Decoding the Narrative: Patterns and Dynamics in Monkeypox Scholarly Publications

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Abstract—This study conducts a bibliometric analysis of monkeypox research to uncover trends, influential publishers, and key research topics. A dataset of Google Scholar-indexed articles was analyzed using bibliometric methods and tools such as Publish or Perish (PoP), VOSviewer, and Bibliometrix. The study reveals a growing research interest in monkeypox, with a notable increase in publications over the past decade. The Wiley Online Library emerged as the leading publisher, while highly cited articles covered various aspects of the disease. Cluster analysis identified key research topics, including clinical features, zoonotic transmission, and outbreak patterns. Network visualization and bigram analysis showcased relationships between authors, keywords, and publishers, with "monkeypox" being the most frequent keyword. By visualizing topic trends over time, the study identified emerging areas of investigation. The findings contribute to a comprehensive understanding of monkeypox research, aiding in identifying research gaps and guiding future studies. This research highlights the relevance of bibliometric analysis in health and information sciences. By uncovering trends, influential publishers, and key topics in monkeypox research, this study informs prevention, vaccination, and treatment strategies for mitigating the impact of monkeypox on public health.

Keywords—*Bibliometrics; monkeypox virus; research trends; publication patterns; research impact*

I. INTRODUCTION

Health problems have become a concern lately, still not recovering from COVID-19, which has haunted humans since 2019 [1]. Now in 2022, the outbreak of the monkeypox virus is a scourge that is quite scary for humans. Monkeypox is a disease of animals that mutate to be able to transmit to humans. Monkeypox is caused by the MPXV virus, which is a member of the genus Orthopoxvirus and the family Poxviridae. This case initially spread from the Democratic Republic of Congo to several parts of the world, such as America, Asia, and Europe. Even the death rate caused by the MPXV virus for unvaccinated cases reaches 10% [2].

With the spread of this virus variant in various parts of the world, more research on this monkeypox virus is to find solutions for prevention [3], vaccination [4], and treatment [5]. The health impact is devastating in terms of health and the economy [6]. Preventive measures are needed to solve this problem. Research needs a method to find things that are being studied a lot and map the topic and author to the geographical location of the researcher. Looking for trending topics by geography, time, etc., is essential.

From the literature search, there are still not many studies regarding the bibliometric analysis of monkeypox cases. This research is significant due to the scarcity of studies focusing on the bibliometric analysis of monkeypox cases. The lack of research in this area highlights the importance of conducting this study to reveal trends and insights related to monkeypox over the years.

Despite the urgency of this matter, there exists a scarcity of studies specifically focusing on bibliometric analysis of monkeypox cases. This research aims to fill this critical gap by employing advanced methodologies, including word cluster analysis, network visualization, overlays, and density using VOSviewer software. Additionally, bigram analysis is utilized to examine the relationships between authors, words, and publishers through Bibliometrix. These information science methods, particularly in bibliometrics, play a pivotal role in analyzing patterns, trends, and relationships within scientific literature. The objective of this study is to comprehensively map the scientific landscape, identify research gaps, and provide a profound understanding of the monkeypox domain through the application of these methodologies to monkeypox research.

II. LITERATURE REVIEW

Bibliometric analysis is a scientific method that integrates mathematical and statistical approaches to analyze and visualize data to determine the structure of topics periodically, develop models, and seek research priorities in a particular field [7]. Bibliometrics research is widely used in the health sector, but according to this paper observation, there have not been many studies involving monkeypox bibliometrics analysis. Publish or Perish (PoP) is software that makes it easy to mine database data from various sources, such as databases indexed by Scopus, Web of Science, Crossref, PubMed, Google Scholar (GS), and others [8]–[10]. In this study mine from the GS-indexed database. GS is a service that makes it easy to collect scientific publications indexed by GS. GS also provides a database that can be used for scientific purposes. Unlike similar services such as Scopus, Web of Science, Pubmed, and others, which require a subscription to access

their databases, GS can be used complementary to mine databases indexed by GS [11].

Many publications use this software [12]–[14]. Arias-Chávez et al. [15] using PoP to mine publication data relating to global scientific production on social networks during the Covid-19 pandemic. Postigo-Zumarán et al. [16] used PoP to search for publications on world scientific production on education and COVID-19 between January 2020 to September 2021. Data from the research of both publications came from five databases, namely Scopus, WoS, GS, Microsoft Academic, and Crossref.

VOSviewer can process data in RIS, JSON, and TXT files. Researchers have widely used VOSviewer to visualize literature data, as has been done by Huang, Z. et al. [17], Kirkendall and Krustrup [18], Pagan-Castaño et al. [19] ,and Papatsounis et al. [20]. Bamel et al. [21] examines leading publication trends over a two-decade period (2000-2020), researching the extent and impact of intellectual capital research in the Journal of Intellectual Capital (JIC). Huang, X. et al. [22] investigates related research advances in pharmaceutical science and pharmaceutical education from a bibliometric point of view and aims to provide advice in facilitating the development of pharmaceutical science and pharmacy graduate education [23].

Bibliometrix is open-source software for comprehensive scientific mapping analysis of scientific literature. Mayara et al. [24] build the map the research literature on Biochemistry education, indexed on the Web of Science covering the scientific production, build upon a recent method to simplify some of the key steps of merging datasets when using the R package Bibliometrix to perform bibliometric analyses. Andrea [25] built a new method to simplify some of the key steps of combining data sets when using the Bibliometrics R package to perform bibliometric analysis.

The significance of this research extends beyond the realm of health sciences and biomedical research. It also highlights the relevance of information sciences in investigating and visualizing trends and patterns in health-related research. By leveraging bibliometric analysis, this study demonstrates the applicability of information science methods in analyzing and synthesizing large volumes of scientific literature. This research provides valuable insights into the field of monkeypox, enabling researchers to gain a deeper understanding of the topic and identify areas that require further investigation.

Furthermore, by employing bibliometric analysis, this study contributes to the broader field of information sciences by showcasing the power of these methodologies in uncovering hidden patterns, revealing research trends, and facilitating evidence-based decision-making. Overall, this research is a significant step in bridging the gap between health sciences, biomedical research, and information sciences, highlighting the interdisciplinary nature of scientific inquiry and its potential for meaningful contributions to public health and knowledge management.

III. METHODOLOGY

A. Data Collections and Processing

This study relies on a meticulous and systematic approach to collecting and processing article data indexed by Google Scholar (GS). Unlike subscription-based databases like Scopus or Web of Science, GS provides open access to its data, eliminating the need for researchers to subscribe. This open-source nature enhances accessibility and inclusivity in obtaining data for research purposes.

To ensure the reliability and comprehensiveness of the study, we leverage the PoP (Publish or Perish) feature of Google Scholar. PoP is an open-source application that facilitates the collection of journal data not only from GS but also from various reputable sources such as Scopus, Web of Science, PubMed, Crossref, and Semantic Scholar. The data collected is systematically stored in *.ris format, a widely accepted format for bibliographic citation data, enabling seamless processing in subsequent stages of bibliometric analysis.

For data visualization and in-depth analysis, we employ two powerful tools: VOSviewer and Bibliometrix. VOSviewer is instrumental in creating visual maps based on various parameters such as words, authors, and publishers. This visualization is crucial for identifying emerging research topics, discerning gaps in the literature, and determining the novelty of a study [26]–[29].

Bibliometrix, designed as open-source software integrated with the R programming language, plays a pivotal role in conducting comprehensive scientific mapping analysis. It allows the import of data from various databases, including Scopus, Web of Science, PubMed, Crossref, and others [30]–[32].

B. Bibliometrics Analysis

Impact of specific articles: To discern the primary contributors in the field, this paper meticulously compiled data on monkeypox-related articles using the Publish or Perish software, which facilitates a nuanced examination of academic publications.

This research focuses on uncovering trends, influential publishers, and key research topics within the field of monkeypox. Cluster analysis was conducted to identify common themes and interconnections among research studies [33]. Network visualization techniques were employed to visualize relationships between authors, keywords, and publishers [34]. The collected data were analyzed and interpreted to reveal patterns, emerging topics, and prominent contributors within the monkeypox research domain. Insights were drawn from the network visualization, cluster analysis, and keyword co-occurrence analysis to understand the research landscape comprehensively.

IV. RESULTS

A. Annual Publications

From the results of the collection using PoP, 752 articles were collected in that period. The data is saved in *.ris format and extracted with VOSviewer and Bibliometrix. Bibliometric

analysis using VOSviewer visualizes a network of frequently occurring topics with an occurrence value of 20 from the title and abstract of the article. From the processing results, it can be from the results of collecting data all the time using PoP from GS, 313 articles entitled monkeypox were obtained. Fig. 1 shows the number of publications from year to year. It can be seen that in the last ten years, the number of publications that have a topic entitled monkeypox has increased. In 2022 the number of publications increased sharply to 144 from only six articles in 2021. The reappearance of monkeypox caused an increase in publication at this time. The highest number of publications on monkeypox topics in 2022 was in 2017, with 12 publications. In 2010 and 2015, there were 11 publications using monkeypox titles.
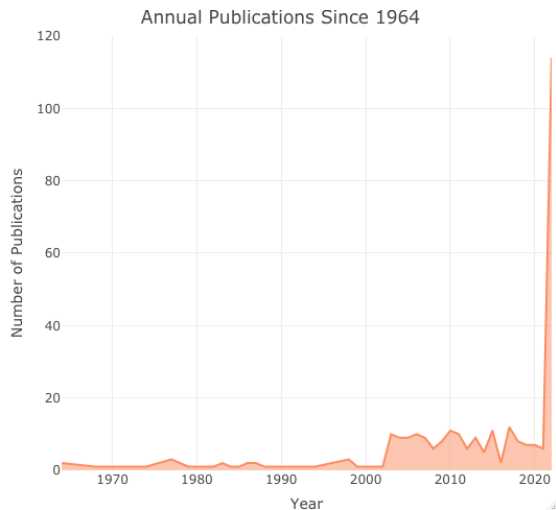

Fig. 1. Distribution of the publications per year.

B. Publications' Patterns

Table I illustrates the leading publishers contributing to the field of monkeypox research, highlighting the number of articles they have published on this specific topic. At the forefront, Wiley Online Library takes the lead with an impressive 26 articles, closely followed by Academic Oxford with 25 articles. The American Society for Microbiology secures the third position, having published 24 articles. Notable contributions are also observed from the National Center for Biotechnology Information (22 articles) and The American Journal of Tropical Medicine and Hygiene (20 articles). Elsevier, a well-established publisher, has contributed significantly with 19 articles, while The BMJ, Europe PMC, and The International Journal of Infectious Diseases have also made substantial contributions with 16, 15, and 10 articles, respectively. PubMed NCBI, a widely used database, also features in the top 10 publishers with 10 articles. Collectively, this comprehensive overview sheds light on the pivotal role these publishers play in disseminating valuable insights and knowledge within the realm of monkeypox research.

Table II enumerates the top 10 articles with the title "Monkeypox," presenting essential details such as citation counts, authors, and publication years. Topping the list is "The detection of monkeypox in humans in the Western Hemisphere" by Reed K.D. et al. (2004), acknowledged with a

remarkable 655 citations. Following closely is Likos A.M. et al.'s (2005) "A tale of two clades: monkeypox viruses," recognized with 296 citations, emphasizing the diversity within monkeypox viruses. The third position is secured by Hooper J.W. et al.'s (2004) "Smallpox DNA vaccine protects nonhuman primates against lethal monkeypox," renowned for its findings on the protective potential of a smallpox DNA vaccine with 240 citations. "Poxvirus dilemmas—monkeypox, smallpox, and biologic terrorism" by Breman J.G. et al. (1998) claims the fourth spot with 223 citations, delving into the complexities of poxviruses and their implications in biologic terrorism. Lastly, "Human monkeypox: clinical features of 282 patients" authored by Ježek Z. et al. (1987) completes the top five, boasting 175 citations for its insights into the clinical features of human monkeypox patients. Collectively, these top-cited articles constitute pivotal contributions to the understanding of monkeypox, showcasing their enduring impact on scholarly discourse and research endeavors.

TABLE I. THE TOP 10 PUBLISHERS WHO PUBLISHED ARTICLES WITH THE TOPIC MONKEYPOX

Sources	Publisher	Articles
1	Wiley Online Library	26
2	Academic Oxford	25
3	American Society for Microbiology	24
4	National Center for Biotechnology Information	22
5	The American Journal of Tropical Medicine and Hygiene	20
6	Elsevier	19
7	The BMJ	16
8	Europe PMC	15
9	The International Journal of Infectious Diseases	10
10	PubMed NCBI	10

TABLE II. THE TOP 10 ARTICLES WITH THE TITLE MONKEYPOX

Num.	Title	Cited	Author	Year
1	The detection of monkeypox in humans in the Western Hemisphere	655	Reed K.D. et al. [35]	2004
2	A tale of two clades: monkeypox viruses	296	Likos A.M. et al. [36]	2005
3	Smallpox DNA vaccine protects nonhuman primates against lethal monkeypox	240	Hooper J.W. et al. [37]	2004
4	Poxvirus dilemmas—monkeypox, smallpox, and biologic terrorism	223	Breman J.G. et al. [38]	1998
5	Human monkeypox: clinical features of 282 patients	175	Ježek Z. et al. [39]	1987

C. Topics Cluster

Table III provides a comprehensive overview of topics clusters in the context of monkeypox research. The clustering of topics in the analysis reveals seven distinct thematic clusters prevalent in the literature on monkeypox. In Cluster 1, the focus is on the analysis of human monkeypox cases and

outbreaks. The cluster encompasses discussions on clinical features, detection, diagnosis, and patient-related aspects. Geographical references to regions like Congo, Democratic Republic, the United States, and the Western Hemisphere are also prominent, emphasizing the global nature of the disease.

TABLE III.   CLUSTERS OF TOPICS IN MONKEYPOX RESEARCH

Cluster	Topics
1	Case, clinical feature, congo, democratic republic, detection, diagnosis, drc, human monkeypox, human monkeypox case, human monkeypox infection, June, may, monkeypox, monkeypox case, outbreak, patient, patient, person, republic, United States, western hemisphere, year, Zaire.
2	Cynomolgus macaque, disease, evaluation, family poxciridae, genus orthopoxvirus, human, infection, macaque, monkeypox virus, monkeypox virus challenge, monkeypox virus infection, mpxv, nonhuman primate, protection, smallpox, smallpox vaccine, treatment, western Africa, zoonotic disease.
3	Comparison, cowpox, differentiation, evidence, mpv, orthopoxvirus, vaccinia, vaccinia virus, varicella zoster virus, variola, variola virus, varv, virus.
4	Animal, central Africa, concern, covid, emergence, first human case, monkeypox disease, Nigeria, spread, west Africa, world.
5	abstract, country, europe pmc, laboratory, lesson, monkeypox outbreak, study, symptom
6	Journal, man, monkeypox infection, mpx, transmission,
7	Africa, Europe, recent outbreak.

Cluster 2 centers around the impact of monkeypox virus on nonhuman primates. Topics within this cluster include disease evaluation, infection in macaques, discussions on smallpox vaccine, and the broader context of zoonotic disease. This cluster delves into the complex interplay between the virus and nonhuman primates, providing valuable insights into potential transmission dynamics. The third cluster involves a comparative analysis of orthopoxviruses, drawing parallels between monkeypox and related viruses such as vaccinia, variola, and cowpox. Discussions within this cluster focus on differentiation, evidence, and the distinct characteristics of these viruses. This comparative perspective contributes to a nuanced understanding of the broader orthopoxvirus family.

In Cluster 4, the analysis shifts towards the ecological impact of monkeypox, specifically in animals. Central Africa and Nigeria are focal points, addressing concerns related to the emergence of monkeypox, its potential connection to COVID, and its spread in West Africa and globally. This cluster underscores the broader implications of the disease within the animal population. The fifth cluster is centered on the study of monkeypox outbreaks and the lessons derived from them. Topics within this cluster include the abstracts of studies, lessons learned, symptoms, and country-specific analyses. This cluster provides valuable insights into the dynamics of monkeypox outbreaks and serves as a resource for understanding and managing future occurrences.

Cluster 6 focuses on journal publications related to monkeypox, highlighting aspects such as infection in humans (man), transmission dynamics, and the role of journals in disseminating information. This cluster sheds light on the dissemination of knowledge within the academic community and the dynamics of information exchange. Lastly, Cluster 7

explores the perspectives on monkeypox in Africa and Europe. This geographical focus includes discussions on recent outbreaks, providing insights into how monkeypox is perceived and managed in these regions. The cluster captures the regional nuances and highlights the importance of considering diverse perspectives in understanding and addressing monkeypox.

D. Relationship Analysis

In Fig. 2 present a detailed analysis of the intricate relationship between authors, abstract content, and publishers using Bibliometrix. The network visualization reveals a rich tapestry consisting of 19 authors, 20 frequently occurring words in the abstracts, and 20 prominent publishers.

Among the 20 words recurrently found in the abstracts, "monkeypox" emerges as the most prevalent, appearing a remarkable 444 times. Other frequently occurring terms include "virus" (22 times), "human" (78 times), "infection" (45 times), "outbreak" (45 times), "disease" (37 times), "smallpox" (29 times), "mpxv" (27 times), "Africa" (25 times), "mpx" (24 times), "variola" (19 times), "zoonotic" (19 times), and "orthopoxvirus" (17 times).

The prevalence of "monkeypox" in abstracts is further underscored by 19 authors consistently incorporating this term in their contributions. Notably, Ii Zuka stands out, utilizing 13 of the identified frequently occurring words a total of 29 times. Following closely are M Saijo, who employs 10 words 25 times, and Ci Hutson, who incorporates 9 words 21 times.

In the realm of publishers, ASM emerges as a leading contributor, publishing articles that prominently feature the identified frequently used words a substantial 151 times. WOL (Wiley Online Library) follows closely with 142 instances, Academic Oxford with 124 instances, NCBI (National Center for Biotechnology Information) with 112 instances, and Elsevier with 89 instances. These findings highlight the pivotal role of these publishers in disseminating research that revolves around the recurrent themes identified in the abstracts, providing key insights into the landscape of monkeypox literature.
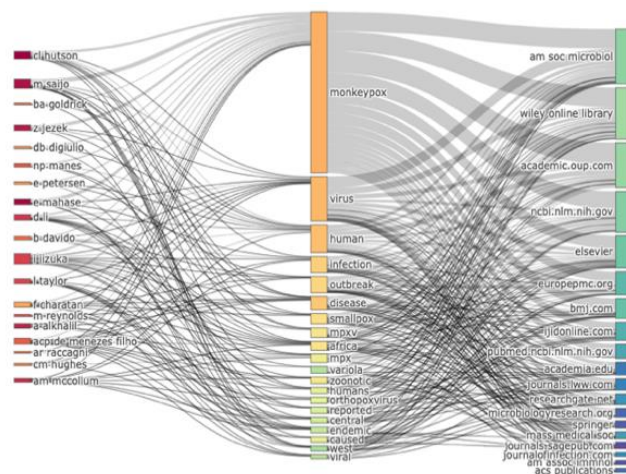

Fig. 2.   Sankey diagram relationship between author, abstract, and publisher.

E. Bigram Analysis

To conduct a comprehensive analysis of co-occurring terms within the abstracts of 313 identified articles, this paper employed bigram analysis. Fig. 3 illustrates the noteworthy findings from this analysis. Notably, the phrase "monkeypox virus" emerges as the most frequently occurring bigram, appearing a substantial 117 times, constituting 22% of the total occurrences. Following closely is "human monkeypox," observed in 71 instances, comprising 13% of all identified bigrams.
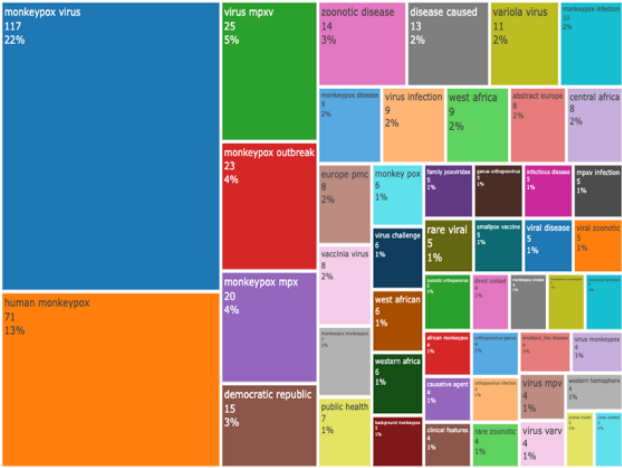
Fig. 3.   The most frequent bigrams.

The subsequent five most prevalent bigrams include "virus mpxv" (25 occurrences, 5%), "monkeypox outbreak" (23 occurrences, 4%), "monkeypox mpx" (20 occurrences, 4%), "democratic republic" (15 occurrences, 3%), and "zoonotic disease" (14 occurrences, 3%). This insightful analysis sheds light on the prominent word associations within the abstracts, offering valuable insights into prevalent themes and connections in the realm of monkeypox research.

F. Mapping of Monkeypox Topics

Fig. 4 shows the network of keywords. The red color indicates the topics in cluster 1, the green color represents the members in cluster 2, the blue color represents the terms in cluster 3, and the yellow color represents the topics in cluster 4, the purple color represents the members in cluster 5, the light blue color represents the members in cluster 6, the orange color represents the members in cluster 7. The topic "monkeypox" is the topic that most often appears in cluster 1 with a total number of link strength (TLS) of 874 and occurrence of 214. In cluster 2, "monkeypox virus" became the center of the cluster with a TLS value of 469 and occurrences of 96. The topic "virus" became the center of cluster 3 with a TLS value of 112 and the number of occurrences 24. The topic "animal" is the center of cluster 4 with the number of TLS 65 and the number of occurrences 11. The topic "monkeypox outbreak" is the center of cluster 5 with the number of TLS 106 and the number of occurrences 29. The topic "mpx" is the center of cluster 6 with the number of TLS 136 and the number of occurrences 20. The topic "africa" is the center of cluster 7 with the number of TLS 80 and the number of occurrences 17.
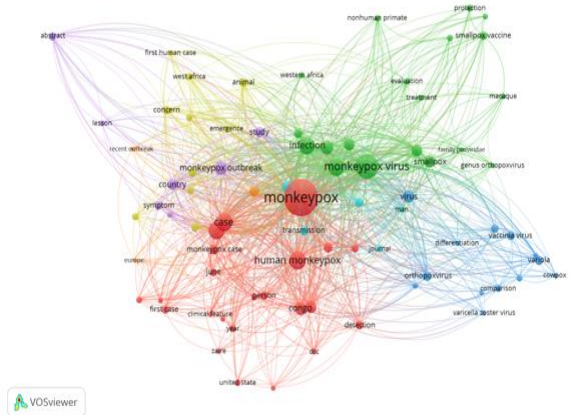
Fig. 4.   Network visualization of monkeypox topics.
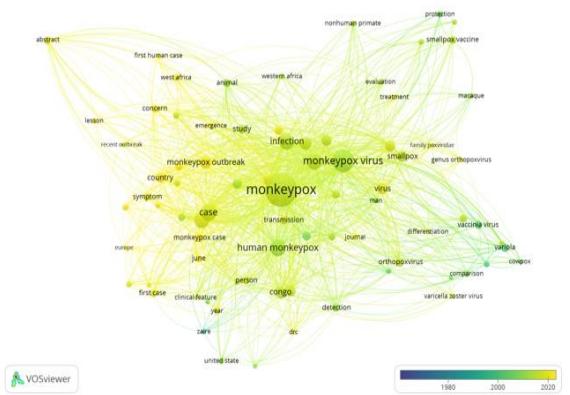
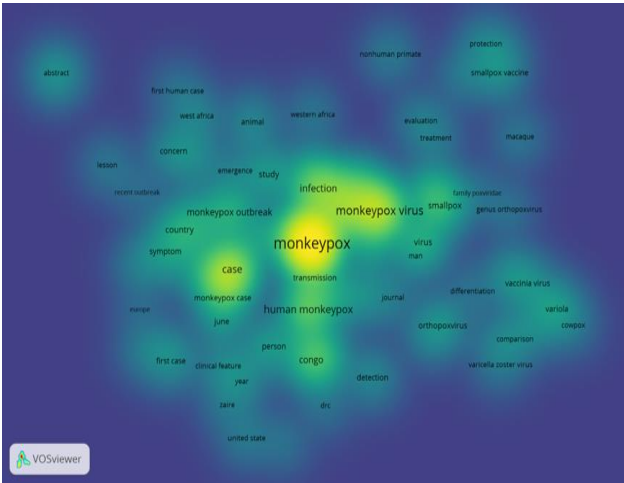Fig. 5.   Overlay visualization of monkeypox topics.

Fig. 6.   Density visualization of monkeypox topics.

Fig. 5 maps the trend of the topic network regarding the "monkeypox virus" from 1964 to 2022. Publications using the title "monkeypox" are mapped from 1964 to 2022. The yellow topics are the most recently discussed with the keyword "monkeypox ". Fig. 6 is a density visualization, and this image shows that the lighter the yellow color and the larger the circle size, the stronger the link with the keyword. So the topic

"monkeypox virus", "monkeypox virus", "case", "infection", and "congo" is a general topics with the keywords "monkeypox virus". Meanwhile, if the color fades and shrinks mixed with green, this is not a common topic to discuss. So the topics "europe," "family poxciridae ", and " recent outbreak" become topics that are not very strongly related to topics.

V. DISCUSSIONS

The results of bibliometric analysis align with existing literature and contribute valuable insights into the publication patterns and trends in monkeypox research. The upward trajectory in annual publications, particularly the significant surge in 2022, corroborates with the findings of Bunge et al., who noted the changing epidemiology of human monkeypox as a potential threat [2]. The correlation between the rise in publications and the resurgence of monkeypox cases emphasizes the dynamic nature of this emerging public health issue, echoing discussions on the evolving landscape of infectious diseases such as COVID-19 [1].

Examining publishers in the field, this study identifies Wiley Online Library (WOL), Academic Oxford, and the American Society for Microbiology (ASM) as key contributors, aligning with the diverse range of publishers identified in various bibliometric analyses [7]. This information provides researchers with valuable insights into where to find relevant studies on monkeypox, similar to the considerations made by researchers in exploring information science publications [8].

The identification of highly cited articles in this study, such as "The Detection of Monkeypox in Humans in the Western Hemisphere" [35], reinforces the importance of foundational research in shaping the discourse within the field, as highlighted by the significance of top-cited articles in various scientific domains [7]. These influential papers serve as crucial references and contribute to the collective knowledge base on monkeypox.

The exploration of topic clusters aligns with the systematic review conducted by Bunge et al., which underscores the importance of understanding various aspects of monkeypox, including clinical features and zoonotic transmission [2]. These findings further emphasize the interconnectedness between different research topics within the field, similar to the identification of trends, patterns, and collaborations in nursing career research through bibliometric analysis [7].

The network visualization and bigram analysis align with the broader literature on bibliometric analyses, showcasing the significance of specific keywords such as "monkeypox" and the role of authors and publishers in contributing to the body of knowledge [11]. Similar network analyses have been conducted in various fields, from nursing career research to the exploration of pharmaceutical science and education [7], [22].

Finally, the visualization of topic trends over time contributes to the understanding of the evolving research interests related to the monkeypox virus. This mirrors the approach taken in other bibliometric analyses, where visualizing trends aids in identifying emerging areas of investigation [19], [29].

VI. CONCLUSIONS

In conclusion, this research on the bibliometric analysis of monkeypox provides valuable insights into the trends and patterns of research in the field. The study reveals a significant increase in the number of publications on monkeypox over the last decade, indicating a growing research interest in the disease. The Wiley Online Library, Academic Oxford, and the American Society for Microbiology are identified as the top publishers in this area. The most cited articles on monkeypox cover various aspects of the disease, including detection, virus characterization, vaccination, and clinical features. These highly cited articles serve as foundational research in the field.

The analysis of topic clusters highlights the main themes and areas of focus in monkeypox research, such as clinical features, zoonotic transmission, animal hosts, and outbreak patterns. This information helps researchers identify research gaps and explore interconnected topics within the field. The network visualization and bigram analysis provide insights into the relationships between authors, abstract keywords, and publishers. The word "monkeypox" emerges as the most frequently occurring keyword, emphasizing its central importance in the field. Furthermore, the visualization of topic trends over time demonstrates the evolving research interests related to monkeypox, allowing researchers to identify emerging areas of investigation. Overall, this bibliometric analysis serves as a foundation for future research in monkeypox and provides researchers with valuable information for guiding their studies, identifying research gaps, and contributing to the understanding and managing of the disease.

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