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Research hotspots and trend prospects in the field of outbreak and prevention of zoonoses from the perspective of One Health: A visual analysis based on CiteSpace

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ABSTRACT

Objective: To systematically sort out the research status of the field of zoonotic disease outbreak and prevention from the perspective of One Health, reveal its knowledge structure, hot spot evolution and cooperation network, and then provide a basis for the scientific research layout and prevention and control practice in this field.

Methods: Relevant literature on One Health and the prevention and control of zoonotic disease outbreaks was retrieved from the Web of Science database from September 24, 2004 to January 5, 2026. CiteSpace 6.4.R1 software was used for visual analysis.

Results: A total of 691 publications were retrieved. The annual number of publications has been growing steadily since 2012, with an overall marked acceleration after 2020. The national cooperation network analysis shows that USA ($n=203$) is the main knowledge-producing country, while England, Australia and other countries have high centrality in the network (all >0.1) and serve as key hubs. The keyword clustering analysis formed 14 clusters with significant structure ($Q=0.7622$), encompassing specific host research and forward-looking governance themes. The temporal evolution analysis shows that 2020 marked a turning point, with research hotspots shifting from classical epidemiology towards traceability, spillover mechanism and global monitoring driven by the COVID-19. The emerging frontier focuses on studies of seroprevalence.

Conclusions: This field has established a dual knowledge structure integrating basic science and governance strategies. Future research should deepen the understanding of human-animal interface mechanism, and leverage existing cooperation network to promote balanced development in zoonotic disease prevention.

KEYWORDS: One Health; Zoonosis; Outbreak; Prevention; Visual analysis

1. Introduction

Zoonosis, as infectious diseases that spread from non-human animal sources to humans, pose a persistent and severe challenge to global public health security[1]. According to the World Health Organization, approximately 60% of known human infectious diseases originate from animals, and 75% of new infectious diseases fall under the category of zoonotic diseases[2]. From highly pathogenic avian influenza and Middle East Respiratory Syndrome to Ebola virus disease and the recent COVID-19 pandemic that profoundly changed the global landscape, each outbreak not only causes significant loss of life and economic disruption but also exposes the vulnerability of humans in the face of complex ecosystem health threats[3].

Significance

This study provides the first systematic CiteSpace-based mapping of research on zoonotic disease outbreaks and prevention through a One Health lens. It identifies COVID-19 as a decisive shift from classical epidemiology toward spillover mechanisms, source tracing, and global surveillance, while highlighting seroprevalence as an emerging frontier. By revealing knowledge structures, collaboration hubs, and evolving priorities, these findings inform interdisciplinary research planning, early-warning strategies, and proactive governance of future zoonotic threats.

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Against this backdrop, the One Health concept, as a cross-disciplinary and cross-sectoral collaborative solution, was formally proposed in 2004[4]. This concept emphasizes the intrinsic connection and interdependence among human, animal, and environmental health, advocating for the integration of public health, veterinary departments, and environmental science to achieve source prevention and full-chain governance of health threats[5]. With the deepening of the One Health concept in the global consensus, related academic research has shown a comprehensive growth. However, while existing research is abundant, most studies focus on specific pathogens or single intervention measures. Traditional narrative reviews, while providing in-depth insights, often struggle to objectively and quantitatively reveal the macro-level knowledge structure, interdisciplinary evolution paths, and potential collaboration networks of the entire field when dealing with massive literature. Particularly from the One Health perspective, which emphasizes holistic and interdisciplinary connections, a systematic review of the field's knowledge graph is still lacking. Therefore, this study utilizes the CiteSpace bibliometric tool to conduct a visual analysis of the literature in this field from 2004 to 2026 for the first time. It aims to fill this gap in macro-quantitative analysis, reveal the intellectual turning points, core research groups, and cutting-edge trends hidden behind research papers through data mining, and provide a more objective reference for the scientific research layout in this field.

2. Methods

2.1. Search strategy

To ensure that the included literature precisely captures the core intersection of “outbreak” and “prevention” of zoonotic diseases under the One Health paradigm, this study employed a relatively strict Boolean search strategy. This approach requires that a single paper explicitly address all four conceptual dimensions—One Health, zoonotic diseases, outbreak events, and prevention/control—within its title, abstract, or keywords. While this strategy may potentially exclude papers that mention a concept only implicitly or focus on a single dimension (*e.g.*, prevention without a specific outbreak context), our priority was to guarantee the thematic focus and representativeness of the analysis sample. This allows us to more clearly delineate the core research trajectory that deeply integrates the One Health concept with the entire chain of outbreak and prevention. Therefore, we searched for relevant studies using the following terms: (“One Health”) AND (“zoonotic disease*” OR zoonosis OR “zoonotic infection*”) AND (“outbreak*” OR emergency* OR epidemic* OR pandemic* OR “spillover event*”) AND (“prevent*” OR control* OR manage* OR surveill* OR “risk assessment”). The type of literature is

limited to “article” or “review”, the language is limited to English, and the citation index is selected from the Web of Science (WOS) Core Collection for the period September 24, 2004 to January 5, 2026.

2.2. Analysis tool

Set up the CiteSpace folder with four subfolders: input, output, data, and project. The complete records and references of 691 articles retrieved from WOS were exported in plain text format, named “download_XX.txt,” and then imported into the input folder for analysis in CiteSpace 6.4 R1 software. After eliminating the duplicate literature, 691 articles were left. Time slicing was performed from September 24, 2004 to January 5, 2026, years per slice was set to one, selection criteria top N was set to 50, pruning selected pathfinder, pruning sliced networks simplified atlas, node types selected author, institution, country, keywords, and reference. The output results mainly include the annual publication analysis, countries and institutions cooperation analysis, co-authors analysis, co-occurring keywords and cluster analysis, keywords with citation bursts, and co-cited reference analysis. Relevant contents are visualized as knowledge maps, and key nodes and links in different maps are interpreted and analyzed[6]. The node represents the analyzed research object. The higher the frequency of occurrence, the larger the range of nodes. The color and thickness of the node inner circle represent the frequency of occurrence in different periods. If the node has a purple outer circle, it represents a high betweenness centrality. Centrality reflects the role of the nodes in the knowledge network, nodes with high centrality (>0.1) were usually considered turning points or pivotal points in a field[7,8]. The links between the nodes represent the co-occurrence relationship, and the thickness of the links represents the strength of the co-occurrence. The more the links, the thicker, and the closer relationship between the nodes. CiteSpace provides module value (Q value) and average silhouette value (silhouette, S value) based on the network structure and clustering results. It is generally believed that a Q value > 0.3 (empirical value) means that the cluster structure is significant, an S value at 0.7 clustering has certain significance and credibility, and above 0.5 that clustering is generally reasonable. The larger the cluster structure, the smaller the cluster ID[9].

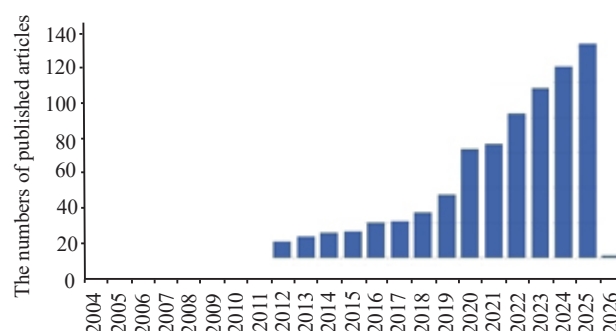


Figure 1. Annual trend chart of publications. Note: Data for 2026 includes only publications indexed as of January 5, 2026.

3. Results

3.1. Annual publications analysis

In this study, 691 included documents (publications up to January 5, 2026 were included) were statistically analyzed according to the published time, and the annual publication trends are shown in Figure 1. Since the “One Health” concept was first proposed in 2004, there was no rapid publication of research results in the form of papers in this field. It was not until 2012 that papers began to be published successively. Since 2012, the annual publication volume has shown a steady increase, reaching 36 articles by 2019. Since 2020, due to the global pandemic, it has entered a period of rapid growth, and by 2025, the publication volume has risen to 122 articles, reflecting the continuous increase in the attention paid to the One Health concept in this research topic.

3.2. Countries and institutions analysis

Generate co-occurrence network analysis of countries and institutions (Figure 2A). Node $N=367$, link $E=833$, module value $Q=0.7867$, S value=0.9319. Each node represents a country or institution. The United States has an absolute dominance in the number of publications ($n=203$), but its centrality is relatively low (Centrality=0.02), indicating that although it is the main knowledge-producing country, its cooperation network is more inclined towards internal closure. Its role as a “bridge” connecting different research groups is not the strongest. It is notable that some high-productivity countries also exhibit high centrality, such as India (Centrality=0.10), China (Centrality=0.11), Germany (Centrality=0.19), and Canada (Centrality=0.13). This suggests that these countries are not only important knowledge producers but also actively play key hub roles in international cooperation networks. While the United Kingdom (Centrality=0.35), Australia (Centrality=0.15), Italy (Centrality=0.17), and Brazil (Centrality=0.17) have lower publication volumes, they play an irreplaceable role in promoting cross-regional knowledge flow and integration due to their extremely high centrality. This diverse

cooperation pattern may be related to their long-term participation in global health projects, active international cooperation institutions, or being located in areas with zoonotic disease hotspots (Figure 2B).

3.3. Keywords analysis

3.3.1. Co-occurring keywords analysis

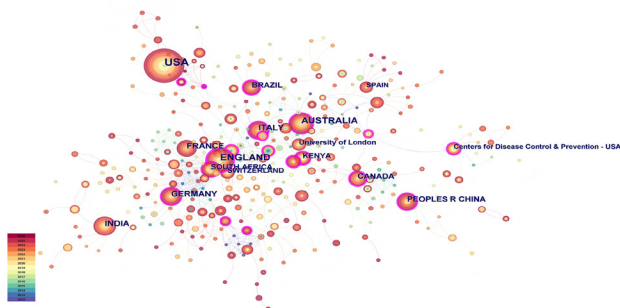
Keywords are expressions that condense and refine the core content of an article[10], and they showcase the research hotspots of the research topic in that field. By analyzing the centrality of the key words, one can understand their importance within the co-occurrence network as a whole[11]. The top 10 key words with the highest centrality are detailed in Figure 3B. Co-occurring keywords are the analysis of frequently used key words in the literature, which help to reveal the mutations and transformations between research hotspots[12]. In the software, a pathfinding network algorithm was selected to analyze the key words of the WOS database literature, resulting in a key word map (Figure 3A). Node $N=440$, link $E=898$. According to the frequency of occurrence, the top 10 key words are one health, outbreak, transmission, virus, public health, infection, epidemiology, risk factors, risk, and emergence.

3.3.2. Keywords cluster analysis

We used the LLR algorithm in CiteSpace software to obtain the keyword clustering graph (Figure 4A). The module value $Q=0.7622$, S value=0.8797, and the representative clustering labels in the graph are #0 domestic species, #1dromedary camel, #2 thematic analysis, #3 epidemiologic conundrum, #4 q fever control, #5 old world fruit bat, #6 next pandemic zoonosis, #7 interdisciplinary field, #8 epidemiological situation, #9 zoonoses report, #10 hendra virus, #11 emerging zoonotic diseases, #12 using North American Animal Disease Spread Model (Figure 4B).

Keywords cluster analysis co-occurrence map can analyze the first appearance time of keywords and the changing trend over time[13]. It can be known from the survey (Figure 5) that the research topic of zoonoses outbreak and prevention and control from the perspective of One Health has been in a continuous

A



B

Rank	Country/ region	<i>n</i>	Centrality	Institution	<i>n</i>	Centrality
1	USA	203	0.02	University of London	32	0.05
2	England	94	0.35	CDC	27	0.12
3	Australia	76	0.15	University of Montpellier	20	0.04
4	India	57	0.10	University of California System	20	0.04
5	France	56	0.05	World Health Organization	20	0.00
6	Germany	50	0.19	Food and Agriculture Organization	15	0.11
7	Italy	50	0.17	International Livestock Research Institute	15	0.02
8	Canada	43	0.13	Egyptian Knowledge Bank	14	0.03
9	Brazil	41	0.17	Institut National de la Sante et de la Recherche Medicale	11	0.05
10	China	41	0.11	Indian Council of Agricultural Research	11	0.01

Figure 2. Co-occurrence network analysis of countries and institutions in global zoonotic disease research. (A): The network map of countries and institutions. Note: The size of a node represents the number of publications (*i.e.*, the frequency of occurrence) of a country or institution; the color of a link indicates the year of first co-occurrence, with blue representing earlier years and red representing later years. (B): Top 10 countries and top 10 institutes publishing research on the outbreak and prevention of zoonotic diseases from the perspective of One Health.

evolution process. Through comprehensive analysis, the evolution process can be divided into two stages. The period from 2012 to 2020 was the growth stage. During this period, disease, biodiversity, outbreak and public health emerged as dominant nodes. And it frequently co-occurs with epidemiology, risk factors and avian influenza. The period from 2020 to 2026 was the outbreak period, with a sharp increase in node density and centrality. The COVID-19 pandemic significantly affected the shift of research hotspots. The emergence of nodes such as COVID-19, disease emergence, COVID-19 evolution, and A (H3N2)virus has driven the field to develop rapidly towards acute infectious diseases.

3.3.3. Keywords with citation bursts

Burst words refer to keywords that frequently appear in a short period of time. By analyzing them, one can identify the hotspots and cutting-edge trends in the research field[14]. Burst intensity is a quantitative expression of keywords, indicating that they are widely cited within a short period[15]. Through the detection of emergent words, we obtained 12 emergent keywords (Figure 6). Among them, “seroprevalence” is the emerging word that has persisted until now, with an emergence intensity of 3.25. It indicates that the research paradigm is shifting from passive monitoring based on case reports to active assessment of the population’s exposure level through serology. This reflects the urgent needs of researchers in the post-pandemic era to capture asymptomatic infections, reveal the true infection burden, and assess the immune barriers of the population.

4. Discussion

The One Health concept emphasizes the intrinsic connection and collaborative governance among human, animal and environmental health, serving as a pivotal framework for addressing complex zoonotic threats[16]. With global climate change, ecological

environment alteration and the evolution of human-animal contact patterns, the outbreak frequency and impact of new and re-emerging zoonoses are increasing day by day, making it particularly urgent to integrate multidisciplinary resources from the perspective of One Health for forward-looking prevention and control. Although research in this field is increasing day by day, there is still a lack of systematic sorting out of the evolution context, core focus and future trends of its knowledge structure[17,18]. Therefore, unlike previous studies that focused on specific diseases or technical details of prevention and control, this research, through quantitative methods, depicted the “knowledge map” of this field from a macroscopic perspective. This not only verified the known research hotspots, but more importantly, identified the key hub countries/themes that connect different research sections, and quantified the role of the COVID-19 pandemic as a watershed for the transformation of the research paradigm. This is something that traditional reviews cannot achieve.

The results of this study show that the annual number of published papers related to this topic has steadily increased since 2012 and has experienced an explosive growth after 2020, reaching 122 papers by 2025. This trend is closely related to the rising global attention to emerging infectious diseases, especially the driving effect of the COVID-19 pandemic. This is consistent with the observations of many scholars that major public health crises can significantly accelerate the scientific research output and knowledge iteration in related fields[19]. In the national cooperation network, the United States has an absolute dominant position in terms of the number of published papers, but its centrality is relatively low, suggesting that although it is a major knowledge-producing country, its role as a “bridge” connecting different research groups may not be the strongest. In the national cooperation network, the United States holds an absolute dominant position in terms of the number of published papers, but its relatively low centrality suggests that although it is a major knowledge-producing country, its role as a bridge connecting different research groups may not be the

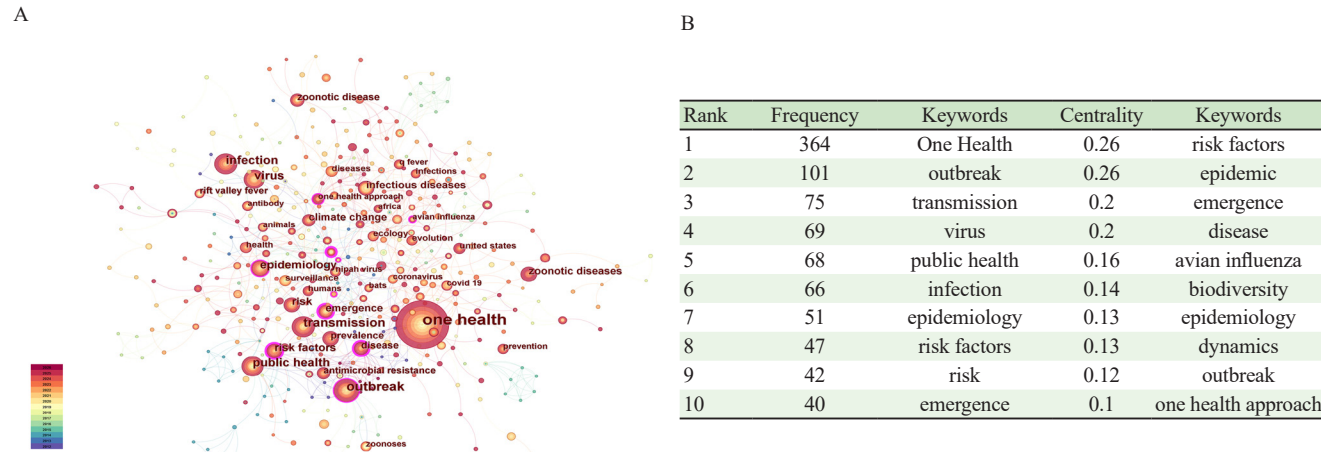
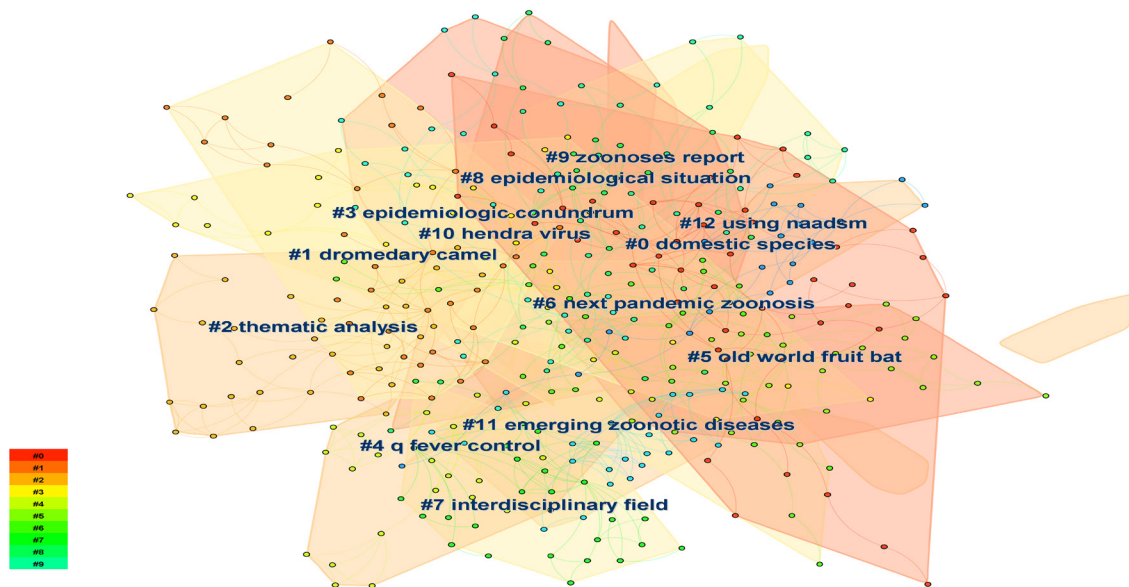


Figure 3. Co-occurrence network analysis of keywords in global zoonotic disease research. (A): The network map of co-occurring keywords. Note: Note: The size of a node represents the number of publications (*i.e.*, the frequency of occurrence) of a country or institution; the color of a link indicates the year of first co-occurrence, with blue representing earlier years and red representing later years. (B): Top 10 keywords in frequency and top 10 keywords in centrality on the outbreak and prevention of zoonotic diseases from the perspective of One Health.

A



B

Cluster-ID	Size	Silhouette	Label
0	47	0.795	Domestic species; Prominent role; Distinct spread; RNA viruses; Potential reservoir
1	34	0.816	Dromedary camel; Viral haemorrhagic fever; Epidemic potential; Other zoonotic pathogen; Middle East respiratory syndrome coronavirus
2	31	0.807	Thematic analysis; Civil society perspective; Future situation; Afro-Palaeoctic; Environmental law
3	28	0.893	Epidemiologic conundrum; Good governance; Contemporary emerging zoonosis; Predicting future Rift Valley fever virus; Exotic zoonotic disease preparedness
4	27	0.936	Q fever control; Comprehensive literature review; One Health concept; Last decade; Case-control study
5	27	0.832	Old World fruit bat; Large scale ecosystem service; Strategic scenario analysis; Valencia Spain; Disaster evolution
6	26	0.935	Next pandemic zoonosis; Vietnam initiative; Studying emerging zoonotic infectious diseases; Strategic approach; Bioethical perspective
7	26	0.856	Interdisciplinary field; Public health campaign; Hand hygiene; Western Kenya; Working condition
8	26	0.878	Epidemiological situation; Brief review; Ebola virus disease; Urban brown rat; Surface water
9	25	0.94	Zoonoses report; European Union; Western ghats India; Kyasanur Forest disease outbreak; Low mammalian species richness
10	25	0.891	Hendra virus; Reverse zoonotic event; Roosting behaviour; Virus epidemiology; Pteropus Giganteus
11	23	0.953	Emerging zoonotic diseases; Avian influenza; Zoonoses report; European Union; Epidemiological situation
12	20	0.898	Using North American Animal Disease Spread Model; Swine population; Influenza spread; Cross-species transmission mechanism; Influenza viruses

Figure 4. Keywords cluster analysis co-occurrence map. (A): Keyword clustering co-occurrence network. Note: Node color represents cluster ID (#0–#12). Polygons are colored by cluster to group keywords; polygon size indicates the relative keyword count or semantic breadth of the cluster, while shape has no substantive meaning. The color bar at the lower left maps cluster IDs 0–9 to their colors. Node size reflects keyword frequency. (B): Information of keyword clusters.

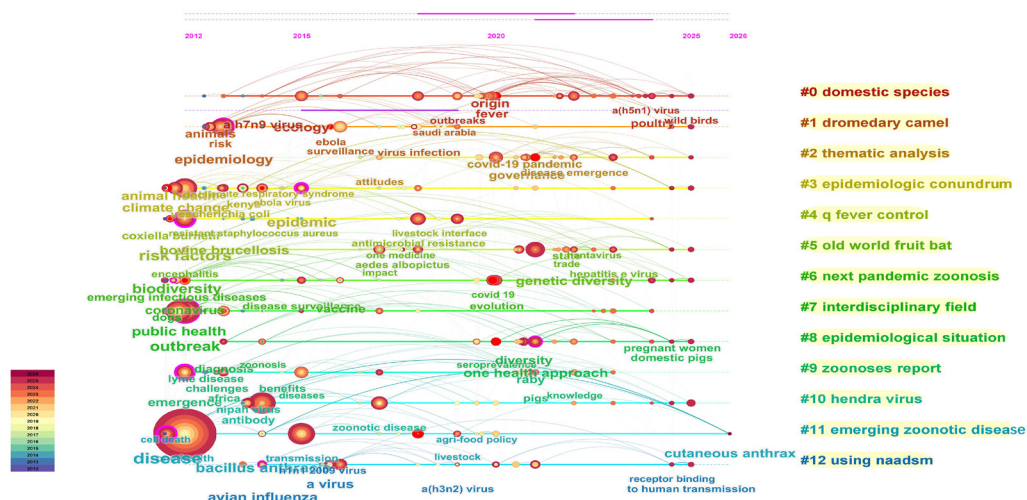


Figure 5. Cluster timeline of keywords map. Note: Horizontal axis: year (2012–2026); vertical axis: cluster ID (#0–#12). Node size = frequency; node color indicates the first/active year per the color bar (lower left: red = 2026, purple = 2012). Lines represent co-occurrence or temporal continuity. Cluster labels on the right. The timeline reveals a clear shift in research hotspots, especially after 2020.

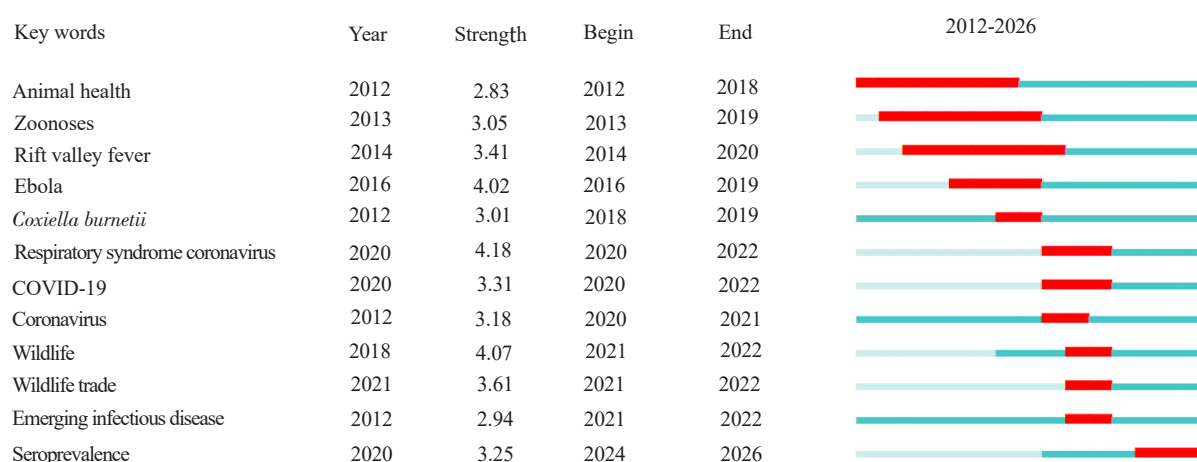


Figure 6. Top 12 keywords with the strongest citation bursts. Note: Right panel timeline (2004-2026): Light blue = background timeline; dark blue = years when the keyword appears in the literature; red = burst period. Left panel shows burst strength and duration.

strongest[20]. Notably, our analysis identifies two distinct types of key players in the global collaboration landscape. On one hand, several top-producing countries also exhibit high centrality, such as Germany, Canada, China, and India, indicating that they function as both major knowledge producers and crucial collaborative hubs. On the other hand, countries like the United Kingdom, Australia, Italy, and Brazil, despite having slightly fewer publications than the USA, demonstrate exceptionally high centrality. This underscores their indispensable role in promoting cross-regional knowledge flow and integration within the network[20,21].

Keyword co-occurrence, clustering, and time evolution analysis jointly reveal the multi-level knowledge structure and development dynamics of this field. Firstly, at the keyword co-occurrence level, the frequent words “one health”, “outbreak”, “transmission”, “virus”, and “public health” constitute the core narrative framework of the field; among them, “risk factors” and “emergence” have high centrality, indicating that risk assessment and new emergence mechanisms are the key intersection points connecting different research directions. Secondly, cluster analysis and timeline graphs further outline the composition and evolution of core themes: the modularity value ($Q=0.7622$) and average silhouette value ($S=0.8797$) of the clustering network indicate excellent clustering effect, and the 12 keywords clusters formed include both key storage host research represented by “domestic species” and “single-humped camel”, as well as forward-looking warning and governance strategies represented by “epidemiologic conundrum” and “next pandemic zoonosis”; the timeline graph shows that the themes from 2012 to 2020 mainly revolved around classical epidemiology and ecological factors, and after 2020, the node density and correlation significantly increased, indicating that the COVID-19 pandemic became a key turning point in reshaping the research agenda. Finally, keyword emergence detection precisely identifies the shift in research frontiers: the keyword with the highest emergence intensity “covid-19” rapidly became the core of the field’s research in 2020, driving research to focus on traceability, spill-over mechanisms, and global monitoring; while the latest emerging keyword “seroprevalence” suggests that serological assessment has become

an important frontier for understanding infection distribution and intervention effects. These three layers of analysis are progressive and together confirm the development trend of this field from basic description to risk prediction and governance practice. Additionally, it is also worth noting that the latest frontier captured by the emergent word analysis is “seroprevalence”. This hot topic transformation has profound scientific implications, specifically manifested in the following three aspects: First, it marks the expansion of the dimension of disease burden recognition. Traditional case reports can only capture patients with clinical symptoms, while serological surveys can reveal the existence of a large number of asymptomatic or mild infections, thereby depicting a more complete “infection iceberg” panorama. This is crucial for accurately assessing the actual transmission range and fatality rate of zoonotic diseases. Second, it reflects the technological upgrade of monitoring and early warning tools. As the future direction emphasized in this study, “strengthening monitoring and early warning tools”, serological monitoring is its core component. Through cross-sectional or longitudinal serological surveys in animal hosts such as poultry, wild bats, and camels, the latent circulation and spill-over risks of pathogens in animal populations can be identified before human cases occur, truly implementing the concept of “One Health” for source prevention at the animal end. Third, it serves the parameter optimization of risk assessment models. “Seroprevalence” data can provide key parameters such as the proportion of susceptible individuals and the persistence of immunity, thereby more accurately predicting the possibility and scale of epidemic outbreaks. Therefore, the emergence of this word is not just an isolated hotspot, but a key hub that connects “deepening research on the mechanism of the human-animal interface” and “strengthening monitoring and early warning tools” as the two future directions.

Our study used a visualization analysis system to depict the knowledge map of the field of human-animal zoonotic disease outbreaks and prevention from the perspective of One Health. The study believes that the research activity in this field is significantly driven by major epidemic events and is currently in a stage of rapid development; this field has formed a multi-disciplinary research theme structure centered on specific host-pathogen

ecology, epidemiology and risk assessment, as well as forward-looking governance and preparedness; the United States is the main knowledge producer, while countries such as England, Australia, and China play key hub roles in the international cooperation network; COVID-19 has become a watershed for the current situation and research development of human-animal zoonotic disease outbreaks and prevention, strongly guiding the research front towards pandemic prevention, spill-over mechanisms, and monitoring and evaluation based on new technologies such as serology.

5. Limitations

While this study uses bibliometric methods to map the research landscape of zoonotic outbreak prevention and control from a One Health perspective, several limitations should be noted. First, our reliance on the Web of Science Core Collection and English-language publications may introduce database and language bias, potentially excluding relevant studies from other sources or non-English contexts. Second, the strict Boolean search strategy, while ensuring thematic focus, may have omitted peripheral but valuable literature; thus, our findings primarily reflect core research trends and should be interpreted cautiously regarding interdisciplinary areas. Third, bibliometric outcomes such as cluster formation and burst detection are sensitive to algorithm parameters (*e.g.*, the pathfinder pruning algorithm and top N=50 selection). Although we optimized settings within empirically validated ranges, different parameter choices could yield slightly varied results—an inherent methodological limitation.

6. Conclusions

The recommended future research directions are as follows: First, deepen the research on the mechanisms of specific human-animal interfaces. We should continue to focus on the viral ecology of key hosts such as the dromedary camel and fruit bat, and integrate social science methods such as “thematic analysis” to quantitatively study the “risk factors” and “transmission” mechanisms of spill-over events. In particular, it is necessary to combine the latest serological monitoring data to clarify the dynamic transmission patterns of the virus in natural hosts and spillover hosts. Second, strengthen the research and validation of serology-based monitoring and early warning tools. Promote the practical application of model tools such as the North American Animal Disease Spread Model in disease monitoring, and verify them using monitoring data such as seroprevalence. Third, promote the transformation of governance strategies from passive response to prevention.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Data availability statement

The data supporting the findings of this study are available from the corresponding author upon request.

Authors' contributions

Li YT is responsible for the research design of the article, data visualization, and article writing, and is in charge of the overall article. Jiang F, Zhao DT, Wang YN, and Liu YZ are responsible for data cleaning and preprocessing. Sun Y, Liu J and Wang R are responsible for the re-verification of the data results and the preliminary organization of the research findings. Jiang ZY is responsible for searching and organizing the data cases. Liang WJ is responsible for the revision of the first draft of the article and the verification of the data. Lu JH is responsible for providing directional guidance for the overall research and offering financial support.

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