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RESEARCH PAPER

Global network mapping research landscape and trends of the endogenous retroviruses: a look through bibliometric analysis

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Abstract
Endogenous retrovirus (ERV) research amalgamates host-retroviral coevolutionary, phylogenomic, infection, immunity, and cellular studies in various hosts ranging from fish to humans. Henceforth, a bibliometric analysis of these publications may aid in the identification of trends in ERV research. It was the foremost bibliographic study, with the key aim to conduct the bibliometric network analysis (e.g. co-authorship, co-occurrence, citation, bibliographic coupling, and co-citation analysis) to find the most prolific authors, organizations, and countries in ERV research, based on the mapping of bibliographic data. Second, the mapping based on text data comprised to chalk out the research trend over the time. The global literature about endogenous retroviruses published between 1985 and Sep 2021 was searched in the Web of Science (Core Collection) database using the "ENDOGENOUS RETROVIRUS" keyword. The bibliometric analysis of this dataset was carried out using VOSviewer version 1.6.17. According to findings, English was the de facto language of these publications, and 2157 were original articles. Among 2939 published documents, "endogenous retrovirus" was the most frequent keyword. Moreover, it revealed the United States as a core contributor to studies on the ERV. The Journal of Virology published a substantial amount of manuscripts in ERV. Robert Koch Institute and Harvard University were leading organizations for research in this field. The application of ERV research from China could be the research hotspot to follow in the coming years. Current bibliometric analysis provides a comprehensive picture of ERV research progress and has highlighted the contribution of different stakeholders.

Keywords VOSviewer · Core collection · Bibliometric analysis · Networking · Research trends · Co-authorship · Co-occurrence · Bibliographic coupling · Co-citation

1 Introduction

The endogenous retroviruses (ERVs) are integrated retroviral fossil signatures in the vertebrate genome (Malfavon-Borja and Feschotte 2015) that are vertically transmitted by standard Mendelian inheritance mechanisms and retained in the host genome over millions of years of molecular fossil of infection (Aiewsakun and Katzourakis 2017; Herniou et al. 1998). The abundant and diverse ERVs are found in the genome of various vertebrates ranging from fish to humans (Hayward et al. 2015; Herniou et al. 1998). Generally among eukaryotes, about forty-three viral families are known to have forged endogenous relationships with their hosts. These endogenous viruses (EVs) are hosted by simplest life forms like amoeba, algae to higher taxa such as amphibians, annelids, arachnids, avians, cnidarians, collembolids, crustaceans, echinoderms, fish, fungi, ichthyosporeans, insects, mammals, molluscs, nematodes, oomycetes, plants, platyhelminths, reptiles, tunicates, and unspecified heterokonts (Hurst 2022). The ERVs constitute a significant part of the host genome. For example, in humans, almost 8% and 14% in chickens (Malfavon-Borja and Feschotte 2015; Naville and Volff 2016). ERVs are the most powerful tool for studying host-retroviral coevolution. They provide a primary perspective into the deep retroviral evolutionary phylogenomics history of infection and immunity (Hayward et al. 2015; Naville and Volff 2016). The integration event of ERVs did not lead to drastic mutations in the host

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genome. ERVs provide regulatory sequences, beneficially altering the genetic networks, cellular functions, and gene regulation (Geis and Goff 2020; Robbez-Masson and Rowe 2015; Schlesinger and Goff 2015; Ye et al. 2020). Denovo DNA methylation of ERVs within the host genome tends to leave epigenetic marks during the early stages of embryogenesis. This DNA methylation protects the genome against disadvantageous transcriptions (Geis and Goff 2020). ERV-encoded products (RNA, cDNA, and proteins) can directly contribute to various disease conditions, such as cancer, senescence, and chronic inflammations in aberrant amounts (Cosby et al. 2019; Geis and Goff 2020).

The bibliometric network analysis is regarded as a hallmark in research publications, and scientists work as teammates to achieve mutual research goals. The study of the social network and co-authorship networks are dominant tools to assess the collaboration trends and identify leading scientists, journal sources, and organizations (Fonseca Bde et al. 2016). Previously, studies have been conducted to address viral infectious diseases such as COVID-19 (Farooq et al. 2021; Yu et al. 2020), Zika virus (Albuquerque et al. 2017), Dengue (Maula et al. 2018; Zyoud 2016), Ebola (Kawuki et al. 2020; Yi et al. 2016), and West Nile virus (Al-Jabi 2017). Other research studies were mainly focused on assessing bacterial infections and parasitic diseases, including campylobacteriosis, tuberculosis, Kala-azar, and malaria (Groneberg et al. 2015; Ramos et al. 2013; Sweileh et al. 2016a, b).

The bibliometric networking analysis shows that the nodes of test items are highly interconnected to form a mesh of interaction and interlink network among authors, organizations, articles, countries, and institutions. Hence, in this perspective, the bibliometric study falls in the collaborative network domain. A collaborative network (CN) is a network made up of a variety of entities (e.g., organizations and people). They are mainly autonomous, geographically dispersed, and heterogeneous in terms of the operating environment, culture, science, social capital, and goals but work together to achieve common or compatible goals (Newman 2001). In a bibliographic study, "total link strength" indicates "the number of articles in which two terms occur together." Total link strength attributes show connectivity between items and contain weight attributes, i.e., Occurrences, documents, citations, and norm citations (Pinto et al. 2014; Waltman and van Eck 2013). In the bibliometric study, the co-authorship networks have their descriptive and synthetic power to describe the evolution of research communities because social networks play a significant role in the generation of knowledge (Biscaro and Giupponi 2014). It also helps to chalk out the interlinked global recognitions and landmark articles based on prior works of scientists, organizations, and countries. Another key aspect of the bibliometric analysis is science mapping, which relies on bibliographic coupling, textual analysis, and co-citation analysis (Glanzel and Czerwon 1996; Waltman and van Eck 2012). The articles are the vertices of the bibliographic coupling, and an edge is formed when they share at least one reference (Biscaro and Giupponi 2014). Co-citation analysis examines the structure and development of scientific communities and areas.

This methodology is robust and reliable because the citation is a valid and reliable indicator of the relevance of an article, journal, or scientist in scientific communication. Two approaches have emerged in recent decades within this framework: document co-citation (focused on documents and publications) and author co-citation (focused on researchers) (Reyes-Gonzalez et al. 2016). These analyses help to map the structure of scientific and technological fields and their evolution over time. The latest advances in bibliometric tools allow scientists to identify research productivity, knowledge gaps, and research trends in different fields. Among bibliometric tools, VOSviewer offers to map research trends, productivity, and productivity (van Eck and Waltman 2010).

In the field of ERV, the research productivity has not been explored to date. The current study bibliometrically analyzed the languages, yearly publications, countries and collaboration patterns, institutions, journals, and citations in the Web of Science (Core Collection). This study analyzed the global research output for ERVs. Present investigation documented research output and trends among scientists to explore ERVs. Moreover, it also revealed the preference and current research trends in biomedical journals. Our study has implications for future research trends and direction in ERVs.

2 Materials and methods

2.1 Data collection and analysis

We conducted this comprehensive study to identify ERV research directions and trends of publications available in the Web of Science, Core Collection database. The duration of the search was from 1985 to Sep 2021.

2.2 Data inclusion and exclusion criteria

We included all relevant articles about Endogenous Retroviruses. Our research comprised reviews, books, editorials, letters, and conference abstracts. In addition, articles published in other languages were also included. We excluded Scopus or other databases in our analysis.

2.3 Data analysis

The dataset was obtained in Tab-delimited file format, using the keyword "ENDOGENOUS RETROVIRUS." Data were analyzed by VOSviewer version 1.6.17 (van Eck and Waltman 2010). The study included aspects: co-authorship, co-occurrence, bibliographic coupling, and co-citation patterns among documents, authors, organizations, countries, and prolific journals. Furthermore, we also analyzed the themes, abstracts, and keywords of the published data source available on WOS (Core Collection) to date.

3 Results

3.1 Evaluation of the dataset from WOS

The study corpus was comprised of 2939 documents published on WOS (Core collection) in the studied period between Jan 1985–Sep 2021. This database consists of original articles (2157; 73.39%) and reviews articles (459; 15.61%). Most of the published material was in English (2912; 99.08%), followed by French (12, 0.408%), as mentioned in Table 1. A total of 80 countries contributed to the scientific output in the field of ERV research. Among them, the top 10 are mentioned in Table 1. The United States published most papers (1032; 35.11%), followed by Germany (466; 15.85%) and England (303; 10.31%). According to the findings, 2250 research institutions play their role; the ten most proliferative institutions are in Table 1. Centre National De La Recherche Scientifique (CNRS) contributed most in the scientific community with 138 publications (4.69%).

3.2 Bibliometric analysis of the themes, trends, and keywords

In the co-occurrence map based on text, data revealed the six themes of the research over time. The red cluster included terms like evolution, phylogeny, DNA methylation, gene expression, and molecular characteristics of cancer cells, and the green cluster comprised HERV, transcription, and transposable elements. The main key terms in the yellow cluster were porcine endogenous retroviruses, ERV expression, and transmission. The blue cluster indicated xenotransplantation, clinical trials on xenotransplantation for liver failure, and diabetes treatment. The yellow cluster was associated with DNA methylation, multiple sclerosis, and pathogenesis in primates, more specifically in humans (human endogenous retroviruses HERVs). The purple cluster complicated melanoma transcriptional activity in HERVs. The light blue cluster elaborated on factors related to HERVs and their role in placentation. (Fig. 1a).

The co-occurrence map of titles and abstracts showed that ERV research trends mainly focused on porcine endogenous retrovirus, transplantation, treatment, multiple sclerosis, pathogenesis, HERV, HERV-K, promotors, evolution, and phylogenetic (Fig. 1b). Based on the occurrence (minimum five times) of author-provided keywords, documents in the dataset were selected to analyze. Out of the 4112 keywords, 253 met the analysis threshold, revealing that 253 keywords appeared in 11 clusters with 2747 links and 4892 total link strength. The keyword "endogenous retrovirus" (occurrence 313; total link strength 587) appeared most, followed by "xenotransplantation" (occurrence 222; total link strength 458), "human endogenous retrovirus" (occurrence 125; total link strength 277), and "porcine endogenous retrovirus" (occurrence 100; total link strength 192) (Fig. 1c, d). Table 2 shows the top ten most occurring author-provided keywords based on higher values of total link strength.

3.3 Bibliometric analysis of the citation

Eight hundred and twenty-two journals have published about ERVs in different ways, and we selected the criteria as five minimum numbers of publications. According to this criterion, 117 publications met the analysis threshold and revealed the "Journal of Virology" documented 182 publications with 8559 citations (Fig. 2a). In the document citation analysis, we calculated document citations. One thousand research publications are in 8 clusters with 15,033 links. Document citation analysis revealed the top-ranked article authored by Gibbs (2004). Gibb's manuscript was cited 14,78 times (Fig. 2b).

The citation analysis of authors was categorized based on the number of publications and citations. Eleven thousand four hundred seven authors (11,407) contributed to ERV research, and 387 met the threshold analysis. The 387 authors are in ten clusters with 15,834 links and 68,422 total link strength (Fig. 2c). Mallet F appeared as a most-cited author in analysis, with 1973 citations and total link strength of 1719. A total of 2416 organizations contributed to the ERV research during the study. According to the default analysis setting, 310 organizations meet the thresholds (Fig. 2d). The organizations with the greater link strength analysis revealed that Harvard University was top-ranked (61 documents; 3650 citations). In the country viz citation analysis, out of 80 countries, 40 met the analysis threshold., i.e., 1027 documents with 39,919 citations and 17,516 total link strength (Fig. 3a). It revealed the USA as a major contributing country to ERV research. However, China has contributed more significantly than other countries in the past few years. The top-cited article was published in Nature in 2004. Since then, it has been cited 1487 times

Table 1 WOS (Core Collection) is the publication type and language of documented publications globally in ERV research

Sr.No	Parameters		Sum	Percentage
1	Publication type	Articles	2157	73.392
		Review Articles	459	15.618
		Meeting Abstracts	217	7.383
		Proceedings Papers	102	3.471
		Editorial Materials	60	2.042
		Letters	29	0.987
		Book Chapters	18	0.612
		Corrections	14	0.476
		Early Access	10	0.340
		News Items	2	0.068
2	language	English	2912	99.081
		French	12	0.408
		German	4	0.136
		Spanish	4	0.136
		Chinese	2	0.068
		Russian	2	0.068
		Korean	1	0.034
		Polish	1	0.034
		Turkish	1	0.034
3	Country of origin	USA	1032	35.11
		Germany	466	15.85
		England	303	10.31
		France	290	9.86
		Japan	238	8.09
		China	220	7.48
		Canada	157	5.34
		South Korea	150	5.10
		Italy	146	4.96
		Switzerland	120	4.08
4	Funding Agencies	United States Department Of Health Human Services	528	17.965
		National Institutes Of Health (NIH) the USA	525	17.863
		European Commission	187	6.363
		NIH National Institute Of Allergy Infectious Diseases (NIAID)	178	6.056
		Nih National Cancer Institute (NCI)	140	4.764
		National Natural Science Foundation Of China (NSFC)	104	3.539
		NIH National Institute Of General Medical Sciences (NIGMS)	89	3.028
		Pennsylvania Commonwealth System of Higher Education (PCSHE)	179	1.77%
		University of London	161	1.59%
		US Department of Veterans Affairs	147	1.45%

with 82.61 average citations per year. A clear change in research hubs was noted. This highlights a shift in research hubs, and this shift has moved from western countries to China (Fig. 3b).

3.4 Bibliometric analysis of co-authorship

In the co-authorship network analysis, the metrics of authors' positions to build a map based on the author's publications, countries, and organizations, as the co-authorship networking and bibliographic coupling network comprised many components. The current study revealed that the USA ranked on top with 38 links, 632 total link strength, 1017 documents, and 39,423 citations (Fig. 4a). Totally 11,408 authors contributed to the scientific world of ERV publications. Among them, 135 appeared highly connected. Danner Joachim has co-authored 53 articles with 1408 citations (Fig. 4b). The literature search revealed that 2416 organizations had published related papers, and among them, 305 organizations had the most extensive set of collaboration

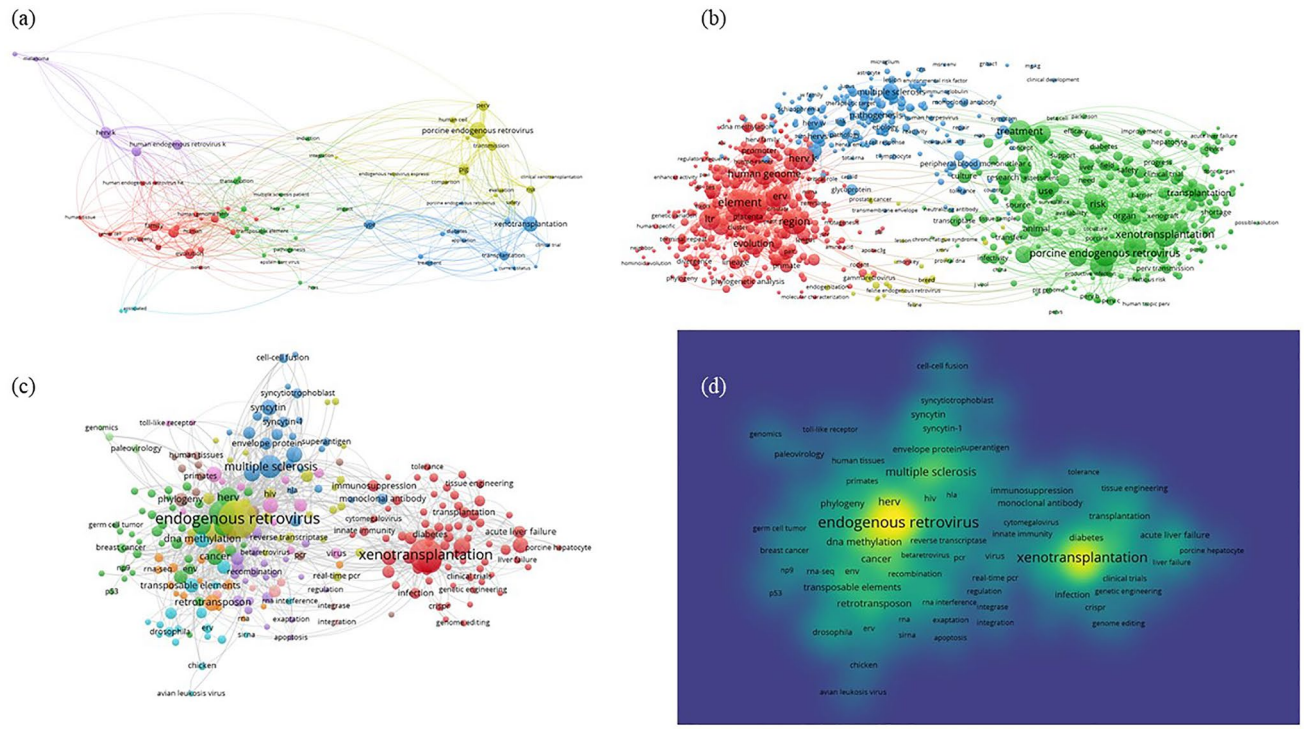

Fig. 1 Bibliometric analysis of research themes based on the terms used in titles. **a** The distribution of the themes. Six clusters of various colors are shown according to their categories and relevance. The cluster size depends on the sum of the terms used. Out of 6916 terms from the title field, 77 were 60% more relevant for analysis. **b** The network visualization map shows the research trend based on the titles and abstracts of the publications. The size of nodes indicates the rate of appearance of a specific term. The distance between nodes denoted their correlation. Out of 50,547 research trends, 815 most relevant ones were categorized into four clusters. **c** The bibliometric analysis of the co-occurrence of author-provided keywords in the publications. The size of the nodes represents the occurrence frequency, and the curves among the nodes indicate their co-occurrence in the same publication. The shorter distance between two nodes, the larger the co-occurrence of the two keywords. **d** The density visualization of co-occurrence of author-provided keywords in the publications

Table 2 Top ten most occurring author-provided keywords based on higher values of total link strength

	Keywords	Occurrences	Total link strength
1	Endogenous retrovirus	313	587
2	Xenotransplantation	222	458
3	Human endogenous retroviruses	125	277
4	Multiple sclerosis	96	258
5	Porcine endogenous retrovirus	100	192
6	HERV	65	175
7	HERV-K	60	165
8	Retrovirus	82	162
9	Pig	47	156
10	HERV-W	44	153

connections. Robert Koch Institute has published 85 documents with 2891 citations, followed by UCL (75 papers with 2459 citations). The leading partner of the organization is UCL and Harvard University, respectively. Most of the research mainly concentrates on the immunological aspects of ERVs (Fig. 4c).

3.5 Bibliometric analysis of bibliographic coupling and co-citation

When multiple authors quote one or more articles in common, they are said to be bibliographically connected. On the other hand, co-citation analysis primarily focuses on detecting pairs of highly cited works. Co-citation analysis is essentially a forward-looking approach, whereas bibliographic coupling is retrospective (Boyack and Klavans 2010). The bibliographic coupling diagrams of documents and journals, authors, countries, and organizations are shown in Fig. 5. Among 2924 documents, 1000 highly liked publications were categorized into three clusters. The core article was published in the "Microbiology and Molecular Biology Reviews" by Voisset et al. in 2008 (Fig. 5a). Among 816 journals, "Journal of virology" appeared as a core journal due to 182 ERV-based publications and 8559 citations with 147,285 total link strength (Fig. 5b). In Fig. 5c,

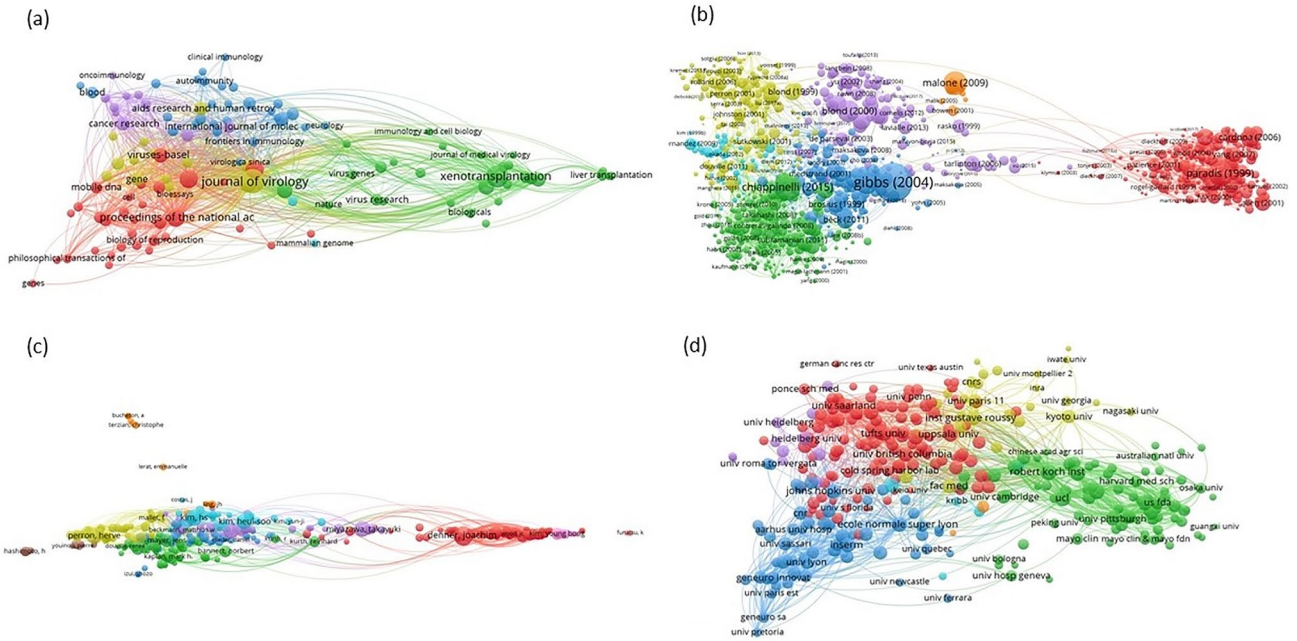

Fig. 2 The bibliographic analysis of the citations. **a** The most influential journals on ERV literature worldwide are categorized based on their citation. These 118 journals were distributed in 6 clusters. **b** The citation of the document. The bigger bubble size referred to the highest count of citations and publications **c** The bibliometric analysis of citations on the basis of authors. The bubble's size reveals the count of the author's citation. **d** The bibliometric analysis of citation of the organizations. The 310 organizations are shown in six clusters

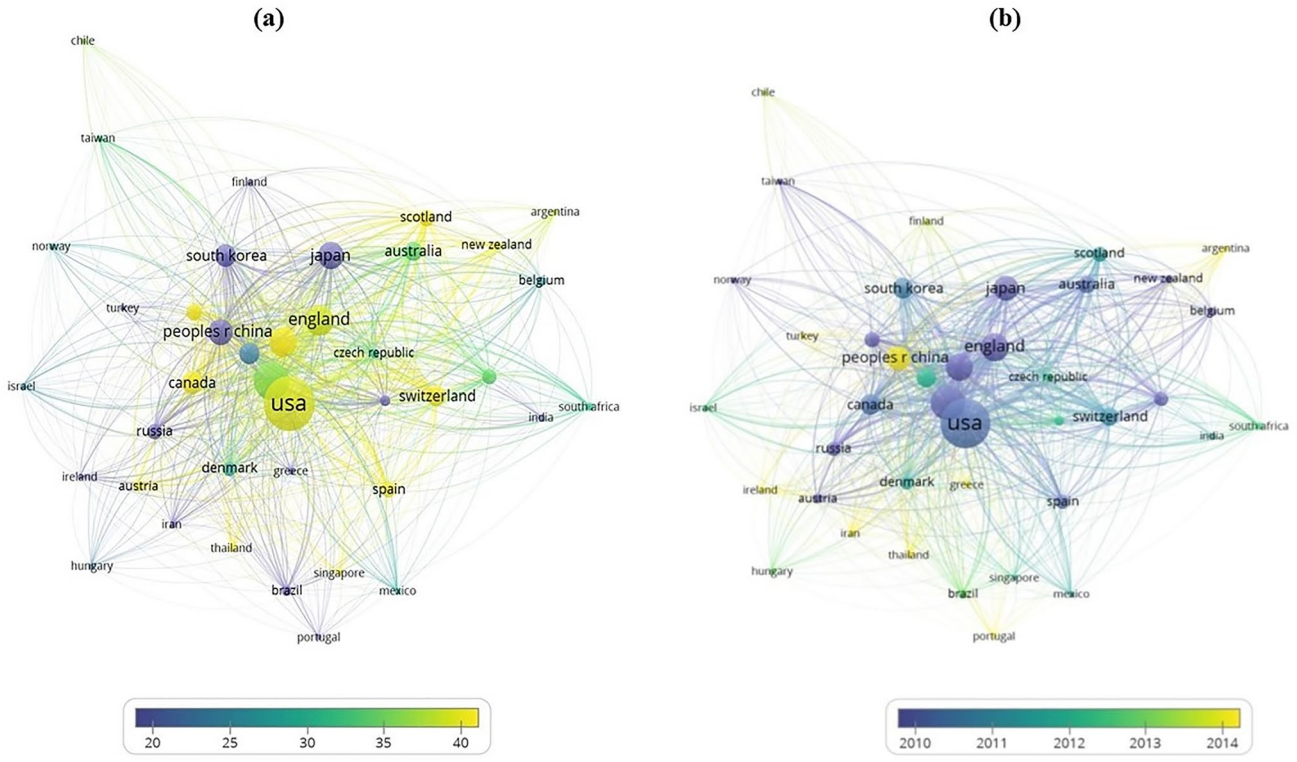

Fig. 3 The bibliometric overlay analysis of country citations. **a** A country overlay analysis based on the number of citations per year. **b** A country overlay analysis based on average annual publications. The color variation defines the research contribution over time. The United States contributed more in the 2010s, and China took a leading role in ERV research after 2014

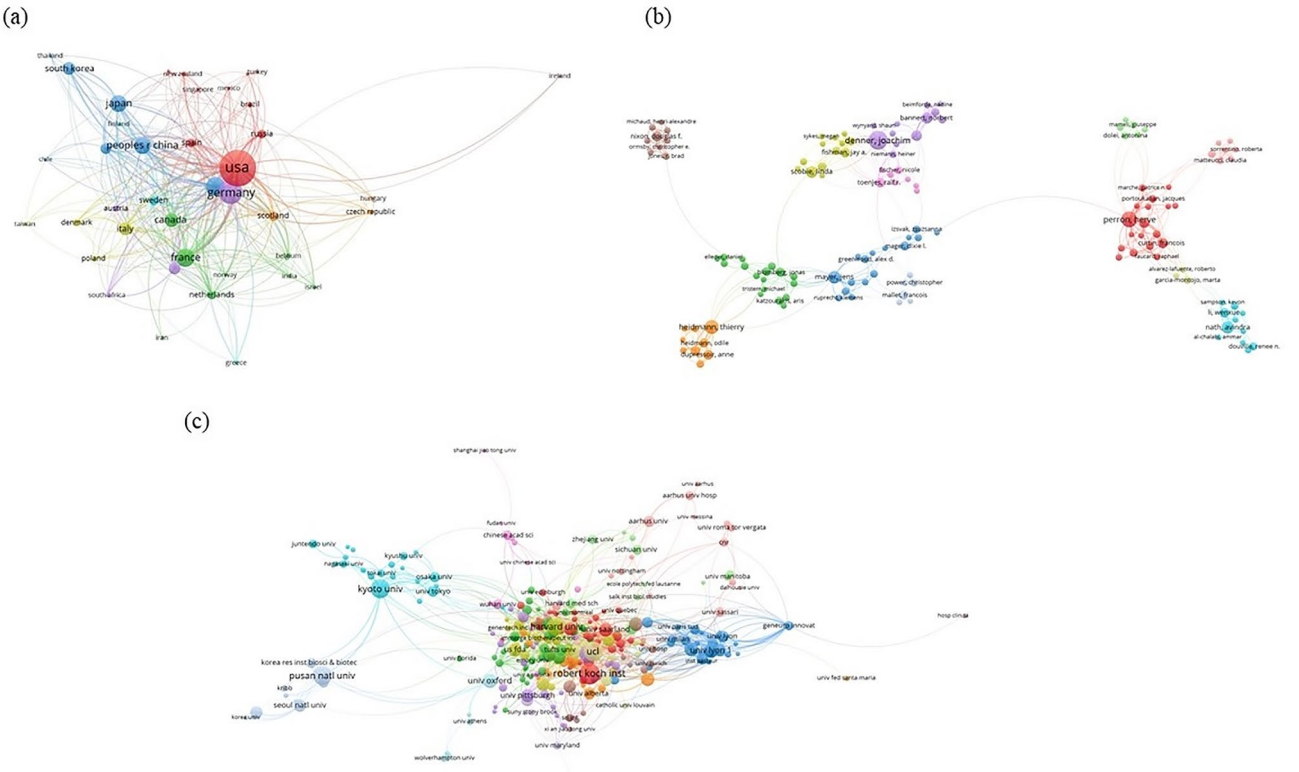

Fig. 4 Bibliometric analysis of the co-authorship, the thickness of links represents the intensity of collaboration between nodes, and the size of the nodes shows the centrality of items. **a** The co-authorship map of collaborating countries. Different colors specify various clusters, and the size of circles indicates the number of publications. The width of the lines denotes the link strength of the countries. **b** The co-authorship map of authors, which shows the authors that cooperate in the field of ERVs. **c** The network co-authorship map of the organizations. The bubble's size indicates the count of publications produced by organizations. The Robert Koch Institute has more publications and citations

Danner Joachim appeared as the core author (53 documents; 1408 citations; 99,716 total link strength). And the Robert Koch Institute appeared as a core organization with 85 publications, 2891 citations, and 178,707 total link strength (Fig. 5d); it showed a strong connection with UCL (7303 link strength). In a bibliographic coupling analysis of countries, the USA (documents 1017; citations 39,423; total link strength 1,053,611) appeared as a core country (Fig. 5e).

The bibliometric analysis of the total cited references yielded 783 out of 72,457 items in 5 clusters with total link strength of 394,074 (Fig. 6a). The node's size indicates the total number of co-citations, and the distance represents how these are related to each other. Authors 984/48542 meet thresholds. Co-citation of authors 984 items in 5 clusters links 164,957 and total link strength 966,741. The representative journal with a minimum of 20 co-citation criteria is "Journal of Virology" with 118,429 co-citations and 635,846 total link strength, followed by "Proceedings of National Academy of Sciences" with 6700 co-citations and 514,908 total link strength (Fig. 6c, d).

4 Discussion

The current bibliometric study sheds light on ERVs' research dimensions developed during the past few decades. This study also presents the main research topics and trends over time, which comprises the leading countries, organizations, and sources (journals) related to ERV. Current findings indicated English as the de facto language, followed by French. Past studies also revealed the same trend. Al-Jabi (2017) and Koo (2017) found that original articles constitute a significant research count compared to review articles and English as a de facto language of the publications. In all of the findings (co-authorship, citation, bibliographic coupling, and co-citation), the USA ranked higher worldwide in the bibliometric analysis due to the maximum number of publications and citations. Our outcomes are also in line with other researchers who reported the USA is the key player in the respective scientific contributions (Adams and Gurney 2018; Al-Jabi 2017; Farooq et al. 2021; Yi et al. 2016).

On the other hand, data from the last decade indicated China has been emerging as a future hotspot for ERV-based

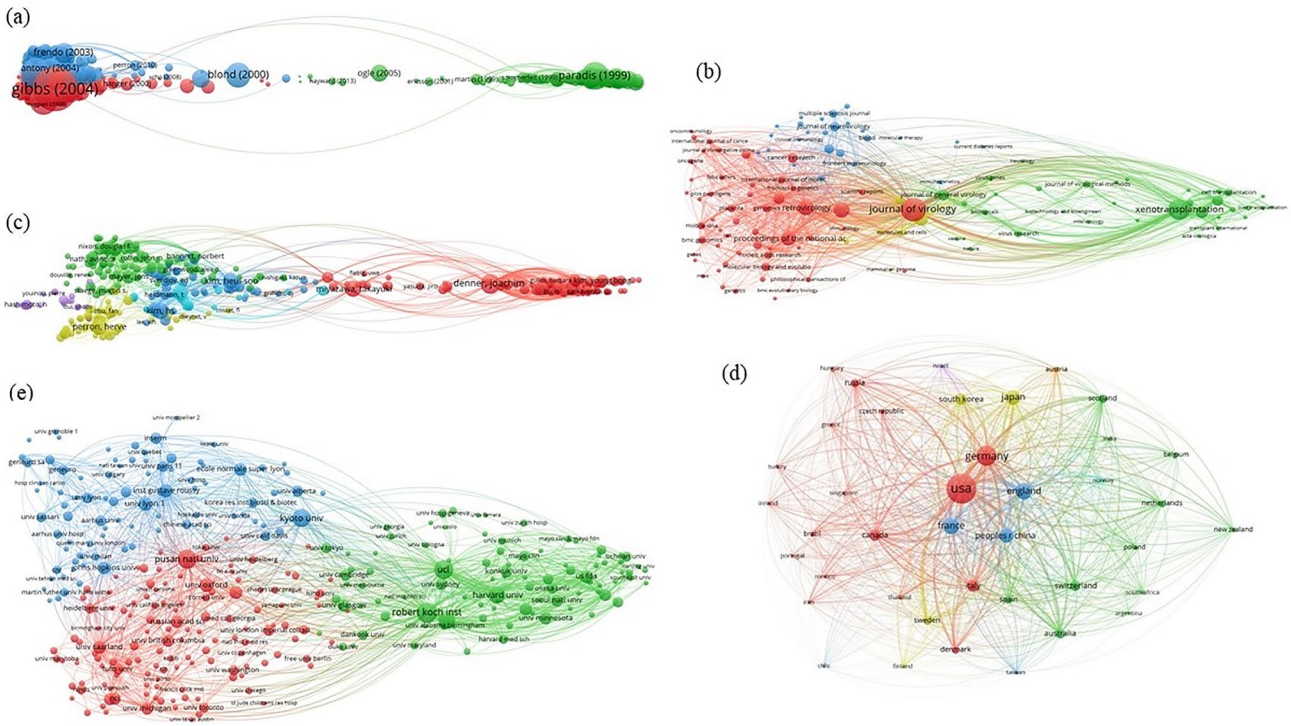

Fig. 5 Bibliometric analysis of the bibliographic coupling and the bibliographic co-citation in ERV research. **a** Bibliographic coupling analysis of documents; **b** bibliographic coupling of sources; **c** Network analysis of the authors; **d** the network of the bibliometric coupling analysis of the organizations; **e** network analysis of the bibliographic coupling analysis of the countries

research and contributing to other countries such as Ireland, Iran, Thailand, Greece, Argentina, Turkey, Portugal, etc. These findings are similar to other scientists who mentioned China as the leading country in their research domains (Chahrour et al. 2020). This scenario puts a significant responsibility on the Chinese researchers to contribute more and unveil more ERV research aspects.

The co-authorship, citation, bibliographic coupling, and co-citation analysis also revealed that the "Journal of Virology" count in terms of publications and citations was more than other journals contributing to ERV research. These findings are not in line with different bibliographic results (Al-Jabi 2017; Farooq et al. 2021; Maula et al. 2018; Ramos et al. 2013). But strongly comply with the study published in BMC Research mentioned (2016) about Ebola research (Yi et al. 2016).

The co-authorship analysis of social networks helped to distinguish between strong and weak collaboration patterns. Moreover, it also evaluated an author's contribution to their team. The current findings also showed that the co-authorship relationship in network analysis boosts the paper's citation count, which aligns with the previous study (Biscaro and Giupponi 2014). In the citation analysis, Harvard University appeared as the most-cited organization. In contrast, in bibliographic coupling, co-authorship, and co-citation analysis, Robert Koch Institute appeared as a noteworthy organization in the bibliographic co-authorship analysis, different from another study revealing the University of Texas's top ranking in the chikungunya virus research (Fonseca Bde et al. 2016).

5 Conclusions

The current study was the first novel bibliometric analysis of ERV research that used data extracted from the Web of Science (Core Collection) for co-authorship, citation, bibliographic coupling, co-citation analysis, and visualization network mapping. Moreover, this study shows themes, trends, prolific authors, core journals, leading and collaborating countries, and ERV research clusters. This study provided a systematic overview of productivity and visibility of research work in ERV research over time. The present findings may pave our understanding regarding ERV research dimensions. The findings revealed United States was the most significant contributor to studies on the ERV. The Journal of Virology was most productive in ERV research. The Robert Koch Institute and Harvard University were leading organizations for research in this field. The application of ERV research from China could be the research hotspot to

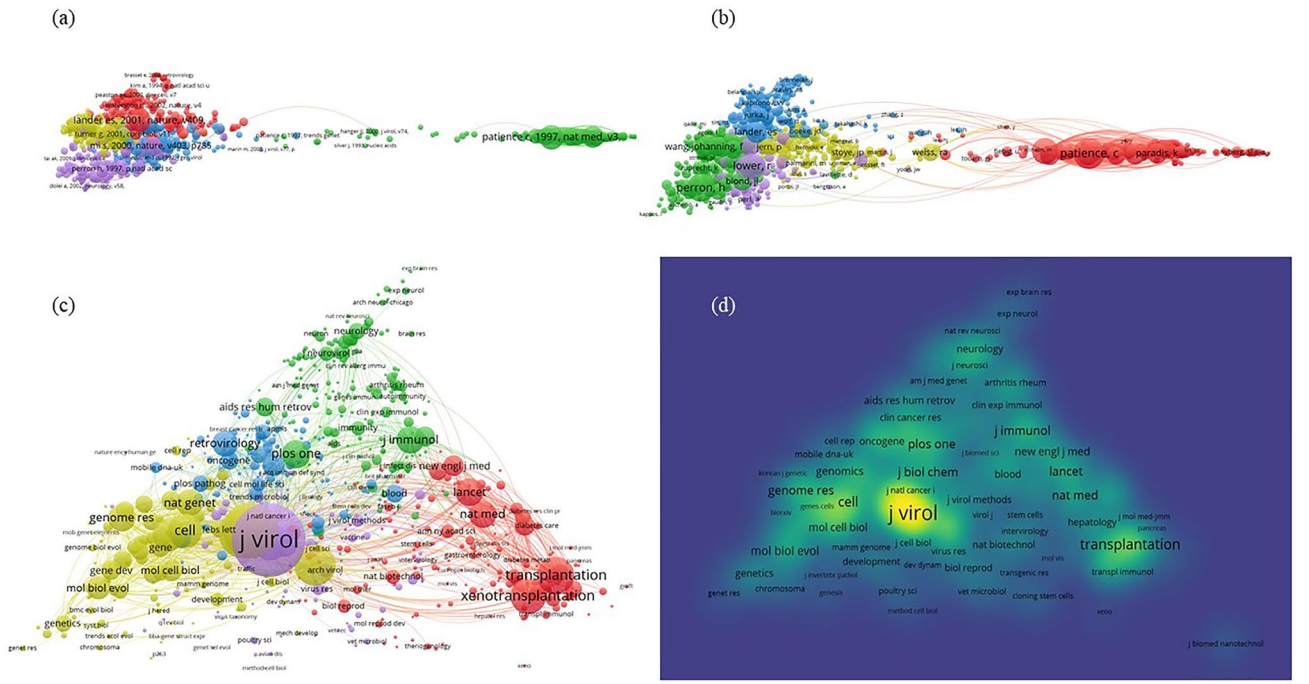

Fig. 6 Bibliometric analysis of the bibliographic co-citation in the ERV research. **a** The network visualization of co-citation of cited references in network visualization. The size of the nodes symbolizes the total counts of co-citations. **b** The network visualization of the co-cited authors. **c** The network map of the co-citation of journals. Different color indicates different clusters. The size of the spheres symbolizes the sums of co-citations and the distance between the two circles shows their correlation. **d** The density visualization map of the co-citation of journals

follow in the coming years. Our research had a limitation. The main focus was devoted to Web of Science search (core collection) from Jan 1985 to Sep 2021. However, we showed research trends and productivity in Endogenous Retroviruses publications in WOS (Core Collection). Future studies may include all other collections including Scopus to find out the comparison and elaborate on the further aspects of ERV research for a comprehensive bibliometric study of the prospects. Present findings have implications for future research trends and topics in Endogenous Retroviruses.

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Author contributions Conceptualization: HC, GZ; Data curation: GZ; Formal analysis: GZ; Investigation: GZ, HC; Methodology: GZ, XH; Project administration: HC, XH; Resources: HC; Software: GZ; Validation: HC, XH; Visualization: GZ; Writing—original draft: GZ; Writing—review and editing: HC.

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Data availability The dataset in the current study comes from the Web of Science (core collection) and is available on its web page. Thomson Reuters does not allow us to make the data freely available. Readers can contact Thomson Reuters to obtain the data (http://thomsonreuters.com/thomson-reuters-web-of-science/).

Declarations

Conflicts of interest The authors declare no conflict of interest.

References

Adams J, Gurney KA (2018) Bilateral and multilateral coauthorship and citation impact: patterns in UK and US International Collaboration. Front Res Metr 3:12. https://doi.org/10.3389/frma.2018.00012

Aiewsakun P, Katzourakis A (2017) Marine origin of retroviruses in the early Palaeozoic Era. Nat Commun 8:13954–13954. https://doi.org/10.1038/ncomms13954

Albuquerque PC, Castro MJ, Santos-Gandelman J, Oliveira AC, Peralta JM, Rodrigues ML (2017) Bibliometric Indicators of the Zika Outbreak. PLoS Negl Trop Dis 11:e0005132. https://doi.org/10.1371/journal.pntd.0005132

Al-Jabi SW (2017) Global research trends in West Nile virus from 1943 to 2016: a bibliometric analysis. Glob Health 13:55. https://doi.org/10.1186/s12992-017-0284-y

Biscaro C, Giupponi C (2014) Co-authorship and bibliographic coupling network effects on citations. PLoS ONE 9:e99502. https://doi.org/10.1371/journal.pone.0099502

Boyack KW, Klavans R (2010) Co-citation analysis, bibliographic coupling, and direct citation: which citation approach represents the research front most accurately? J Assoc Inf Sci Technol 61:2389–2404. https://doi.org/10.1002/asi.21419

Chahrour M, Assi S, Bejjani M, Nasrallah AA, Salhab H, Fares M, Khachfe HH (2020) A bibliometric analysis of COVID-19 research activity: a call for increased output. Cureus 12:e7357. https://doi.org/10.7759/cureus.7357

Cosby RL, Chang NC, Feschotte C (2019) Host-transposon interactions conflict, cooperation, and cooption. Genes Dev 33:1098–1116. https://doi.org/10.1101/gad.327312.119

Farooq RK, Rehman SU, Ashiq M, Siddique N, Ahmad S (2021) Bibliometric analysis of coronavirus disease (COVID-19) literature published in Web of Science 2019–2020. J Fam Commun Med. 28:1–7. https://doi.org/10.4103/jfcm.JFCM_332_20

Fonseca Bde P, Sampaio RB, Fonseca MV, Zicker F (2016) Co-authorship network analysis in health research: method and potential use. Health Res Policy Syst 14:34. https://doi.org/10.1186/s12961-016-0104-5

Geis FK, Goff SP (2020) Silencing and transcriptional regulation of endogenous retroviruses: an overview. Viruses 12:884. https://doi.org/10.3390/v12080884

Glanzel W, Czerwon HJ (1996) A new methodological approach to bibliographic coupling and its application to the national, regional and institutional level. Scientometrics 37:195–221. https://doi.org/10.1007/BF02093621

Groneberg DA, Weber E, Gerber A, Fischer A, Klingelhoefer D, Brueggmann D (2015) Density equalizing mapping of the global tuberculosis research architecture. Tuberculosis 95:515–522. https://doi.org/10.1016/j.tube.2015.05.003

Hayward A, Cornwallis CK, Jern P (2015) Pan-vertebrate comparative genomics unmasks retrovirus macroevolution. Proc Natl Acad Sci U S A 112:464–469. https://doi.org/10.1073/pnas.1414980112

Herniou E, Martin J, Miller K, Cook J, Wilkinson M, Tristem M (1998) Retroviral diversity and distribution in vertebrates. J Virol 72:5955–5966. https://doi.org/10.1128/JVI.72.7.5955-5966.1998

Hurst CJ (2022) Cataloging the presence of endogenous viruses. In: Hurst CJ (ed) The biological role of a virus. Advances in environmental microbiology, vol 9. Springer, Cham, pp 47–112

Kawuki J, Yu X, Musa TH (2020) Bibliometric analysis of Ebola research indexed in web of science and scopus (2010–2020). Biomed Res Int 2020:5476567. https://doi.org/10.1155/2020/5476567

Koo M (2017) A bibliometric analysis of two decades of aromatherapy research. BMC Res Notes 10:46. https://doi.org/10.1186/s13104-016-2371-1

Malfavon-Borja R, Feschotte C (2015) Fighting fire with fire: endogenous retrovirus envelopes as restriction factors. J Virol 89:4047–4050. https://doi.org/10.1128/jvi.03653-14

Maula AW, Fuad A, Utarini A (2018) Ten-years trend of dengue research in Indonesia and South-east Asian countries: a bibliometric analysis. Glob Health Action 11:1504398. https://doi.org/10.1080/16549716.2018.1504398

Naville M, Volff J-N (2016) Endogenous retroviruses in fish genomes: from relics of past infections to evolutionary innovations? Front Microbiol 7:1197. https://doi.org/10.3389/fmicb.2016.01197

Newman MEJ (2001) The structure of scientific collaboration networks. Proc Natl Acad Sci USA 98:404–409. https://doi.org/10.1073/pnas.98.2.404

Pinto M, Pulgarín A, Escalona MI (2014) Viewing information literacy concepts: comparison of two branches of knowledge. Scientometrics 98:2311–2329. https://doi.org/10.1007/s11192-013-1166-6

Ramos JM, Gonzalez-Alcaide G, Bolanos-Pizarro M (2013) Bibliometric analysis of leishmaniasis research in Medline (1945–2010). Parasites Vectors 6:55. https://doi.org/10.1186/1756-3305-6-55

Reyes-Gonzalez L, Gonzalez-Brambila CN, Veloso F (2016) Using co-authorship and citation analysis to identify research groups: a new way to assess performance. Scientometrics 108:1171–1191. https://doi.org/10.1007/s11192-016-2029-8

Robbez-Masson L, Rowe HM (2015) Retrotransposons shape species-specific embryonic stem cell gene expression. Retrovirology 12:45. https://doi.org/10.1186/s12977-015-0173-5

Schlesinger S, Goff SP (2015) Retroviral transcriptional regulation and embryonic stem cells war and peace. Mol Cell Biol 35:770–777. https://doi.org/10.1128/mcb.01293-14

Sweileh WM, Al-Jabi SW, Sawalha AF, AbuTaha AS, Zyoud SH (2016a) Bibliometric analysis of publications on Campylobacter: (2000–2015). J Health Popul Nutr 35:39. https://doi.org/10.1186/s41043-016-0076-7

Sweileh WM, Sawalha AF, Al-Jabi SW, Zyoud SH, Shraim NY, Abu-Taha AS (2016b) A bibliometric analysis of literature on malaria vector resistance: (1996–2015). Glob Health 12:76. https://doi.org/10.1186/s12992-016-0214-4

van Eck NJ, Waltman L (2010) Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics 84:523–538. https://doi.org/10.1007/s11192-009-0146-3

Waltman L, van Eck NJ (2012) A new methodology for constructing a publication-level classification system of science. J Assoc Inf Sci Technol 63:2378–2392. https://doi.org/10.1002/asi.22748

Waltman L, Van Eck NJ (2013) A smart local moving algorithm for large-scale modularity-based community detection. Eur Phys J B 86:1–14. https://doi.org/10.1140/epjb/e2013-40829-0

Ye M, Goudot C, Hoyler T, Lemoine B, Amigorena S, Zueva E (2020) Specific subfamilies of transposable elements contribute to different domains of T lymphocyte enhancers. Proc Natl Acad Sci U S A 117:7905–7916. https://doi.org/10.1073/pnas.1912008117

Yi F, Yang P, Sheng H (2016) Tracing the scientific outputs in the field of Ebola research based on publications in the Web of Science. BMC Res Notes 9:221. https://doi.org/10.1186/s13104-016-2026-2

Yu Y et al (2020) A bibliometric analysis using VOSviewer of publications on COVID-19. Ann Transl Med 8:816. https://doi.org/10.21037/atm-20-4235

Zyoud SH (2016) Dengue research: a bibliometric analysis of worldwide and Arab publications during 1872–2015. Virol J 13:78. https://doi.org/10.1186/s12985-016-0534-2