Elsevier has created a Monkeypox Information Center in response to the declared public health emergency of international concern, with free information in English on the monkeypox virus. The Monkeypox Information Center is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its monkeypox related research that is available on the Monkeypox Information Center - including this research content - immediately available in publicly funded repositories, with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the Monkeypox Information Center remains active.

# Global Trends of Monkeypox-Related Articles: A Bibliometric Analysis Over the Last Five Decades (1964 – July 14, 2022)


Manar Ahmed Kamal, Ramadan Abdelmoez Farahat, Ahmed K. Awad, Shehroze Tabassum, Fatma Labieb, Cosmin A. Bejan, Jaffar A. Al-Tawfiq, Kuldeep Dhama, Ismail Dergaa

PII: S1876-0341(23)00190-9

DOI: https://doi.org/10.1016/j.jiph.2023.05.035

Reference: JIPH2148

To appear in: *Journal of Infection and Public Health*

Received date: 24 November 2022
Revised date: 14 May 2023
Accepted date: 28 May 2023

Please cite this article as: Manar Ahmed Kamal, Ramadan Abdelmoez Farahat, Ahmed K. Awad, Shehroze Tabassum, Fatma Labieb, Cosmin A. Bejan, Jaffar A. Al-Tawfiq, Kuldeep Dhama and Ismail Dergaa, Global Trends of Monkeypox-Related Articles: A Bibliometric Analysis Over the Last Five Decades (1964 – July 14, 2022), *Journal of Infection and Public Health,* (2023) doi:https://doi.org/10.1016/j.jiph.2023.05.035

# Global Trends of Monkeypox-Related Articles: A Bibliometric Analysis Over the Last Five Decades (1964 – July 14, 2022)

**Author list:**

Manar Ahmed Kamal[a#], Ramadan Abdelmoez Farahat[b#*], Ahmed K. Awad[c], Shehroze Tabassum[d], Fatma Labieb[e], Cosmin A. Bejan[f], Jaffar A. Al-Tawfiq[g,h,I], Kuldeep Dhama[j], Ismail Dergaa[k,l,m*]

**Affiliations:**

[a]Faculty of Medicine, Benha University, Benha, Egypt

[b]Faculty of Medicine, Kafrelsheikh University, Kafrelsheikh, 33511, Egypt

[c]Faculty of Medicine, Ain-Shams University, Cairo, Egypt

[d]King Edward Medical University, Lahore, Pakistan

[e]Faculty of Medicine, Beni-Suef University, Beni-Suef, 62511, Egypt

[f]Department of Biomedical Informatics, Vanderbilt University Medical Center, Nashville, TN, USA

[g]Infectious Disease Unit, Specialty Internal Medicine, Johns Hopkins Aramco Healthcare, Dhahran, Saudi Arabia

[h]Division of Infectious Diseases, Department of Medicine, Indiana University School of Medicine, Indianapolis, IN, USA

[i]Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, MD, USA

[j]Division of Pathology, ICAR-Indian Veterinary Research Institute, Bareilly, Izatnagar, Uttar Pradesh, 243122, India

[k] Primary Health Care Corporation (PHCC), Doha, Qatar

[l]Research Unit Physical Activity, Sport, and Health, UR18JS01, National Observatory of Sport, Tunis, 1003, Tunisia

[m]High Institute of Sport and Physical Education, University of Sfax, Sfax, Tunisia

# Those authors contributed equally as a first author

*Corresponding author:

Dr. Ismail Dergaa (Ph.D./M.Sc.), Primary Health Care Corporation (PHCC), Doha, PO Box 26555, Qatar. ORCID: 0000-0001-8091-1856. Email: Phd.dergaa@gmail.com; idergaa@phcc.gov.qa; Tel: + 97466633683.



**Abstract**

**Background**

The first human monkeypox (MPX) case was identified in the Democratic Republic of Congo (DRC) in 1970 with an outbreak in 2010 and the first human MPX case in the UK in 2022. In this study, we conducted a bibliometric analysis of the literature on monkeypox based on the Web of Science Core Collection (WOSCC) of the Institute for Scientific Information (ISI) to identify relevant topics and trends in monkeypox research.

**Methods**

We searched the Web of Science from 1964 until July 14, 2022, for all publications using the keywords "*Monkeypox*" and "*Monkeypox virus*." Results were compared using numerous bibliometric methodologies and stratified by journal, author, year, institution, and country-specific metrics.

**Results**

Out of 1,170 publications initially selected, 1,163 entered our analysis, with 65.26% (n=759) being original research articles and 9.37% (n=109) being review articles. Most MPX publications were in 2010, with 6.02% (n=70), followed by 2009 and 2022 at 5.67% (n=66) each. The USA was the country with the highest number of publications, with n=662 (56.92%) of total publications, followed by Germany with n=82 (7.05%), the UK with n=74 (6.36%), and Congo with n=65 (5.59%). Journal of Virology published the highest number of MPX publications, followed by Virology Journal and Emerging Infectious Diseases with n=52 (9.25%), n=43 (7.65%), and n=32 (5.69%) publications, respectively. The top contributing institutions were the Centers for Disease Control and Prevention (CDC), the US Army Medical Research Institute of Infectious Diseases, and the National Institutes of Health (NIH)National Institute of Allergy and Infectious Diseases (NIAID).

**Conclusion**

Our analysis provides an objective and robust overview of the current literature on MPX and its global trends; this information could serve as a reference guide for those aiming to conduct further MPX-related research and as a source for those seeking information about MPX.

Keywords:
Africa ,Control, Diagnosis, MPX, Prevention, Transmission, Global Health, Public Health



## Introduction

The 2022 multi-country Monkeypox (MPX) outbreak is alarming due to the fast spread across different non-endemic countries worldwide, especially after it was declared a "public health emergency of international concern" by the World Health Organization (WHO) on July 23, 2022 [1]. As of November 10, 2022, MPX has resulted in about 78,278 confirmed cases in locations that have not reported MPX historically [2]. Human monkeypox virus (MPXV) is a double-stranded DNA virus of the Poxviridae family. MPX is a zoonotic viral disease that can transmit primarily between animals and humans and through secondary transmission from person to person through close contact with someone who has an MPX rash. It can also spread vertically from mother to fetus. MPXV infects a wide range of mammalian species, but its natural host

reservoir remains unknown [3]. Clinical manifestations of MPX can range from less severe to more serious symptoms, which require care in a health facility. However, symptoms are usually self-limited, requiring supportive care [3]. It is characterized by fever, headache, muscle aches, back pain, and swollen lymph nodes, followed by a rash on the face, palms, soles, groin, genital, anal regions, throat, anus, or vagina, or on the eyes [3]. The asymptomatic infection has been reported, but research is still underway to find out whether asymptomatic people can spread the disease or if it can spread through bodily fluids [3].

First introduced in the late 19th century, bibliometric analysis is a scientific method to study articles and other publications and evaluate the contributions of countries, institutions, authors, and journals in a specific field of research. It can also predict trends and hotspots in a certain research field through information analysis [4]; however, such studies are rare in the MPX research field [5–8]. In the current study, we expanded the timeline from 1964 to July 14, 2022, and we analyzed the top 30 most-cited monkeypox-related articles, journals, countries, institutions, authors, and years of monkeypox-related articles. Thus, in this study, we reviewed the literature on MPX and MPXV based on the Web of Science Core Collection (WOSCC) of the Institute for Scientific Information (ISI). To identify the most relevant topics and trends in monkeypox research, we screened the 30 most-cited MPX-related articles, journals, countries, institutions, authors, and years of monkeypox-related articles. Based on this

process, we addressed the following research questions: a) What is the distribution of MPX studies by year of publication? b) Which are the most productive authors, institutions, and countries? c) Which are the most contributing studies to the field? Moreover, d) What are the past and upcoming trends in MPX research? We hope this study can add a new reference for future human MPX research and prevention.

**Methods**

We searched extensively over one electronic database [Web of Science (WOS)] for relevant studies published from 1964 to July 14, 2022. The search keywords and corresponding Medical Subject Headings (MeSH) were as follows: ("*MonkeyPox*" OR "*MonkeyPox Virus*").

The data extraction variables from the included studies are as follows: (1) Summary of total records (document type, publication year, and country); (2) Top 30 most-cited monkeypox-related articles (rank, title, year, study design, total global citation score, journal, and journal impact factor (IF)); (3) Top 30 most-cited journals, countries, institutions, authors, and years of monkeypox-related articles (number of publication records, total local citation score, and total global citation score).

Bibliometric analysis was performed using the HistCite software (Clarivate Analytics, Philadelphia, PA, USA). The impact factor data was extracted from the Journal Citation Report – Clarivate Analytics 2021.

## Results

From 1964 to July 14, 2022, the total records identified through WOS database searching were 1170 and decreased to 1163 after removing seven duplications. Only 1163 records entered the bibliometric analysis (**Figure 1**)

### Summary of included records

Of the 1,163 included publications, 65.26% (n=759) were original research articles, and 9.37% (n=109) were review articles. The lowest numbers represented reviews, early access (i.e., Preprints) and book chapters, with 0.09% (n=1) and 0.17% (n=2), respectively. The year 2010 was the most prolific in MPX research, with 6.02% (n=70) publications, followed by 2009 and 2022 (multi-state outbreak) at 5.67% (n=66) each. They were followed by 2011 at 5.16% (n=60) with the least number of publications with n=1 per year in 1996, 1995, 1990, 1989, 1975, 1974, 1971, and 1967. The USA was the country with the highest number of MPX publications, n=662 (56.92%), followed by Germany n=82 (7.05%), the UK n=74 (6.36%), and Congo n=65 (5.59%). Further details about the types, years, and countries with MPX publications are listed in **Table 1.**

### Top 30 Most-Cited Monkeypox-Related Articles

In our analysis, "*The detection of monkeypox in humans in the Western Hemisphere*" by Reed et al., published in the New England Journal of Medicine in 2004, was the most highly cited paper with 356 citations, followed by "*A preliminary assessment of silver nanoparticle inhibition of MPXV plaque formation*" by Rogers et al. published in Nanoscale Research Letters in 2008 with 262 citations, and "*Immunogenicity of a highly attenuated MVA smallpox vaccine and protection against monkeypox*" by Earl et al. published in nature in 2004 with 261 citations. **Table 2** contains additional information about the top 30 most cited monkeypox-related articles, including their journals and years of publication.

**Top 30 Most-Cited Journals, Countries, Institutions, Authors, and Years of Monkeypox-Related Articles**

This analysis found that the Journal of Virology had the highest contribution to the monkeypox literature, followed by Virology Journal and Emerging Infectious Diseases journal with 52, 43, and 32 publications, respectively. Following its initial wave in 2010, MPX began to spread widely among world countries, influencing the number of publications produced by each. The United States has produced the most publications: n = 662; total citation score (TLCS) of 6,086; and total global citation score (TGCS) of 18,668. Germany follows with n = 82; TLCS = 717; and TGCS = 2,105 then comes

Canada with n=40, TLCS= 344, and TGCS=2,095. The institution that produced the most publications is the Centers for Disease Control and Prevention, CDC (n= 166, TLCS= 2,295, TGCS =4,917), followed by the US Army Medical Research Institute of Infectious Diseases (n= 66, TLCS=1,307, TGCS= 3,652), and NIH National Institute of Allergy Infectious Diseases, NIAID (n=71, TLCS= 835, TGCS=2,181).

Drs. Damon IK, Jahrling PB, Reynolds MG, Esposito JJ, and Olson VA were the top 5 most prolific authors in this analysis, with 89, 33, 66, 20, and 45 publications, respectively. Although 2010 corresponds to the highest publications number (n=70), 2004 is the highest-ranked year due to the high TLCS of 903 and TGCS of 2,605, followed by 2005 (n=50, TLCS=973, TGCS=2519), 2009 (n=66, TLCS=480, TGCS=2,231), and 2007 (n=56, TLCS=655, TGCS=1,974). More details regarding the top 30 Most-Cited Journals, Countries, Institutions, Authors, and Years of Monkeypox-Related Articles are listed in **Table 3.**

## Discussion

The worldwide upsurge in the COVID-19 virus cases has not entirely settled, and there has been new distress about the appearance of numerous cases of human MPXV infection. Due to this situation, WHO declared it a public health emergency of international concern (PHEIC) on July 23, 2022 [1]. As of November 10, 2022, 78,278

confirmed MPX cases had been documented across 103 non-endemic countries worldwide [2].

This analysis showed an increasing trend of MPX-related publications after 2002, which mainly coincides with the 2003 US monkeypox outbreak [9]. Generally, more than 50 papers were published annually after this reference year, reaching a peak of 70 publications in 2010. In contrast, the number of papers published each year before 2001 was less than 10. Notably, given the current 2022 multi-state MPX outbreak and the fact that 66 relevant publications were already identified by July 14, 2022 (i.e., the last date for including publications in this analysis), it is likely that 2022 will become the year with the highest number of MPX-related publications.

The USA published more than 600 MPX-related papers during the recent five decades, corresponding to the most publications across all the countries (**Table 1**). The maximum number of published papers on MPX and the peak number of total citations were contributed by Dr. Damon Inger K (**Table 3**). Moreover, Drs. Jahrling PB, Reynolds MG, Esposito JJ, Olson VA, Meyer H, and Li Y produced many highly cited published papers (**Table 3**). Furthermore, the analysis should be interpreted with caution due to the fast-changing nature of MPX-related paper production, citation parameters, and all rankings, especially in the recent PHEIC. Similarly, Cheng et al. [6] found that the highest number of documents was contributed by Damon IK (CDC), followed by

Reynolds MG and Olson VA. However, the three most cited authors in the same study were Z. Jezek, F. Fenner, and J. G. Breman [6]. Furthermore, Adeiza et al. [8] found that Inger Damon (CDC) was the top author, followed by Reynolds MG and Karem KL. Additionally, they presented the author's collaboration links result, according to which Damon Inger K, McCollum Andrea, Marrennikova SS, and Meyer Hermann were the most prolific researchers who collaborated and contributed extensively to the domain of MPX- research. However, our study lacked a global collaborative network for MPX-related publications, author's collaboration links result, and co-authorship network analysis by the organization. Moreover, Lin et al.[7] reported that Damon Inger K (n=89) was the top author with the most published records, followed by Reynolds Mary G (n = 58), Carroll Darin S (n = 55), Karem Kevin I (n = 51), and Olson Victoria A (n= 39). However, Damon Inger K (n = 3,327) was the top cited author, followed by Jahrling PB (n = 1,602), Esposito JJ (n = 1,514), Meyer Hermann (n = 1,306), and Reynolds Mary G (n = 1,016). The differences in results between our study and these studies could be attributed to different data collection dates and timelines of included years in each study.

As of July 14, 2022, the USA, Germany, and Canada were the top countries responsible for most MPX-related publications during these five decades, emphasizing their impact on MPX research. CDC was the most productive and cited institution, followed by the US Army Medical Research Institute of Infectious Diseases, NIH National Institute of

Allergy Infectious Diseases (NIAID), WHO, and the National Institutes of Health (NIH) as evidenced by **Table 3**; this indicates that almost all the prolific scientific research institutions of the world worked in the domain of MPX research. In line with previous studies, Cheng et al. [6] identified the USA as the leading country in MPX research, followed by Germany and the Democratic Republic of the Congo (DRC). Notably, CDC emerged as the top institution in terms of MPX-related publications.

Similarly, Rodríguez-Morales et al. [5] reported that the USA had the highest number of articles in the field, followed by Switzerland and the DRC. Moreover, their study highlighted that CDC, WHO, and the US Army Medical Research Institute of Infectious Diseases were the top institutions contributing to MPX-related papers. The differences in results between our study and theirs may be attributed to variations in data collection dates, the timeline of included years, and the databases used. Nevertheless, both studies converge on the significance of 2003 as a pivotal year in the era of MPX research, marking a substantial increase in the number of published papers and signaling promising trends for further in-depth investigations. Additionally, Adeiza et al. [8] also observed that the USA occupied the top position in terms of publishing MPX articles, with Germany and the UK following suit. These findings highlight the global attention and collaborative efforts invested in advancing MPX research, with a particular focus

on these prominent countries. The USA was the top country publishing MPX articles, followed by Germany and UK. Likewise, Lin et al.[7] reported that the USA, followed by Germany, and DRC were the three top countries, with CDC being the top-most productive institution. This discrepancy may be due to the different dates of data collection, the timeline of included years in each study, and the included databases between the two studies.

Our study showed that the Journal of Virology, Virology, and Emerging Infectious Diseases were the top three journals, with each journal having a total local citation score (TLCS) almost greater than 500 and a Total Global Citation Score (TGCS) almost greater than 1000 (**Table 3**). These journals were prominent and vital in disseminating scientific findings related to MPX disease. The journal of virology published the highest number of MPX-related papers and was the most frequently cited journal (**Table 3**), indicating the significant role of human MPX in virus-related publications. However, Cheng et al.[6] reported that PLOS ONE published the highest MPX-related papers, followed by the Journal of Virology and Virology. Furthermore, Adeiza et al.[8] identified that Virology, Journal of Virology, and PLOS ONE were the top journals. However, Lin et al.[7] reported that the Journal of Virology, Vaccine, and Virology were the top journals. The analysis of our study suggested that scientific efforts existed to learn about and investigate human MPX. Global collaboration will be the trend in the future, giving humanity faith that there is still light at the end of the tunnel in combating

and annihilating this infectious disease. In this regard, Farahat et al. [10] have highlighted the need for global contributions to addressing the gaps in different aspects of monkeypox, especially between Arabs and foreign researchers [10].

Some of our study's most important strength points are: (1) our study's timeline of included years was from 1964 up to July 14, 2022, while Lin et al.[7] study's timeline of included years was from 1975 to June 18, 2022. (2) Top 30 most-cited monkeypox-related articles, and (3) Top 30 most-cited journals, countries, institutions, authors, and years of monkeypox-related articles. However, there are some limitations to our study. The total number of citations received by a published paper, which constitutes the basis of citation analysis, is one of the chief limitations of our study. The citation number represents scientific influence. However, many elements affect citation numbers [11]. For instance, older published papers can receive a greater number of citations than recently published ones; hence, older published papers can be favoured by this strategy. Other factors contributing to citation rates include incomplete citing, author self-citations, journal self-citations, and omission bias [12,13]. Moreover, some significant papers receive fewer citations until their results become well-known. Secondly, the literature database used for the data collection in our study is confined to the Web of Science core database, which may not thoroughly evaluate the development course of MPX. We aim to soon expand data collection from other well-recognized scientific databases such as PubMed and Scopus. Thirdly, our study can only shed light on the

advancement and evolution of MPX in limited research domains to a certain extent, which may not completely depict the real situation due to the limitations of bibliometric analysis methods. Integration of more accurate conclusions with other analysis methods and software is needed. Hence, the results obtained in our study are for reference only. Fourthly, the monkeypox topic is dynamic nowadays, especially in the context of the ongoing 2022 multi-country outbreak, and many papers have been published more quickly since July 14, 2022, and onwards till the current time; thus, citation parameters and all rankings may be changed quickly as the MPX is keeping on moving as a public health emergency of international concern (PHIEC). In this regard, we searched as of November 19, 2022, through WOS and found total publications become 1868 as compared to the included studies in our search strategy (n= 1170), indicating major number of published studies (n=698), especially in the context of the PHIEC.

To summarise, we believe it is crucial to emphasize the significance of our findings in guiding future research endeavors. By analyzing the bibliometric trends and contributions in MPX research, our study has identified common research aims, such as understanding the distribution of MPX studies, recognizing productive authors, institutions, and countries, highlighting influential studies, and identifying past and upcoming trends. These findings serve as a valuable reference for future researchers, allowing them to identify research gaps and areas that require further focus. Additionally, the insights gained from our study enable researchers to explore

collaboration opportunities, predict emerging trends, and conduct comparative analyses. By capitalizing on this knowledge, future researchers can make meaningful contributions to the field of MPX research, address important research questions, and contribute to the prevention, control, and management of MPX outbreaks.

**Figures and tables legends**

**Figure 1**: Flowchart of included studies.

**Table 1**: Summary of Total Monkeypox-Related Records (N = 1163).

**Table 2**: Top 30 Most-Cited Monkeypox-Related Articles.

**Table 3**: Top 30 Most-Cited Journals, Countries, Institutions, Authors, and Years of Monkeypox-Related Articles.



**References**:

[1] Farahat RA, Khan SH, Memish ZA. Availability of monkeypox vaccinations for low and middle-income countries: Challenges and recommendations. Travel Med Infect Dis 2022;50:102473. https://doi.org/10.1016/j.tmaid.2022.102473.

[2] CDC. 2022 Monkeypox Outbreak Global Map n.d. https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html (accessed November 12, 2022).

[3] WHO. Monkeypox n.d. https://www.who.int/news-room/questions-and-answers/item/monkeypox (accessed November 12, 2022).

[4] Kamal MA, Al-Arawi RM. Liraglutide in Treatment of Diabetes Mellitus Type 2: Systematic Review and Bibliometric Analysis Over The Last Two Decades. Metabolism 2022;128:154997. https://doi.org/10.1016/j.metabol.2021.154997.

[5] Rodríguez-Morales AJ, Ortiz-Martínez Y, Bonilla-Aldana DK. What has been researched about monkeypox? a bibliometric analysis of an old zoonotic virus causing global concern. New Microbes New Infect 2022;47:100993. https://doi.org/10.1016/j.nmni.2022.100993.

[6] Cheng K, Zhou Y, Wu H. Bibliometric analysis of global research trends on monkeypox: Are we ready to face this challenge? J Med Virol 2022. https://doi.org/10.1002/jmv.27892.

[7] Lin J, Li G, Zhong P, Zeng Q, Liu L, Chen L. Bibliometric analysis of human monkeypox research from 1975 to 2022 and novel prevention and control strategies. Front Public Heal 2022;10.

https://doi.org/10.3389/fpubh.2022.995965.

[8] Adeiza S, Shuaibu A. Trends in Monkeypox Research: A Sixty Year Bibliometric Analysis. Microbes Infect Dis 2022:0–0. https://doi.org/10.21608/mid.2022.147680.1334.

[9] Reynolds MG, Davidson WB, Curns AT, Conover CS, Huhn G, Davis JP, et al. Spectrum of Infection and Risk Factors for Human Monkeypox, United States, 2003. Emerg Infect Dis 2007;13:1332–9. https://doi.org/10.3201/eid1309.070175.

[10] Farahat RA, Elsaid M. Monkeypox and its research trends in Arab countries: A brief bibliometric analysis. Travel Med Infect Dis 2022;49:102413. https://doi.org/10.1016/j.tmaid.2022.102413.

[11] Hirsch JE. An index to quantify an individual's scientific research output. Proc Natl Acad Sci 2005;102:16569–72. https://doi.org/10.1073/pnas.0507655102.

[12] Mishra S, Fegley BD, Diesner J, Torvik VI. Self-citation is the hallmark of productive authors, of any gender. PLoS One 2018;13:e0195773. https://doi.org/10.1371/journal.pone.0195773.

[13] The Ups and Downs of Journal Impact Factors. Ann Occup Hyg 2008. https://doi.org/10.1093/annhyg/men002.

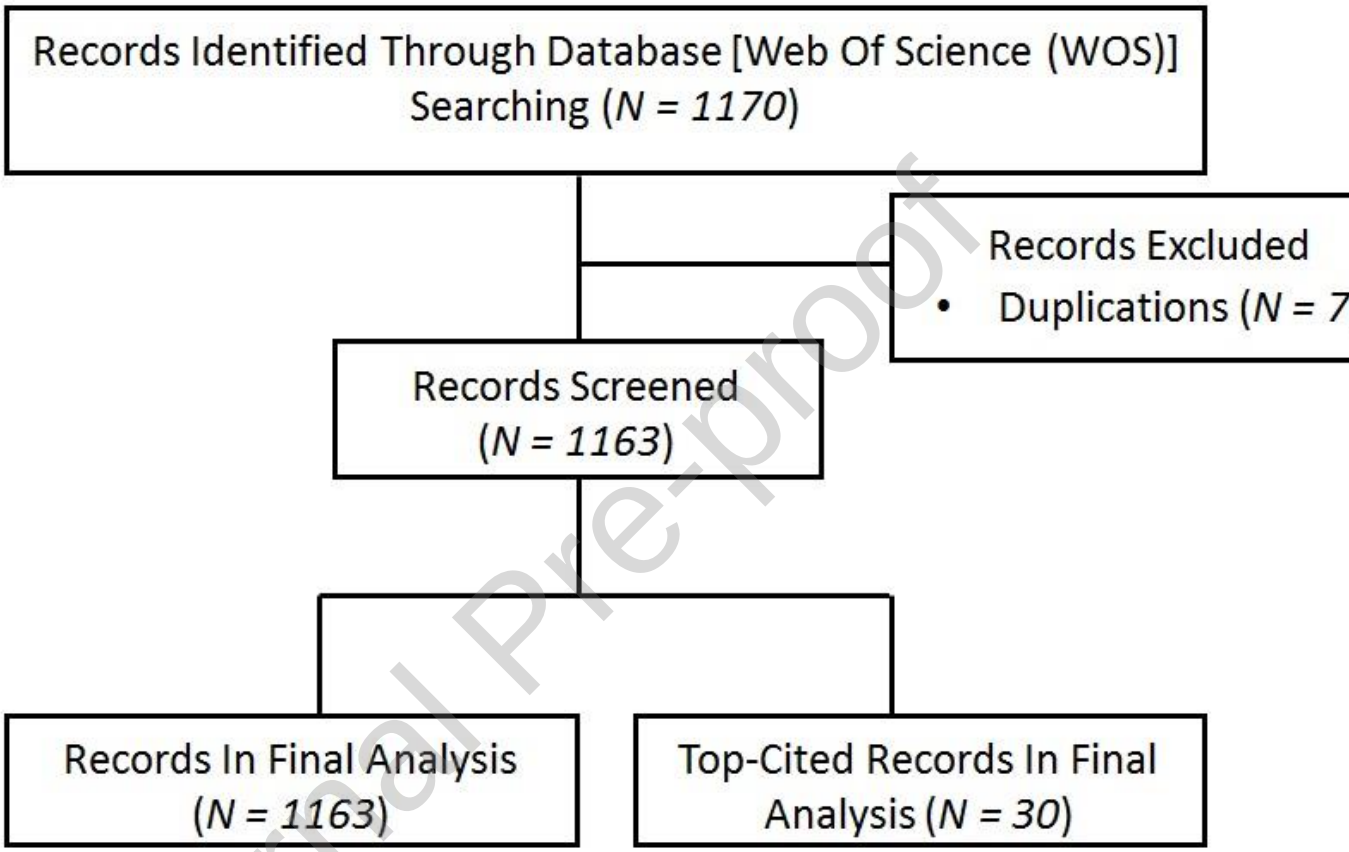


**Figure 1**: Flowchart of included studies.



| *Variables* | *N* | *%* |
|---|---|---|
| **Document Type** | 1. | |

| | | |
|---|---|---|
| **Original Research Article** | 759 | 65.26 |
| **Review Article** | 109 | 9.37 |
| **Editorial Material** | 72 | 6.19 |
| **Original Research Article; Proceedings Paper** | 12 | 1.03 |
| **Editorial Material; Book Chapter** | 1 | 0.09 |
| **Letter** | 44 | 3.78 |
| **Note** | 8 | 0.69 |
| **News Item** | 33 | 2.84 |
| **Proceedings Paper** | 9 | 0.77 |
| **Original Research Article; Book Chapter** | 22 | 1.89 |
| **Meeting Abstract** | 50 | 4.30 |

| | | |
|---|---|---|
| **Reprint** | 5 | 0.43 |
| **Letter; Early Access** | 10 | 0.86 |
| **Editorial Material; Early Access** | 13 | 1.12 |
| **Original Research Article; Early Access** | 6 | 0.52 |
| **Correction** | 7 | 0.60 |
| **Review; Early Access** | 2 | 0.17 |
| **Review; Book Chapter** | 1 | 0.09 |
| | **Publication Year** | 2. |
| **2022** | 66 | 5.67 |
| **2021** | 32 | 2.75 |
| **2020** | 53 | 4.56 |
| **2019** | 42 | 3.61 |

| | | |
|---|---|---|
| **2018** | 46 | 3.96 |
| **2017** | 42 | 3.61 |
| **2016** | 22 | 1.89 |
| **2015** | 51 | 4.39 |
| **2014** | 41 | 3.53 |
| **2013** | 48 | 4.13 |
| **2012** | 48 | 4.13 |
| **2011** | 60 | 5.16 |
| **2010** | 70 | 6.02 |
| **2009** | 66 | 5.67 |
| **2008** | 46 | 3.96 |

| | | |
|---|---|---|
| **2007** | 56 | 4.82 |
| **2006** | 45 | 3.87 |
| **2005** | 50 | 4.30 |
| **2004** | 43 | 3.70 |
| **2003** | 50 | 4.30 |
| **2002** | 23 | 1.98 |
| **2001** | 12 | 1.03 |
| **2000** | 7 | 0.60 |
| **1999** | 3 | 0.26 |
| **1998** | 9 | 0.77 |
| **1997** | 5 | 0.43 |

| | | |
|---|---|---|
| **1996** | 1 | 0.09 |
| **1995** | 1 | 0.09 |
| **1994** | 7 | 0.60 |
| **1993** | 2 | 0.17 |
| **1992** | 2 | 0.17 |
| **1991** | 4 | 0.34 |
| **1990** | 1 | 0.09 |
| **1989** | 1 | 0.09 |
| **1988** | 8 | 0.69 |
| **1987** | 6 | 0.52 |
| **1986** | 4 | 0.34 |

| | | |
|---|---|---|
| **1985** | 5 | 0.43 |
| **1984** | 6 | 0.52 |
| **1983** | 3 | 0.26 |
| **1981** | 4 | 0.34 |
| **1980** | 4 | 0.34 |
| **1979** | 2 | 0.17 |
| **1978** | 4 | 0.34 |
| **1977** | 6 | 0.52 |
| **1976** | 3 | 0.26 |
| **1975** | 1 | 0.09 |
| **1974** | 1 | 0.09 |

| | | |
|---|---|---|
| **1973** | 3 | 0.26 |
| **1972** | 11 | 0.95 |
| **1971** | 1 | 0.09 |
| **1968** | 2 | 0.17 |
| **1967** | 1 | 0.09 |
| **1964** | 2 | 0.17 |
| **Unknown** | 31 | 2.67 |
| | | **Country** 3. |
| **Afghanistan** | 1 | 0.09 |
| **Albania** | 2 | 0.17 |
| **Argentina** | 3 | 0.26 |
| **Australia** | 19 | 1.63 |

| | | |
|---|---|---|
| **Austria** | 5 | 0.43 |
| **Bangladesh** | 2 | 0.17 |
| **Belgium** | 34 | 2.92 |
| **Bolivia** | 2 | 0.17 |
| **Brazil** | 27 | 2.32 |
| **Cameroon** | 5 | 0.43 |
| **Canada** | 40 | 3.44 |
| **Cent Africa Republic** | 10 | 0.86 |
| **Colombia** | 4 | 0.34 |
| **Congo** | 1 | 0.09 |
| **Cote Ivoire** | 3 | 0.26 |

| | | |
|---|---|---|
| **Croatia** | 1 | 0.09 |
| **Czech Republic** | 4 | 0.34 |
| **DEM REP CONGO** | 65 | 5.59 |
| **Denmark** | 10 | 0.86 |
| **Ecuador** | 1 | 0.09 |
| **Egypt** | 5 | 0.43 |
| **Ethiopia** | 4 | 0.34 |
| **Finland** | 4 | 0.34 |
| **France** | 38 | 3.27 |
| **French Guiana** | 1 | 0.09 |
| **FRG** | 1 | 0.09 |

| | | |
|---|---|---|
| **Gabon** | 4 | 0.34 |
| **Georgia** | 5 | 0.43 |
| **Germany** | 82 | 7.05 |
| **Ghana** | 1 | 0.09 |
| **Greece** | 2 | 0.17 |
| **India** | 19 | 1.63 |
| **Indonesia** | 5 | 0.43 |
| **Iran** | 2 | 0.17 |
| **Israel** | 11 | 0.95 |
| **Italy** | 15 | 1.29 |
| **Japan** | 23 | 1.98 |

| | | |
|---|---|---|
| **Luxembourg** | 1 | 0.09 |
| **Madagascar** | 1 | 0.09 |
| **Malaysia** | 4 | 0.34 |
| **Malta** | 1 | 0.09 |
| **Mexico** | 4 | 0.34 |
| **Montenegro** | 1 | 0.09 |
| **Nepal** | 2 | 0.17 |
| **Netherlands** | 16 | 1.38 |
| **Nigeria** | 30 | 2.58 |
| **Norway** | 6 | 0.52 |
| **Oman** | 3 | 0.26 |

| | | |
|---|---|---|
| **Pakistan** | 3 | 0.26 |
| **Panama** | 1 | 0.09 |
| **Peoples R China** | 11 | 0.95 |
| **Peru** | 3 | 0.26 |
| **Poland** | 4 | 0.34 |
| **Portugal** | 5 | 0.43 |
| **Rep Congo** | 13 | 1.12 |
| **Russia** | 43 | 3.70 |
| **Saudi Arabia** | 3 | 0.26 |
| **Senegal** | 3 | 0.26 |
| **Serbia** | 2 | 0.17 |

| | | |
|---|---|---|
| **Sierra Leone** | 4 | 0.34 |
| **Singapore** | 6 | 0.52 |
| **Slovakia** | 1 | 0.09 |
| **South Africa** | 14 | 1.20 |
| **South Korea** | 2 | 0.17 |
| **Spain** | 12 | 1.03 |
| **St Kitts & Nevi** | 1 | 0.09 |
| **Sudan** | 3 | 0.26 |
| **Sweden** | 10 | 0.86 |
| **Switzerland** | 33 | 2.84 |
| **Taiwan** | 1 | 0.09 |

| | | |
|---|---|---|
| **Tanzania** | 2 | 0.17 |
| **Thailand** | 2 | 0.17 |
| **Trinidad Tobago** | 1 | 0.09 |
| **TUNISIA** | 1 | 0.09 |
| **Turkey** | 3 | 0.26 |
| **U Arab Emirates** | 1 | 0.09 |
| **Uganda** | 1 | 0.09 |
| **UK** | 74 | 6.36 |
| **Ukraine** | 1 | 0.09 |
| **USA** | 662 | 56.92 |
| **USSR** | 8 | 0.69 |

| | | |
|---|---|---|
| **Venezuela** | 1 | 0.09 |
| **Vietnam** | 3 | 0.26 |
| **ZAIRE** | 1 | 0.09 |
| **Zambia** | 2 | 0.17 |
| **Zimbabwe** | 1 | 0.09 |
| **Unknown** | 134 | 11.52 |

**Table 1**: Summary of Total Monkeypox-Related Records (N = 1163).

| ***SCR*** | ***Title*** | ***Year*** | ***Study Design*** | ***TGCS*** | ***Journal*** | ***IF (2021)*** |
|---|---|---|---|---|---|---|
| **1st** | The detection of monkeypox in humans in the Western Hemisphere | 2004 | Laboratory Study | 356 | New England Journal of Medicine | 176.079 |
| **2nd** | A preliminary assessment of silver nanoparticle inhibition of monkeypox virus plaque formation | 2008 | Laboratory Study | 262 | Nanoscale Research Letters | 5.418 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **3rd** | Immunogenicity of a highly attenuated MVA smallpox vaccine and protection against monkeypox | 2004 | Animal Study | 261 | Nature | 69.504 |
| **4th** | Smallpox vaccine-induced antibodies are necessary and sufficient for protection against monkeypox virus | 2005 | Animal Study | 205 | Nature Medicine | 87.241 |
| **5th** | Major increase in human monkeypox incidence 30 years after smallpox vaccination campaigns cease in the Democratic Republic of Congo | 2010 | Observational Study | 205 | Proceedings of The National Academy of Sciences of The United States of America | 12.779 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **6th** | Outbreak of human monkeypox, Democratic Republic of Congo, 1996-1996 | 2001 | Laboratory Study | 184 | Emerging Infectious Diseases | 16.126 |
| **7th** | Human monkeypox: an emerging zoonosis | 2004 | Review | 178 | Lancet Infectious Diseases | 71.421 |
| **8th** | A tale of two clades: monkeypox viruses | 2005 | Laboratory Study | 175 | Journal of General Virology | 5.141 |
| **9th** | Smallpox DNA vaccine protects nonhuman primates against lethal monkeypox | 2004 | Animal Study | 173 | Journal of Virology | 6.549 |
| **10th** | Potential antiviral therapeutics for smallpox, monkeypox | 2003 | Laboratory Study | 132 | Antiviral Research | 10.103 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | and other orthopoxvirus infections | | | | | |
| **11th** | Virulence differences between monkeypox virus isolates from West Africa and the Congo basin | 2005 | Laboratory Study | 131 | Virology | 3.513 |
| **12th** | Human Infection Caused By Monkeypox Virus In Basankusu Territory, Democratic-Republic-of-Congo | 1972 | Laboratory Study | 130 | Bulletin of The World Health Organization | 13.831 |
| **13th** | Poxvirus dilemmas - Monkeypox, smallpox, and biologic terrorism | 1998 | Review | 127 | New England Journal of Medicine | 176.079 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **14th** | Modified vaccinia virus Ankara protects macaques against respiratory challenge with monkeypox virus | 2005 | Animal Study | 125 | Journal of Virology | 6.549 |
| **15th** | The pathology of experimental aerosolized monkeypox virus infection in cynomolgus monkeys (Macaca fascicularis) | 2001 | Laboratory Study | 124 | Laboratory Investigation | 5.515 |
| **16th** | Human monkeypox: an emerging zoonotic disease | 2007 | Review | 121 | Future Microbiology | 3.553 |
| **17th** | Human monkeypox, 1970-79 | 1980 | Case Series | 111 | Bulletin of The World Health Organization | 13.831 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **18th** | Antiviral treatment is more effective than smallpox vaccination upon lethal monkeypox virus infection | 2006 | Laboratory Study | 109 | Nature | 69.504 |
| **19th** | Human Monkeypox - Clinical-Features of 282 Patients | 1987 | Observational Study | 108 | Journal of Infectious Diseases | 7.759 |
| **20th** | Extended interhuman transmission of monkeypox in a hospital community in the Republic of the Congo, 2003 | 2005 | Case Series | 103 | American Journal of Tropical Medicine and Hygiene | 3.707 |
| **21st** | Re-emergence of monkeypox in Africa: a | 1998 | Review | 98 | British Medical Bulletin | 5.841 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | review of the past six years | | | | | |
| **22nd** | Outbreaks of disease suspected of being due to human monkeypox virus infection in the Democratic Republic of Congo in 2001 | 2002 | Laboratory Study | 94 | Journal of Clinical Microbiology | 11.677 |
| **23rd** | Monkeypox transmission and pathogenesis in prairie dogs | 2004 | Animal Study | 94 | Emerging Infectious Diseases | 16.126 |
| **24th** | ISOLATION of MONKEYPOX VIRUS FROM WILD SQUIRREL INFECTED IN NATURE | 1986 | Laboratory Study | 93 | Lancet | 202.731 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **25th** | Human monkeypox and smallpox viruses: genomic comparison | 2001 | Laboratory Study | 93 | FEBS Letters | 3.864 |
| **26th** | The Transmission Potential of Monkeypox Virus In Human-Populations | 1988 | Observational Study | 85 | International Journal of Epidemiology | 9.685 |
| **27th** | Monkeypox zoonotic associations: Insights from laboratory evaluation of animals associated with the multi-state us outbreak | 2007 | Laboratory Study | 85 | American Journal of Tropical Medicine and Hygiene | 3.707 |
| **28th** | Human Monkeypox - A Newly Emerged Orthopoxvirus Zoonosis | 1985 | Case Series | 83 | American Journal of Tropical Medicine and Hygiene | 3.707 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | In The Tropical Rain Forests Of Africa | | | | | |
| **29th** | Subunit recombinant vaccine protects against monkeypox | 2006 | Animal Study | 82 | Journal of Immunology | 5.446 |
| **30th** | Characterization of wild-type and cidofovir-resistant strains of Camelpox, cowpox, monkeypox, and vaccinia viruses | 2002 | Laboratory Study | 80 | Antimicrobial Agents and Chemotherapy | 5.938 |

**Table 2**: Top 30 Most-Cited Monkeypox-Related Articles. **Abbreviations**: SCR: Standard Competition Ranking; TGCS: Total Global Citation Score; IF: Impact Factor; H-Index: Hirsch index.

| | *Variables* | *Records* | *TLCS* | *TGCS* |
|---|---|---|---|---|
| | | | **Journal** | 1. |
| **1st** | Journal Of Virology | 52 | 685 | 1957 |
| **2nd** | Virology | 43 | 536 | 1537 |
| **3rd** | Emerging Infectious Diseases | 32 | 645 | 1229 |
| **4th** | Vaccine | 46 | 358 | 1146 |
| **5th** | Journal of General Virology | 20 | 406 | 997 |
| **6th** | New England Journal of Medicine | 13 | 416 | 850 |

| | | | | |
|---|---|---|---|---|
| **7th** | Bulletin of The World Health Organization | 22 | 607 | 843 |
| **8th** | Journal of Infectious Diseases | 26 | 410 | 802 |
| **9th** | Nature | 10 | 197 | 784 |
| **10th** | Plos One | 42 | 0 | 741 |
| **11th** | Antimicrobial Agents And Chemotherapy | 18 | 274 | 736 |
| **12th** | Journal of Clinical Microbiology | 11 | 309 | 730 |
| **13th** | Nature Reviews Microbiology | 3 | 40 | 710 |

| | | | | |
|---|---|---|---|---|
| **14th** | Antiviral Research | 31 | 92 | 705 |
| **15th** | American Journal of Tropical Medicine And Hygiene | 38 | 468 | 565 |
| **16th** | Proceedings of The National Academy of Sciences of The United States of America | 9 | 257 | 519 |
| **17th** | Viruses-Basel | 30 | 101 | 438 |
| **18th** | Journal of Immunology | 11 | 102 | 430 |
| **19th** | Clinical Infectious Diseases | 14 | 256 | 412 |
| **20th** | Nature Medicine | 5 | 60 | 367 |

| | | | | |
|---|---|---|---|---|
| **21st** | Journal of Virological Methods | 15 | 129 | 317 |
| **22nd** | Plos Pathogens | 13 | 0 | 306 |
| **23rd** | Live Variola Virus: Considerations For Continuing Research | 3 | 0 | 304 |
| **24th** | Lancet Infectious Diseases | 11 | 43 | 296 |
| **25th** | Clinical Microbiology Reviews | 2 | 1 | 295 |
| **26th** | Nanoscale Research Letters | 1 | 0 | 262 |
| **27th** | Veterinary Microbiology | 3 | 69 | 254 |

| | | | | |
|---|---|---|---|---|
| **28th** | Revue Scientifique Et Technique-Office International Des Epizooties | 4 | 3 | 247 |
| **29th** | Virology Journal | 18 | 0 | 226 |
| **30th** | Lancet | 16 | 173 | 223 |
| | | | **Country** | 2. |
| **1st** | USA | 662 | 6086 | 18668 |
| **2nd** | Germany | 82 | 717 | 2105 |
| **3rd** | Canada | 40 | 344 | 2095 |
| **4th** | UK | 74 | 237 | 1859 |

| | | | | |
|---|---|---|---|---|
| **5th** | Switzerland | 33 | 1011 | 1536 |
| **6th** | Belgium | 34 | 259 | 1314 |
| **7th** | France | 38 | 103 | 968 |
| **8th** | DEM REP CONGO | 65 | 474 | 807 |
| **9th** | Australia | 19 | 73 | 805 |
| **10th** | Russia | 43 | 194 | 721 |
| **11th** | Netherlands | 16 | 182 | 519 |

| | | | | |
|---|---|---|---|---|
| **12th** | Brazil | 27 | 74 | 495 |
| **13th** | Japan | 23 | 151 | 381 |
| **14th** | Rep Congo | 13 | 250 | 313 |
| **15th** | Sweden | 10 | 20 | 299 |
| **16th** | Nigeria | 30 | 95 | 297 |
| **17th** | Denmark | 10 | 59 | 194 |
| **18th** | USSR | 8 | 147 | 188 |

| | | | | |
|---|---|---|---|---|
| **19th** | South Africa | 14 | 60 | 175 |
| **20th** | India | 19 | 21 | 159 |
| **21st** | Czech Republic | 4 | 55 | 153 |
| **22nd** | Spain | 12 | 24 | 148 |
| **23rd** | Italy | 15 | 19 | 135 |
| **24th** | Israel | 11 | 48 | 120 |
| **25th** | Norway | 6 | 7 | 113 |

| | | | | |
|---|---|---|---|---|
| **26th** | Austria | 5 | 6 | 102 |
| **27th** | Oman | 3 | 28 | 102 |
| **28th** | Poland | 4 | 39 | 99 |
| **29th** | Georgia | 5 | 24 | 71 |
| **30th** | Sudan | 3 | 61 | 70 |
| | | | **Institution** | 3. |
| **1st** | Centers For Disease Control and Prevention (CDC) | 166 | 2295 | 4917 |
| **2nd** | US Army Medical Research Institute of Infectious Diseases | 66 | 1307 | 3652 |

| | | | | |
|---|---|---|---|---|
| **3rd** | NIH National Institute of Allergy Infectious Diseases (NIAID) | 71 | 835 | 2181 |
| **4th** | World Health Organization (WHO) | 27 | 968 | 1412 |
| **5th** | National Institutes of Health (NIH) | 23 | 419 | 1335 |
| **6th** | Saint Louis University | 33 | 565 | 1253 |
| **7th** | Katholieke University Leuven | 21 | 182 | 1117 |
| **8th** | University of California Los Angeles | 24 | 352 | 933 |
| **9th** | Stanford University | 16 | 36 | 908 |

| | | | | |
|---|---|---|---|---|
| **10th** | Med Coll Wisconsin | 10 | 332 | 829 |
| **11th** | University of Pennsylvania | 20 | 245 | 810 |
| **12th** | Bundeswehr Inst Microbiology | 15 | 325 | 779 |
| **13th** | *Oregon* Health & Science University | 19 | 125 | 765 |
| **14th** | *University* of *Florida* | 17 | 126 | 699 |
| **15th** | Emory University | 17 | 123 | 672 |
| **16th** | Robert Koch Institute | 25 | 152 | 662 |

| | | | | |
|---|---|---|---|---|
| **17th** | US Food Drug Administration (FDA) | 23 | 147 | 653 |
| **18th** | *SIGA Technologies, Inc* | 21 | 340 | 649 |
| **19th** | *Southern Research* Institute | 14 | 165 | 642 |
| **20th** | **1.1.1** State Research Center of Virology and Biotechnology VECTOR | 24 | 185 | 609 |
| **21st** | *University* of *Victoria* | 9 | 175 | 593 |
| **22nd** | Johns Hopkins University | 8 | 248 | 583 |
| **23rd** | Minist Hlth (Congo) | 39 | 439 | 578 |

| | | | | |
|---|---|---|---|---|
| **24th** | *National Cancer Institute* (*NCI*) | 12 | 95 | 561 |
| **25th** | *University* of Washington | 7 | 30 | 550 |
| **26th** | *National Institute* of *Biomedical Research* | 13 | 366 | 468 |
| **27th** | *University* of Western Ontario | 5 | 76 | 453 |
| **28th** | *University* of Georgia | 13 | 25 | 450 |
| **29th** | U.S. Centers For Disease Control and Prevention (CDC) | 28 | 219 | 447 |
| **30th** | Wisconsin Division of Public Health | 3 | 297 | 441 |

**Author** 4.

| | | | | |
|---|---|---|---|---|
| **1st** | Damon IK | 89 | 1969 | 3165 |
| **2nd** | Jahrling PB | 33 | 668 | 1622 |
| **3rd** | Reynolds MG | 66 | 1031 | 1566 |
| **4th** | Esposito JJ | 20 | 825 | 1539 |
| **5th** | Olson VA | 45 | 911 | 1468 |
| **6th** | Meyer H | 27 | 589 | 1354 |
| **7th** | Li Y | 39 | 793 | 1320 |

| | | | | |
|---|---|---|---|---|
| **8th** | Carroll DS | 48 | 521 | 1008 |
| **9th** | Moss B | 21 | 415 | 987 |
| **10th** | Formenty P | 11 | 609 | 980 |
| **11th** | Regnery RL | 16 | 663 | 978 |
| **12th** | Jezek Z | 19 | 799 | 949 |
| **13th** | Huggins JW | 16 | 259 | 886 |
| **14th** | Karem KL | 39 | 518 | 882 |

| | | | | |
|---|---|---|---|---|
| **15th** | Hooper JW | 16 | 241 | 870 |
| **16th** | Bray M | 15 | 118 | 756 |
| **17th** | McFadden G | 12 | 100 | 739 |
| **18th** | Jordan R | 17 | 392 | 731 |
| **19th** | Shchelkunov SN | 30 | 241 | 724 |
| **20th** | De Clercq E | 10 | 85 | 707 |
| **21st** | Lloyd-Smith JO | 8 | 183 | 700 |

| | | | | |
|---|---|---|---|---|
| **22nd** | Breman JG | 7 | 253 | 611 |
| **23rd** | Americo JL | 14 | 270 | 610 |
| **24th** | Buller RML | 9 | 288 | 593 |
| **25th** | Nalca A | 12 | 156 | 586 |
| **26th** | Szczeniowski M | 12 | 473 | 580 |
| **27th** | Earl PL | 13 | 267 | 579 |
| **28th** | Hruby DE | 22 | 316 | 573 |

| | | | | |
|---|---|---|---|---|
| **29th** | Karem K | 20 | 316 | 552 |
| **30th** | Arita I | 13 | 357 | 530 |
| | | **Publication Year** | | 5. |
| **1st** | 2004 | 43 | 903 | 2605 |
| **2nd** | 2005 | 50 | 973 | 2519 |
| **3rd** | 2009 | 66 | 480 | 2231 |
| **4th** | 2007 | 56 | 655 | 1974 |
| **5th** | 2010 | 70 | 652 | 1683 |

| | | | | |
|---|---|---|---|---|
| **6th** | 2003 | 50 | 240 | 1580 |
| **7th** | 2006 | 45 | 516 | 1551 |
| **8th** | 2011 | 60 | 389 | 1348 |
| **9th** | 2008 | 46 | 313 | 1342 |
| **10th** | 2002 | 23 | 320 | 1245 |
| **11th** | 2001 | 12 | 382 | 818 |
| **12th** | 2013 | 48 | 157 | 751 |

| | | | | |
|---|---|---|---|---|
| **13th** | 2012 | 48 | 196 | 740 |
| **14th** | 2017 | 42 | 62 | 612 |
| **15th** | 2014 | 41 | 155 | 579 |
| **16th** | 2018 | 46 | 132 | 503 |
| **17th** | 2015 | 51 | 165 | 464 |
| **18th** | 1998 | 9 | 144 | 444 |
| **19th** | 1972 | 11 | 256 | 384 |

| | | | | |
|---|---|---|---|---|
| **20th** | 2019 | 42 | 131 | 372 |
| **21st** | 2000 | 7 | 104 | 317 |
| **22nd** | 1987 | 6 | 266 | 297 |
| **23rd** | 1988 | 8 | 271 | 297 |
| **24th** | 2020 | 53 | 71 | 277 |
| **25th** | 2016 | 22 | 71 | 243 |
| **26th** | 1986 | 4 | 171 | 215 |

| | | | | |
|---|---|---|---|---|
| **27th** | 1997 | 5 | 104 | 198 |
| **28th** | 1995 | 1 | 52 | 170 |
| **29th** | 1980 | 4 | 108 | 160 |
| **30th** | 1985 | 5 | 112 | 159 |

**Table 3**: Top 30 Most-Cited Journals, Countries, Institutions, Authors, and Years of Monkeypox-Related Articles.



Declaration of Competing Interest

The authors declare no conflict of interest