMC MED(Local Burden of Disease HIV Collaborators, 2021)	56	18.67	16.98
VAN BERLEKOM AB, 2020, SCHIZOPHR BULL(Berdenis van Berlekom et al., 2019)	56	14.00	1.76
ULINUHA A, 2008, IEEE TRANS POWER DELIVERY(Ulinuha et al., 2008)	48	3.00	2.72
ULINUHA A, 2011, IET GENER TRANSM DISTRIB(Ulinuha et al., 2011)	45	3.46	4.39
DESHPANDE A, 2020, LANCET GLOBAL HEALTH(Deshpande et al., 2020)	44	11.00	1.38
NGAFWAN N, 2022, FOOD SCI TECH(Ngafwan et al., 2022)	43	21.50	45.85

Most local Cited Documents

Table VII suggests that 2018 papers from UMS's scientific output have the highest local impact factor. The biggest number of local citations went to the article "JAMES SL, 2018, LANCET," with 13. This represents just 0.22 percent of the document's total citations worldwide (5832). Next is a publication titled "GBD 2017 CAUSES OF DEATH COLLABORATORS, 2018, LANCET," which has received 12 local citations (or 0.35 percent of its total worldwide citations) (3451). The work by "DICKER D, 2018, LANCET" has received 12 local citations, or 2.33 percent of its total worldwide citations, placing it in third place (515). According to the statistics, the greatest percentage of local citations in comparison to total citations is 2.33 for the publication titled "DICKER D, 2018, LANCET." As a corollary, the correlation between normalized local and global citations suggests that articles with greater worldwide citations also have higher normalized local citations, suggesting that papers with larger global influence are likewise extensively referenced locally. According to the statistics, the 2018 publications had the greatest ratio of local to global citations (0.22% for "JAMES SL, 2018, LANCET") among the scientific output of UMS. The results may not be representative of the general trend in scientific output at UMS due to the tiny sample size. The context of the "Local Citations" and "Global Citations" data is also important to think about, since the meaning of a "local" citation may differ. The meaning of the numbers in the "Normalized Local

Citations" and "Normalized Global Citations" columns is obscured since their use in data analysis is not explained.

Table 7. Most local Cited Documents

Document	Year	Local Citations	Global Citations	LC/GC Ratio (%)	Normalized Local Citations	Normalized Global Citations
JAMES SL, 2018, LANCET(James et al., 2018b)	2018	13	5832	0.22	15.13	57.26
GBD 2017 CAUSES OF DEATH COLLABORATORS, 2018, LANCET(Roth et al., 2018b)	2018	12	3451	0.35	13.97	33.88
DICKER D, 2018, LANCET(Dicker et al., 2018b)	2018	12	515	2.33	13.97	5.06
STANAWAY JD, 2018, LANCET(Stanaway et al., 2018b)	2018	11	2401	0.46	12.80	23.57
ABBAFATI C, 2020, LANCET(Vos et al., 2020b)	2020	10	3339	0.30	22.77	104.69
KYU HH, 2018, LANCET(Kyu et al., 2018b)	2018	10	1554	0.64	11.64	15.26
ABBAFATI C, 2020, LANCET-a(Murray, Aravkin, et al., 2020b)	2020	8	1856	0.43	18.22	58.19
RIYADI TWB, 2014, SURF COAT TECHNOL(Riyadi et al., 2014)	2014	8	23	34.78	6.15	4.37
MIRZAEI M, 2020, J MIL MED(Mahmoud, 2020)	2020	7	32	21.88	15.94	1.00
ABBAFATI C, 2020, LANCET-a-b(H. Wang et al., 2020b)	2020	6	407	1.47	13.66	12.76

Top network collaboration

The figure 2 analysis of the UMS scientific output reveals that Indonesia and other nations have the most significant network partnerships. With 228 cooperation, Indonesia and Malaysia work together the most often. Indonesia and the United Kingdom, with 85, and Indonesia and Iran, with 70, are the next two countries to collaborate. Other noteworthy partnerships include those between Indonesia and Australia (69 partnerships), Indonesia and India (58 partnerships), and Indonesia and Japan (55 partnerships). This information implies that UMS has a significant worldwide presence and actively participates in international cooperation. Additionally, it shows that UMS maintains partnerships with nations farther away, such as the United Kingdom and Canada, as well as with neighbours like Malaysia and other nations in the area.According to the figure 2, there are 228 network partnerships most often between Indonesia and Malaysia, which seems to be the top network cooperation for UMS scientific output. Collaborations between Indonesia and the UK (85), Iran (70), Australia (69),

India (58), Japan (55), China (51), Iraq (49), Canada (47), Saudi Arabia (47), Bangladesh (43), Italy (43), and the United States are then listed in that order (42).

This analysis of Universitas Muhammadiyah Surakarta (UMS) alongside comparable Indonesian universities, such as the Islamic University of Indonesia (UII) and Muhammadiyah University of Purwokerto (UMP), highlights key trends in publication growth, citation impact, and collaboration patterns(Darmadji et al., 2018; Saky & Isam, 2024). UMS experienced a significant rise in publications in 2018, peaking in 2019, likely due to institutional policies aimed at increasing research output, bolstered funding, and enhanced partnerships with regional institutions, particularly those in Malaysia. Similar to UII, whose collaborations are primarily with nearby institutions or alumni-affiliated faculties, UMS has concentrated its efforts within the region. UMS's strongest performance is in fields such as public health and engineering, where international collaborations and publications in high-impact journals contribute to higher citation rates. In contrast, disciplines like social sciences and education, often published in regional journals, see fewer international citations, highlighting the need for UMS to focus on high-impact journals in these fields. Expanding collaboration networks beyond Southeast Asia and emphasizing interdisciplinary research with global relevance may further enhance UMS's international research visibility.
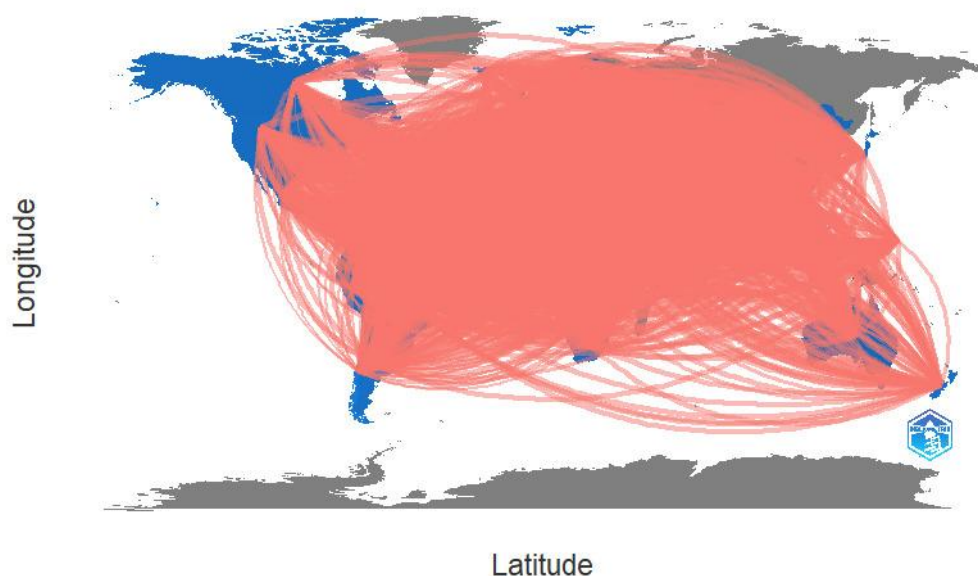

Figure 2. Top network collaboration

It is important to remember that the quantity of partnerships does not always reflect the quality or significance of the research that is conducted. Furthermore, the statistics include no details on the precise sectors or academic disciplines in which these partnerships are occurring. The statistics do, however, indicate that UMS has a significant worldwide presence and actively engages with a wide variety of nations.

Discussion

The data analysis of the UMS research output yields numerous important conclusions. First off, articles from "The Lancet" that are largely focused on causes of death and illness are among the most often quoted worldwide. James SL, 2018, published in the Lancet, received 5832 citations in total, for a normalized citation rate of 57.26. This shows that UMS researchers are actively engaged in the global scientific community and contributing significantly to the area of public health. The greatest local-to-global citation ratio was 2.33% for the publication "Dicker D, 2018, Lancet" when looking at the most locally cited papers. This suggests that while UMS researchers do excellent work that is acknowledged on a global scale, it may not be as well acknowledged within the local community. It's crucial to keep in mind that the

sample size is limited and that the findings could not be generalizable. UMS researchers have solid relationships with other universities in Southeast Asia, especially with Malaysia and the United Kingdom, according to the study of top network collaborations. This implies that UMS researchers are actively participating in international partnerships and advancing knowledge on a global level. With a frequency of 228, the partnership with Malaysia is especially impressive. This can be the result of close cultural and linguistic ties and common scientific interests.

The evidence overall points to UMS researchers having a considerable impact on the global scientific community, especially in the area of public health. However, there is space for development in terms of influence and local awareness. The frequent occurrence of foreign relationships implies that UMS scholars are actively participating in international alliances and advancing knowledge on a global scale. It could be worthwhile to look at the frequent partnership with Malaysia especially. It may be an excellent chance to improve research cooperation between the two nations and raise awareness of UMS research among the local population. According to the data analysis shown above, UMS has a solid track record of producing scientific work in a variety of sectors. The fact that UMS contains a significant number of highly referenced papers—many of which rank among the top 10 most cited works in their respective fields—is one of the study's most striking results. This shows that the work produced by UMS researchers is highly regarded and recognized by the scientific community.

The bulk of the papers on the list of the most widely referenced articles are from the Lancet, a reputable and well-known medical magazine. This implies that UMS has a considerable presence in the fields of medicine and public health and that numerous of its researchers have made important advances in these fields. The publications from the Lancet also have a high normalized TC per year, which shows that they are referenced more often than other works in the same area. The majority of the locally mentioned papers, however, paint a different image. The majority of the time, the local-to-global citation ratio is low, which suggests that the publications are not as often referenced outside. Additionally, the publications are not being referenced as often as other works in the same area, as shown by the low Normalized Local Citations and Normalized Global Citations.

Between 2004 and 2022, UMS's scientific output grew significantly, totaling 1,389 publications. A notable increase occurred in 2018, with 142 publications, likely driven by UMS's strategic initiatives to boost research output and foster international collaborations, especially with regional partners like Malaysia. This growth peaked in 2019 with 272 publications, followed by a slight decline to 209 in 2022, potentially due to disruptions from the COVID-19 pandemic affecting research activities and publication timelines.

UMS's research impact shows notable contrasts across fields, with an average of 18.9 citations per document and a total citation count of 39,994. Fields like public health and engineering benefit from UMS's partnerships with established global institutions, while social sciences and education, often published in regional journals, see fewer citations due to limited global reach. Most of UMS citations are from regional sources, highlighting its strong influence in Southeast Asia but limited global visibility. Collaboration analysis reveals that 28.87% of UMS's publications have international co-authors, primarily from Malaysia, the UK, and Iran, emphasizing a strong regional presence but lower global collaboration than larger Indonesian institutions. To improve citation metrics, UMS could focus on targeting high-impact journals for social sciences and expanding international partnerships in fields with global research relevance, enhancing both its citation impact and international collaboration footprint.

In this discussion, UMS's research strengths, particularly in medical fields with high citation counts, are analyzed in comparison to similar Indonesian universities. UMS excels in areas like public health due to strong international collaborations and publications in high-impact journals, distinguishing it regionally and enhancing its visibility. The university's research output benefits both local and global communities, addressing regional health concerns while contributing to broader scientific discourse, which has strategic implications

for shaping UMS's research policies to target global challenges. However, limitations in this study, such as reliance solely on Scopus data and lack of multilingual publication analysis, may restrict a comprehensive view of UMS's impact. Future research should explore additional databases and incorporate a wider linguistic scope to more fully capture UMS's scholarly contributions.

Implications

The analysis of UMS's scientific output offers crucial new perspectives on the institution's research initiatives and partnerships. The study's findings provide a number of recommendations for UMS and other institutions of a same kind. First and foremost, the study emphasizes how crucial international cooperation are to the advancement of science. According to the statistics, UMS has a wide range of foreign partnerships, notably with Asian and adjacent nations like Malaysia. Because of this, it seems that UMS is in a good position to lead research in Southeast Asia and the larger Asian continent. Second, the study emphasizes how important it is for UMS to concentrate on fields of study that are well-cited internationally. The findings reveal that the most frequently mentioned papers in UMS are those related to health and medicine. This argues that UMS should keep funding research in these areas since it might have a big effect on the health and wellbeing of the whole world.

Third, the analysis shows that UMS should prioritize boosting the quantity of locally referenced publications. The findings reveal a relatively low ratio of local to worldwide citations, suggesting that UMS research may not be having as big of an influence on the local community as it might. This suggests that UMS should concentrate on enhancing the visibility of its research inside the neighborhood, for instance by partnering with neighborhood groups more and disseminating its results more broadly. The report also suggests that UMS should concentrate on raising the proportion of its articles that are published in high-impact journals in order to improve the quality of its research. According to the findings, the bulk of UMS publications are published in low-impact journals, which means that they aren't making as much of an influence on the scientific community as they might. Accordingly, UMS should concentrate on publishing more articles in high-impact journals, since this would raise the profile and influence of its research.

Overall, the report offers crucial insights into the research endeavors of UMS and makes a number of recommendations for the organization. UMS may raise the caliber and influence of its research by emphasizing international partnerships, high-impact research fields, boosting its research's exposure inside the neighborhood, and publishing more articles in high-impact journals.

CONCLUSION

This study applied bibliometric techniques to evaluate the scientific output of Universitas Muhammadiyah Surakarta (UMS) from 2004 to 2022, offering insights into its research strengths and areas for improvement. The analysis identified the Faculty of Medicine and Faculty of Economics as the most prolific departments, with research in medical fields receiving the highest citation counts, highlighting UMS's strong presence in health-related disciplines. UMS's collaborative network is also robust within the Southeast Asian region, particularly with Malaysia, the United Kingdom, and Iran, indicating a regional focus that could be expanded to achieve broader global engagement.

RECOMMENDATION

The findings underscore several actionable recommendations for UMS. To enhance its global research impact, UMS could prioritize interdisciplinary collaborations, especially in areas like public health, engineering, and social sciences, to address globally relevant issues. Additionally, UMS could encourage publication in high-impact journals, especially for research within the social sciences and education, where visibility is currently lower.

Broadening partnerships with institutions outside Southeast Asia, such as those in North America and Europe, would further increase UMS's global research presence.

This study advances understanding of university research performance by offering a detailed, bibliometric-based evaluation of a regional university, often overlooked in global research assessments. By highlighting UMS's strengths and suggesting strategies for enhanced visibility and impact, the study provides a model for similar institutions aiming to improve their global research standing. Limitations include the study's reliance on Scopus data, which may not capture all UMS's outputs or contributions. Future research should incorporate additional databases and expand the timeframe to capture a more comprehensive view of UMS's evolving research performance, setting a foundation for continuous improvement in university research assessments.

REFERENCES

Agarwal, A., Durairajanayagam, D., Tatagari, S., Esteves, S. C., Harlev, A., Henkel, R., Roychoudhury, S., Homa, S., Puchalt, N. G., Ramasamy, R., Majzoub, A., Ly, K. D., Tvrda, E., Assidi, M., Kesari, K., Sharma, R., Banihani, S., Ko, E., Abu-Elmagd, M., … Bashiri, A. (2016). Bibliometrics: Tracking research impact by selecting the appropriate metrics. Asian Journal of Andrology, 18(2), 296–309. https://doi.org/10.4103/1008-682X.171582

Alıç, T., & Hassa, E. (2022). Open Fractures from Gustilo and Anderson to the Present: A Bibliometric Analysis with Global Productivity and Research Trends. Indian Journal of Orthopaedics, 56(12), 2119–2132. https://doi.org/10.1007/s43465-022-00743-z

Al-Moraissi, E. A., Christidis, N., & Ho, Y.-S. (2023). Publication performance and trends in temporomandibular disorders research: A bibliometric analysis. Journal of Stomatology, Oral and Maxillofacial Surgery, 124(1), 101273. https://doi.org/10.1016/j.jormas.2022.08.016

Amran, A., Fauzi, H., Purwanto, Y., Darus, F., Yusoff, H., Zain, M. M., Naim, D. M. A., & Nejati, M. (2017). Social responsibility disclosure in Islamic banks: A comparative study of Indonesia and Malaysia. Journal of Financial Reporting and Accounting, 15(1), 99–115. https://doi.org/10.1108/JFRA-01-2015-0016

Arias-Ciro, J. (2020). Bibliometric Study of the Efficiency of Public Expenditure on Education. Revista CEA, 6(11), 127–144. https://doi.org/10.22430/24223182.1588

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. Quantitative Science Studies, 1(1), 377–386. https://doi.org/10.1162/qss_a_00019

Berdenis van Berlekom, A., Muflihah, C. H., Snijders, G. J. L. J., MacGillavry, H. D., Middeldorp, J., Hol, E. M., Kahn, R. S., & de Witte, L. D. (2019). Synapse Pathology in Schizophrenia: A Meta-analysis of Postsynaptic Elements in Postmortem Brain Studies. Schizophrenia Bulletin, sbz060. https://doi.org/10.1093/schbul/sbz060

Berger, J. M., & Baker, C. M. (2014). Bibliometrics: An Overview. Rajiv Gandhi University of Health Sciences Journal of Pharmaceutical Sciences, 4(3), 81–92. https://doi.org/10.5530/rjps.2014.3.2

Bornmann, L., & Leydesdorff, L. (2014). Scientometrics in a changing research landscape: Bibliometrics has become an integral part of research quality evaluation and has been changing the practice of research. EMBO Reports, 15(12), 1228–1232. https://doi.org/10.15252/embr.201439608

Boshoff, N., & Akanmu, M. A. (2018a). Scopus or Web of Science for a bibliometric profile of pharmacy research at a Nigerian university? South African Journal of Libraries and Information Science, 83(2). https://doi.org/10.7553/83-2-1682

Boshoff, N., & Akanmu, M. A. (2018b). Scopus or Web of Science for a bibliometric profile of pharmacy research at a Nigerian university? South African Journal of Libraries and Information Science, 83(2). https://doi.org/10.7553/83-2-1682

Burstein, R., Henry, N. J., Collison, M. L., Marczak, L. B., Sligar, A., Watson, S., Marquez, N., Abbasalizad-Farhangi, M., Abbasi, M., Abd-Allah, F., Abdoli, A., Abdollahi, M., Abdollahpour, I., Abdulkader, R. S., Abrigo, M. R. M., Acharya, D., Adebayo, O. M., Adekanmbi, V., Adham, D., … Hay, S. I. (2019). Mapping 123 million neonatal, infant and child deaths between 2000 and 2017. Nature, 574(7778), 353–358. https://doi.org/10.1038/s41586-019-1545-0

Cancino, C. A., Merigó, J. M., & Coronado, F. C. (2017). A bibliometric analysis of leading universities in innovation research. Journal of Innovation & Knowledge, 2(3), 106–124. https://doi.org/10.1016/j.jik.2017.03.006

Chen, S., Kong, J., & Feng, L. (2022). The Trend of Drug Therapy on Uveitic Macular Edema: A Bibliometric Analysis of the 100 Most Cited Articles. Frontiers in Medicine, 9, 807319. https://doi.org/10.3389/fmed.2022.807319

Cucari, N., Tutore, I., Montera, R., & Profita, S. (2023). A bibliometric performance analysis of publication productivity in the corporate social responsibility field: Outcomes of SCIVAL analytics. Corporate Social Responsibility and Environmental Management, 30(1), 1–16. https://doi.org/10.1002/csr.2346

Darmadji, A., Prasojo, L. D., Riyanto, Y., Kusumaningrum, F. A., & Andriansyah, Y. (2018). Publications of Islamic University of Indonesia in Scopus Database: A bibliometric assessment. COLLNET Journal of Scientometrics and Information Management, 12(1), 109–131. https://doi.org/10.1080/09737766.2017.1400754

Das, A. K. (2015). Research evaluation metrics—UNESCO Digital Library. https://unesdoc.unesco.org/ark:/48223/pf0000232210

Deshpande, A., Miller-Petrie, M. K., Lindstedt, P. A., Baumann, M. M., Johnson, K. B., Blacker, B. F., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abdollahpour, I., Abegaz, K. H., Abejie, A. N., Abreu, L. G., Abrigo, M. R. M., Abualhasan, A., Accrombessi, M. M. K., Adamu, A. A., Adebayo, O. M., Adedeji, I. A., … Reiner, R. C. (2020). Mapping geographical inequalities in access to drinking water and sanitation facilities in low-income and middle-income countries, 2000–17. The Lancet Global Health, 8(9), e1162–e1185. https://doi.org/10.1016/S2214-109X(20)30278-3

Dicker, D., Nguyen, G., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdel-Rahman, O., Abdi, A., Abdollahpour, I., Abdulkader, R. S., Abdurahman, A. A., Abebe, H. T., Abebe, M., Abebe, Z., … Murray, C. J. L. (2018a). Global, regional, and national age-sex-specific mortality and life expectancy, 1950–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1684–1735. https://doi.org/10.1016/S0140-6736(18)31891-9

Dicker, D., Nguyen, G., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdel-Rahman, O., Abdi, A., Abdollahpour, I., Abdulkader, R. S., Abdurahman, A. A., Abebe, H. T., Abebe, M., Abebe, Z., … Murray, C. J. L. (2018b). Global, regional, and national age-sex-specific mortality and life expectancy, 1950–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1684–1735. https://doi.org/10.1016/S0140-6736(18)31891-9

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. Journal of Business Research, 133, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Ellegaard, O., & Wallin, J. A. (2015a). The bibliometric analysis of scholarly production: How great is the impact? Scientometrics, 105(3), 1809–1831. https://doi.org/10.1007/s11192-015-1645-z

Ellegaard, O., & Wallin, J. A. (2015b). The bibliometric analysis of scholarly production: How great is the impact? Scientometrics, 105(3), 1809–1831. https://doi.org/10.1007/s11192-015-1645-z

Franklin, R. C., Peden, A. E., Hamilton, E. B., Bisignano, C., Castle, C. D., Dingels, Z. V., Hay, S. I., Liu, Z., Mokdad, A. H., Roberts, N. L. S., Sylte, D. O., Vos, T., Abady, G. G., Abosetugn, A. E., Ahmed, R., Alahdab, F., Andrei, C. L., Antonio, C. A. T., Arabloo, J., … James, S. L. (2020). The burden of unintentional drowning: Global, regional and national estimates of mortality from the Global Burden of Disease 2017 Study. Injury Prevention, 26(Supp 1), i83–i95. https://doi.org/10.1136/injuryprev-2019-043484

Gan, C., & Wang, W. (2015). Research characteristics and status on social media in China: A bibliometric and co-word analysis. Scientometrics, 105(2), 1167–1182. https://doi.org/10.1007/s11192-015-1723-2

Gao, M., Zhang, H., Wang, C., Mou, X., Zhu, Q., Wang, J., & Gao, D. (2022). Top 100 Cited Papers on Premenstrual Syndrome/Premenstrual Dysphoric Disorder: A Bibliometric Study. Frontiers in Psychiatry, 13, 936009. https://doi.org/10.3389/fpsyt.2022.936009

Garousi, V. (2015). A bibliometric analysis of the Turkish software engineering research community. Scientometrics, 105(1), 23–49. https://doi.org/10.1007/s11192-015-1663-x

Gautam, P., Kodama, K., & Enomoto, K. (2014). Joint bibliometric analysis of patents and scholarly publications from cross-disciplinary projects: Implications for development of evaluative metrics. Journal of Contemporary Eastern Asia, 13(1), 19–37. https://doi.org/10.17477/JCEA.2014.13.1.019

Grover, S., BM Gupta, G., GM Mamdapur, M., & M Surulinathi, S. (2021). Bibliometric Study of Publications on Impact of Covid-19 and Sleep Disorders. Journal of Young Pharmacists, 13(3s), s72–s77. https://doi.org/10.5530/jyp.2021.13s.74

Guiling, Y., Panatik, S. A., Sukor, M. S. M., Rusbadrol, N., & Cunlin, L. (2022). Bibliometric Analysis of Global Research on Organizational Citizenship Behavior From 2000 to 2019. SAGE Open, 12(1), 215824402210798. https://doi.org/10.1177/21582440221079898

Hossain, S., Urbi, Z., Karuniawati, H., Mohiuddin, R. B., Moh Qrimida, A., Allzrag, A. M. M., Ming, L. C., Pagano, E., & Capasso, R. (2021). Andrographis paniculata (Burm. f.) Wall. ex Nees: An Updated Review of Phytochemistry, Antimicrobial Pharmacology, and Clinical Safety and Efficacy. Life, 11(4), 348. https://doi.org/10.3390/life11040348

James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., Accrombessi, M. M. K., … Murray, C. J. L. (2018a). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1789–1858. https://doi.org/10.1016/S0140-6736(18)32279-7

James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., Accrombessi, M. M. K., … Murray, C. J. L. (2018b). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1789–1858. https://doi.org/10.1016/S0140-6736(18)32279-7

James, S. L., Castle, C. D., Dingels, Z. V., Fox, J. T., Hamilton, E. B., Liu, Z., S Roberts, N. L., Sylte, D. O., Henry, N. J., LeGrand, K. E., Abdelalim, A., Abdoli, A., Abdollahpour, I., Abdulkader, R. S., Abedi, A., Abosetugn, A. E., Abushouk, A. I., Adebayo, O. M., Agudelo-Botero, M., … Vos, T. (2020). Global injury morbidity and mortality from 1990 to 2017: Results from the Global Burden of Disease Study 2017. Injury Prevention, 26(Supp 1), i96–i114. https://doi.org/10.1136/injuryprev-2019-043494

Jose, J., Saberi, M. K., Khamis, F., Mokthari, H., & Al Zakwani, I. (2022). COVID-19 Medical Research in Oman: A Bibliometric and Visualization Study. Oman Medical Journal, 37(4), e406–e406. https://doi.org/10.5001/omj.2022.73

Kang, D.-Y., Kim, H., Kim, K.-W., & Chung, W.-S. (2022). Bibliometric analysis of research relating to the use of herbal medicine for rheumatoid arthritis between 1991 to 2021. Medicine, 101(37), e30413. https://doi.org/10.1097/MD.0000000000030413

Krampen, G. (2008). The evaluation of university departments and their scientists: Some general considerations with reference to exemplary bibliometric publication and citation analyses for a Department of psychology. Scientometrics, 76(1), 3–21. https://doi.org/10.1007/s11192-007-1900-z

Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018a). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3

Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018b). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3

Liauw, T. T. (2018). Institutional Repositories in the Indonesian Higher Education Sector: Current State and Future Prospect.

Lin, X., Wu, G., Gao, B., Wang, S., & Huang, J. (2022). Bibliometric and visual analysis of coronary microvascular dysfunction. Frontiers in Cardiovascular Medicine, 9, 1021346. https://doi.org/10.3389/fcvm.2022.1021346

Local Burden of Disease Child Growth Failure Collaborators. (2020). Mapping child growth failure across low- and middle-income countries. Nature, 577(7789), 231–234. https://doi.org/10.1038/s41586-019-1878-8

Local Burden of Disease HIV Collaborators. (2021). Mapping subnational HIV mortality in six Latin American countries with incomplete vital registration systems. BMC Medicine, 19(1), 4. https://doi.org/10.1186/s12916-020-01876-4

Lozano, R., Fullman, N., Abate, D., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdel-Rahman, O., Abdi, A., Abdollahpour, I., Abdulkader, R. S., Abebe, N. D., Abebe, Z., Abejie, A. N., Abera, S. F., Abil, O. Z., … Murray, C. J. L. (2018). Measuring progress from 1990 to 2017 and projecting attainment to 2030 of the health-related Sustainable Development Goals for 195 countries and territories: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 2091–2138. https://doi.org/10.1016/S0140-6736(18)32281-5

Lozano, R., Fullman, N., Mumford, J. E., Knight, M., Barthelemy, C. M., Abbafati, C., Abbastabar, H., Abd-Allah, F., Abdollahi, M., Abedi, A., Abolhassani, H., Abosetugn, A. E., Abreu, L. G., Abrigo, M. R. M., Abu Haimed, A. K., Abushouk, A. I., Adabi, M., Adebayo, O. M., Adekanmbi, V., … Murray, C. J. L. (2020). Measuring universal health coverage based on an index of effective coverage of health services in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study

2019. The Lancet, 396(10258), 1250–1284. https://doi.org/10.1016/S0140-6736(20)30750-9

Maharana, R. K. (2014). Research growth and development at Sambalpur University during 2008-2012: A bibliometric analysis. Library Philosophy and Practice, 1.

Maharana, R. K., & Sethi, B. B. (2013). A Bibliometric Analysis of the Research Output of Sambalpur University's Publication in ISI Web of Science during 2007-11. Library Philosophy and Practice.

Mahmoud, M. (2020). Screening Efficacy of Available HIV Protease Inhibitors on COVID-19 Protease. Journal of Military Medicine, 2, 100–107. https://doi.org/10.30491/JMM.22.2.100

Matsuura, K. (2005). University-industry collaboration in the information security field: An international comparison. Proceedings. 2005 IEEE International Engineering Management Conference, 2005., 1, 95–98. https://doi.org/10.1109/IEMC.2005.1559095

Meera, & Sahu, S. K. (2014). Research Output of University College of Medical Science, University of Delhi: A Bibliometric Study. Collnet Journal of Scientometrics and Information Management, 8(2), 401–418. https://doi.org/10.1080/09737766.2014.954865

Moed, H. F., Burger, W. J. M., Frankfort, J. G., & Van Raan, A. F. J. (1985). The use of bibliometric data for the measurement of university research performance. Research Policy, 14(3), 131–149. https://doi.org/10.1016/0048-7333(85)90012-5

Murray, C. J. L., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasi-Kangevari, M., Abd-Allah, F., Abdollahi, M., Abedi, P., Abedi, A., Abolhassani, H., Aboyans, V., Abreu, L. G., Abrigo, M. R. M., Abu-Gharbieh, E., Abu Haimed, A. K., Abushouk, A. I., Acebedo, A., Ackerman, I. N., Adabi, M., … Lim, S. S. (2020). Five insights from the Global Burden of Disease Study 2019. The Lancet, 396(10258), 1135–1159. https://doi.org/10.1016/S0140-6736(20)31404-5

Murray, C. J. L., Aravkin, A. Y., Zheng, P., Abbafati, C., Abbas, K. M., Abbasi-Kangevari, M., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abegaz, K. H., Abolhassani, H., Aboyans, V., Abreu, L. G., Abrigo, M. R. M., Abualhasan, A., Abu-Raddad, L. J., Abushouk, A. I., Adabi, M., … Lim, S. S. (2020a). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. The Lancet, 396(10258), 1223–1249. https://doi.org/10.1016/S0140-6736(20)30752-2

Murray, C. J. L., Aravkin, A. Y., Zheng, P., Abbafati, C., Abbas, K. M., Abbasi-Kangevari, M., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abegaz, K. H., Abolhassani, H., Aboyans, V., Abreu, L. G., Abrigo, M. R. M., Abualhasan, A., Abu-Raddad, L. J., Abushouk, A. I., Adabi, M., … Lim, S. S. (2020b). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. The Lancet, 396(10258), 1223–1249. https://doi.org/10.1016/S0140-6736(20)30752-2

Natakusumah, E. K. (2016). BIBLIOMETRIC ANALYSIS OF THE INKOM JOURNAL (ANALISIS BIBLIOMETRIK JURNAL INKOM). BACA: JURNAL DOKUMENTASI DAN INFORMASI, 36(1), Article 1. https://doi.org/10.14203/j.baca.v36i1.199

Nederhof, A. J., Meijer, R. F., Moed, H. F., & van Raan, A. F. J. (1993). Research performance indicators for university departments: A study of an agricultural university. Scientometrics, 27(2), 157–178. https://doi.org/10.1007/BF02016548

Ngafwan, N., Rasyid, H., Abood, E. S., Abdelbasset, W. K., Al-SHAWI, S. G., Bokov, D., & Jalil, A. T. (2022). Study on novel fluorescent carbon nanomaterials in food analysis. Food Science and Technology, 42, e37821. https://doi.org/10.1590/fst.37821

Okubo, Y. (1997). Bibliometric Indicators and Analysis of Research Systems: Methods and Examples (OECD Science, Technology and Industry Working Papers 1997/01; OECD

Science, Technology and Industry Working Papers, Vol. 1997/01). https://doi.org/10.1787/208277770603

Pagell, R. A. (2014). Bibliometrics and University Research Rankings Demystified for Librarians. In C. Chen & R. Larsen (Eds.), Library and Information Sciences (pp. 137–160). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-54812-3_10

Pham-Duc, B., Tran, T., Huu Hoang, D., & Bao Do, C. (2022). Global scientific literature on human resource development: A bibliometric analysis using Scopus database. European Journal of Training and Development. https://doi.org/10.1108/EJTD-01-2022-0004

Qin, Y., Ren, S., Shao, B., Qin, H., Wang, H., Li, G., Zhu, Y., Sun, C., Li, C., Zhang, J., & Wang, H. (2022). The intellectual base and research fronts of IL-37: A bibliometric review of the literature from WoSCC. Frontiers in Immunology, 13, 931783. https://doi.org/10.3389/fimmu.2022.931783

Reitsma, M. B., Kendrick, P. J., Ababneh, E., Abbafati, C., Abbasi-Kangevari, M., Abdoli, A., Abedi, A., Abhilash, E. S., Abila, D. B., Aboyans, V., Abu-Rmeileh, N. M., Adebayo, O. M., Advani, S. M., Aghaali, M., Ahinkorah, B. O., Ahmad, S., Ahmadi, K., Ahmed, H., Aji, B., … Gakidou, E. (2021). Spatial, temporal, and demographic patterns in prevalence of smoking tobacco use and attributable disease burden in 204 countries and territories, 1990–2019: A systematic analysis from the Global Burden of Disease Study 2019. The Lancet, 397(10292), 2337–2360. https://doi.org/10.1016/S0140-6736(21)01169-7

Riyadi, T. W. B., Zhang, T., Marchant, D., & Zhu, X. (2014). Synthesis and fabrication of NiAl coatings with Ti underlayer using induction heating. Surface and Coatings Technology, 258, 154–159. https://doi.org/10.1016/j.surfcoat.2014.09.037

Roth, G. A., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, H. T., Abebe, M., Abebe, Z., Abejie, A. N., Abera, S. F., Abil, O. Z., Abraha, H. N., … Murray, C. J. L. (2018a). Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1736–1788. https://doi.org/10.1016/S0140-6736(18)32203-7

Roth, G. A., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, H. T., Abebe, M., Abebe, Z., Abejie, A. N., Abera, S. F., Abil, O. Z., Abraha, H. N., … Murray, C. J. L. (2018b). Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1736–1788. https://doi.org/10.1016/S0140-6736(18)32203-7

Roth, G. A., Mensah, G. A., Johnson, C. O., Addolorato, G., Ammirati, E., Baddour, L. M., Barengo, N. C., Beaton, A. Z., Benjamin, E. J., Benziger, C. P., Bonny, A., Brauer, M., Brodmann, M., Cahill, T. J., Carapetis, J., Catapano, A. L., Chugh, S. S., Cooper, L. T., Coresh, J., … Fuster, V. (2020). Global Burden of Cardiovascular Diseases and Risk Factors, 1990–2019. Journal of the American College of Cardiology, 76(25), 2982–3021. https://doi.org/10.1016/j.jacc.2020.11.010

Saky, S. A. T. M., & Isam, M. N. (2024). MUHAMMADIYAH UNIVERSITY OF PURWOKERTO'S GLOBAL RESEARCH IMPACT: A BIBLIOMETRIC ANALYSIS. Zawiyah: Jurnal Pemikiran Islam, 10(1), 61–78.

Shehatta, I., Al-Rubaish, A. M., & Mahmood, K. (2020). Ranking Web of Universities: Is Webometrics a Reliable Academic Ranking? Pakistan Journal of Information Management and Libraries, 103–135. https://doi.org/10.47657/2631

Shonhe, L. (2020). Continuous Professional Development (CPD) of librarians: A bibliometric analysis of research productivity viewed through WoS. The Journal of Academic Librarianship, 46(2), 102106. https://doi.org/10.1016/j.acalib.2019.102106

Stanaway, J. D., Afshin, A., Gakidou, E., Lim, S. S., Abate, D., Abate, K. H., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., … Murray, C. J. L. (2018a). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1923–1994. https://doi.org/10.1016/S0140-6736(18)32225-6

Stanaway, J. D., Afshin, A., Gakidou, E., Lim, S. S., Abate, D., Abate, K. H., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., … Murray, C. J. L. (2018b). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1923–1994. https://doi.org/10.1016/S0140-6736(18)32225-6

Tibaná-Herrera, G., Fernández-Bajón, M.-T., & De-Moya-Anegón, F. (2018). Output, collaboration and impact of e-learning research: Bibliometric analysis and visualizations at the country and institutional level (Scopus 2003-2016). El Profesional de La Información, 27(5), 1082. https://doi.org/10.3145/epi.2018.sep.12

Tomanek, M., & Lis, A. (2020). Managing information on the physical education research field: Bibliometric analysis. Physical Education of Students, 24(4), 213–226. https://doi.org/10.15561/20755279.2020.0404

Topal, Z., Bahsi, I., & Tufan, A. (2020). Evaluation of The Psychiatric Research Output From Turkey Via Web Of Science Database: A Bibliometric Analysis. Psychiatry and Clinical Psychopharmacology, 30(4), 1. https://doi.org/10.5455/PCP.20201117083927

Torres-Salinas, D., Delgado López-Cózar, E., & Jiménez-Contreras, E. (2009). An analysis of the output of the University of Navarra in terms of publications made in Social Science and Humanities journals, employing the Web of Science and a number of Spanish ranking systems. Revista Española de Documentación Científica, 32(1), 22–39. https://doi.org/10.3989/redc.2009.1.673

Tripathi, M., & Kumar, S. (2015). A Quantitative Analysis of Research Output of Jawaharlal Nehru University, New Delhi, India. International Information & Library Review, 47(1–2), 39–51. https://doi.org/10.1080/10572317.2015.1051908

Ulinuha, A., Masoum, M. A. S., & Islam, S. (2011). Hybrid genetic-fuzzy algorithm for volt/var/total harmonic distortion control of distribution systems with high penetration of non-linear loads. IET Generation, Transmission & Distribution, 5(4), 425. https://doi.org/10.1049/iet-gtd.2010.0168

Ulinuha, A., Masoum, M. A. S., & Islam, S. M. (2008). Optimal Scheduling of LTC and Shunt Capacitors in Large Distorted Distribution Systems Using Evolutionary-Based Algorithms. IEEE Transactions on Power Delivery, 23(1), 434–441. https://doi.org/10.1109/TPWRD.2007.911166

UMS. (2023). https://www.ums.ac.id/en/en

Van den Berghe, H., Houben, J. A., de Bruin, R. E., Moed, H. F., Kint, A., Luwel, M., & Spruyt, E. H. J. (1998). Bibliometric indicators of university research performance in Flanders. Journal of the American Society for Information Science, 49(1), 59–67. https://doi.org/10.1002/(SICI)1097-4571(1998)49:1<59::AID-ASI8>3.0.CO;2-2

Vos, T., Lim, S. S., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasifard, M., Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abolhassani, H., Aboyans, V., Abrams, E. M., Abreu, L. G., Abrigo, M. R. M., Abu-Raddad, L. J., Abushouk, A. I., … Murray, C. J. L. (2020a). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis

for the Global Burden of Disease Study 2019. The Lancet, 396(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9

Vos, T., Lim, S. S., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasifard, M., Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abolhassani, H., Aboyans, V., Abrams, E. M., Abreu, L. G., Abrigo, M. R. M., Abu-Raddad, L. J., Abushouk, A. I., … Murray, C. J. L. (2020b). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. The Lancet, 396(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9

Wang, H., Abbas, K. M., Abbasifard, M., Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abolhassani, H., Abreu, L. G., Abrigo, M. R. M., Abushouk, A. I., Adabi, M., Adair, T., Adebayo, O. M., Adedeji, I. A., Adekanmbi, V., Adeoye, A. M., Adetokunboh, O. O., Advani, S. M., … Murray, C. J. L. (2020a). Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: A comprehensive demographic analysis for the Global Burden of Disease Study 2019. The Lancet, 396(10258), 1160–1203. https://doi.org/10.1016/S0140-6736(20)30977-6

Wang, H., Abbas, K. M., Abbasifard, M., Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abolhassani, H., Abreu, L. G., Abrigo, M. R. M., Abushouk, A. I., Adabi, M., Adair, T., Adebayo, O. M., Adedeji, I. A., Adekanmbi, V., Adeoye, A. M., Adetokunboh, O. O., Advani, S. M., … Murray, C. J. L. (2020b). Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: A comprehensive demographic analysis for the Global Burden of Disease Study 2019. The Lancet, 396(10258), 1160–1203. https://doi.org/10.1016/S0140-6736(20)30977-6

Wang, Y., Rao, Y., Lin, Z., Sa, R., Yin, Y., Zhang, X., & Zhang, B. (2022). Current Status and Trends of Research on Anthracycline-Induced Cardiotoxicity from 2002 to 2021: A Twenty-Year Bibliometric and Visualization Analysis. Oxidative Medicine and Cellular Longevity, 2022, 1–21. https://doi.org/10.1155/2022/6260243

Yang, Y., Reniers, G., Chen, G., & Goerlandt, F. (2019). A bibliometric review of laboratory safety in universities. Safety Science, 120, 14–24. https://doi.org/10.1016/j.ssci.2019.06.022

Zhang, M., Huang, H., & Tao, S. (2022). A visualization analysis of laboratory security research in recent ten years by CiteSpace. In Q. Zeng (Ed.), Sixth International Conference on Electromechanical Control Technology and Transportation (ICECTT 2021) (p. 173). SPIE. https://doi.org/10.1117/12.2624723