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A Global Scientometric Analysis of Human Infections of the Blood Parasite *Babesia* spp.

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Abstract

The objective of this study was to provide insights into the research focus and trends related to *Babesia* spp. in order to better understand the direction of future scientific and clinical research. Articles related to *Babesia* spp. were systematically retrieved from the Web of Science database. Using VOSviewer software, countries, institutions, authors, references, and keywords associated with research on *Babesia* spp. were visually analyzed. A total of 1805 publications were included in this bibliometric analysis. These publications were distributed across 124 countries, with the majority of them published between 1970 and 2022, notably in the United States. The year with the highest number of publications was 2021. The increasing number of publications related to human babesiosis over time indicates the growing global significance of *Babesia* spp. To establish effective control strategies for human babesiosis, research collaboration should be fostered between researchers in developed countries and those in developing nations.

Keywords: Babesiosis, bibliometric, parasite, VOSviewer

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1. Introduction

Babesiosis is a zoonotic disease with a widespread distribution that is primarily spread by ticksfrom various species of the genus, such as *Rhipicephalus species, Dermacentor species,* and *Ixodes species* (1). Zoonotic *Babesia* species have been reported on almost every country since the first case ofhuman babesiosis was documented in 1957 in a farmer who had undergone splenectomy in Croatia (2). *Babesia microti* is the most commonly reported cause of infection in North America, with most cases occurring in the Northeast and upper Midwest of the United States (3). The identified species that account for the bulk of human cases, including *B. microti, B. divergens, B. duncani, and B. venatorum*,are frequently mentioned in babesiosis-related literature (4).

It is crucial for doctors to be aware of the several ways that people might become infected withBabesia and to obtain a complete patient history on recent travel, tick exposure, and potential parasite exposure through transfusion or transplants. For instance, just 7.2% of Canadian family doctors polled in 2002 knew that blood transfusions can spread babesiosis (5).

Babesia microti infections can range in severity. When it affects adults, 25% of cases are asymptomatic, and when it affects kids, 50% of cases are mild cases with flu-like symptoms. Atypical fevers, chills, headaches, general lethargy, discomfort, and malaise are symptoms in other situations (6).

This scientometric analysis study aims to give a bibliometric evaluation of the articles on human babesiosis.

2. Materials and Methods

2.1. Design of the study

This study was survey-based, characteristic-based, and past-focused designed study and utilized science-metric technique and scientific charting. Since there are no human or animal subjects involved, institutional review board permission is not required.

2.2. Data collection

On October 13, 2023, a extensive search was conducted in the WoSCC of the ISI Web of Science (Thomson Reuters, Philadelphia, PA, USA) online repository. This repository contains research papers from high-impact, highest scientific journals from throughout the world.

Terms and retrieval techniques used were as follows: The MESH search terms (Babesia OR Babesiosis and Human OR Patients) were used. The Topic field and only Science Citation Index Expanded (SCI-EXPANDED) listing was used for the search queries.

The following inclusion and exclusion criteria were applied:

(1) The studies published after the end of 2022 were excluded;

(2) SCI-EXPANDED listing was used for the search queries.

(3) Only the research papers were chosen according to the document type.

2.3. Data analysis

The journals, the authors and institutional connections (institution or organization and country), the years that the research papers were published, the citation numbers, the scientific categories, the search terms and automatically generated from the titles of the research papers were all obtained using WoSCC.

The characteristic-based analysis of the publication years, citation counts, scientific categories, first authors, institutional connections, nations, and journals was carried out using Microsoft Excel.

2.4. Analytical statistics

The tables and graphs were created using Microsoft Word and Microsoft Excel, respectively. Visual data representation was carried out using the VOSviewer 1.6.18 software (Leiden University, Leiden, The Netherlands) was used citation tree rings and lines to create the maps.

2.5. Ethics clearance

The study complied with the Declaration of Helsinki, which was revised in 2013. Ethics committee approval is not required as there is no human or animal research.

2. Results and Discussion

Bibliometric analysis offers valuable epidemiological insights into the historical progression of diseases in the field of medicine worldwide (7). In this analysis, we delved into the global research trends and findings related to babesiosis, a zoonotic parasitic disease. In the available literature there isonly a similar study on babesiosis (8) but this study did not have any mappings or international collaborations analysis. Our bibliometric study unveiled a consistent rise in publications concerning babesiosis from 1980 to 2022. Notably, a significant and sustained increase in publications was observed, particularly between 2010 and 2022, indicating a consistent growth pattern. This finding supports the prediction that Babesia research will be highly dynamic in the coming years, with new species increasingly identified and described in a variety of hosts (9).

This bibliometric analysis showed that the top three of the most productive countries in the process were The United States of America, People Republic of China, France. *B. microti*, thepredominant species responsible for human infections, is distributed worldwide and is responsible for endemic cases in both the United States and China. In China, endemic disease is also caused by *B. venatorum* and a *Babesia* crassa-like agent (10). Babesiosis became a nationally notifiable disease in theUnited States in 2011, and an increase in cases has been observed since then (11). In the United States,more than 2,000 cases are officially reported each year, although it is believed that the actual number isconsiderably higher (10). Over the past ten years, there has been an emergence of novel tick-borne infections, and the incidence rate has shown a consistent increase in various Chinese regions. Recent research has pointed to the concurrent occurrence of *B. microti* infections and malaria in the border areasbetween China and Myanmar, specifically in the southern Yunnan province of the People's Republic ofChina (12). *B. divergens*, which naturally infects cattle, is the primary causative agent of human babesiosis in Europe, with the majority of reported cases concentrated in the British Isles and France (13).

A total of 1805 articles were included the study. The first articles were published in 1980, the most of

the documents published in 2021 (n= 144) (Figure 1). The articles were cited 53649 times in total, 29.72 times per article and H index was 97.

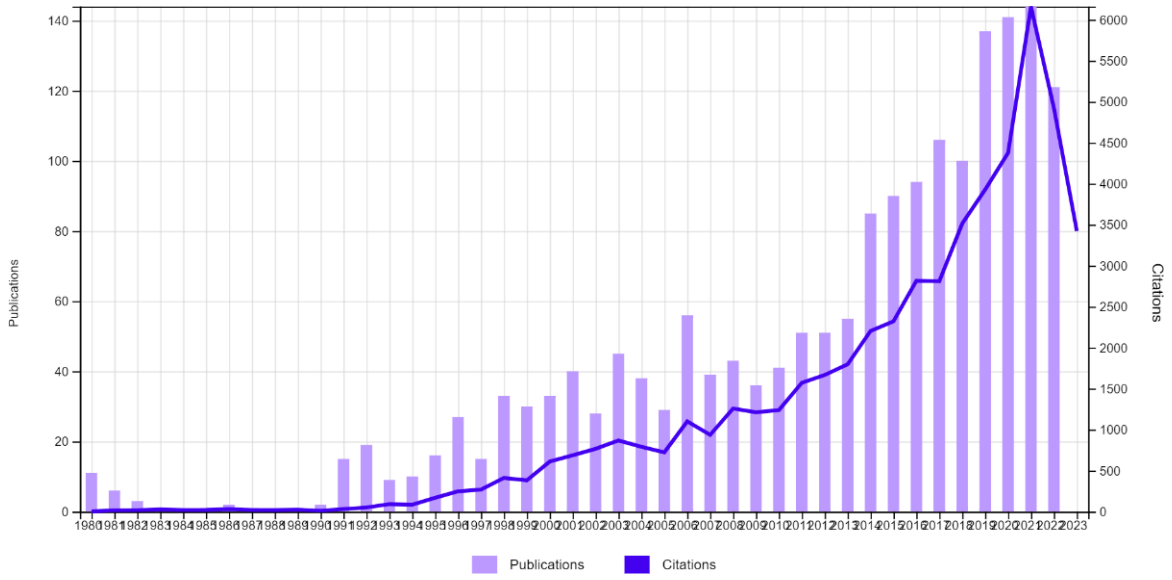

Figure 1. Number of publications and citations made between 1980 and 2022

According to Web of Science research areas, articles have been published in 67 different fields.The vast majority of articles were from Parasitology, Tropical Medicine and Infectious Diseases research areas (Figure 2).

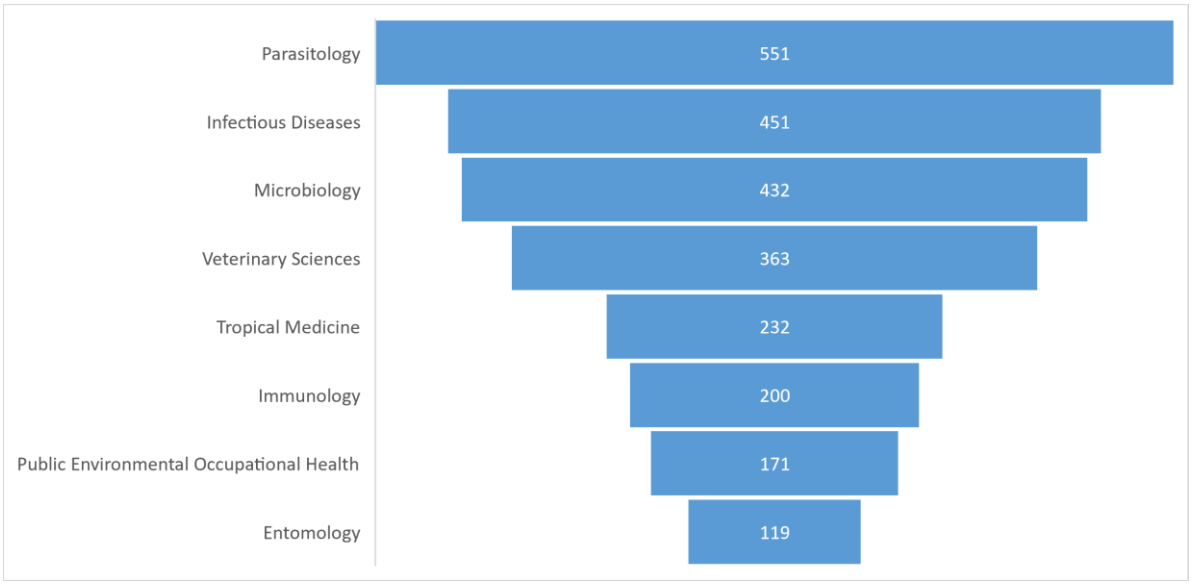

Figure 2. The summary of the article numbers according to research areas
(Research areas with more than 100 publications are shown)

8764 authors contributed the Babesia litarature globally from 124 countries. The most publishedauthor is Krause PJ with 54 articles. Author collaboration is shown in Figure 3. The United States of America (n=851), People Republic of China (n=122), France (n=118), Japan (n=107), and Poland (n=102) were in the top 5 of the mostly publishing countries on Babesia. Türkiye ranks 21st with 30 articles (Table 1). International collaboration is shown in Figure 4.

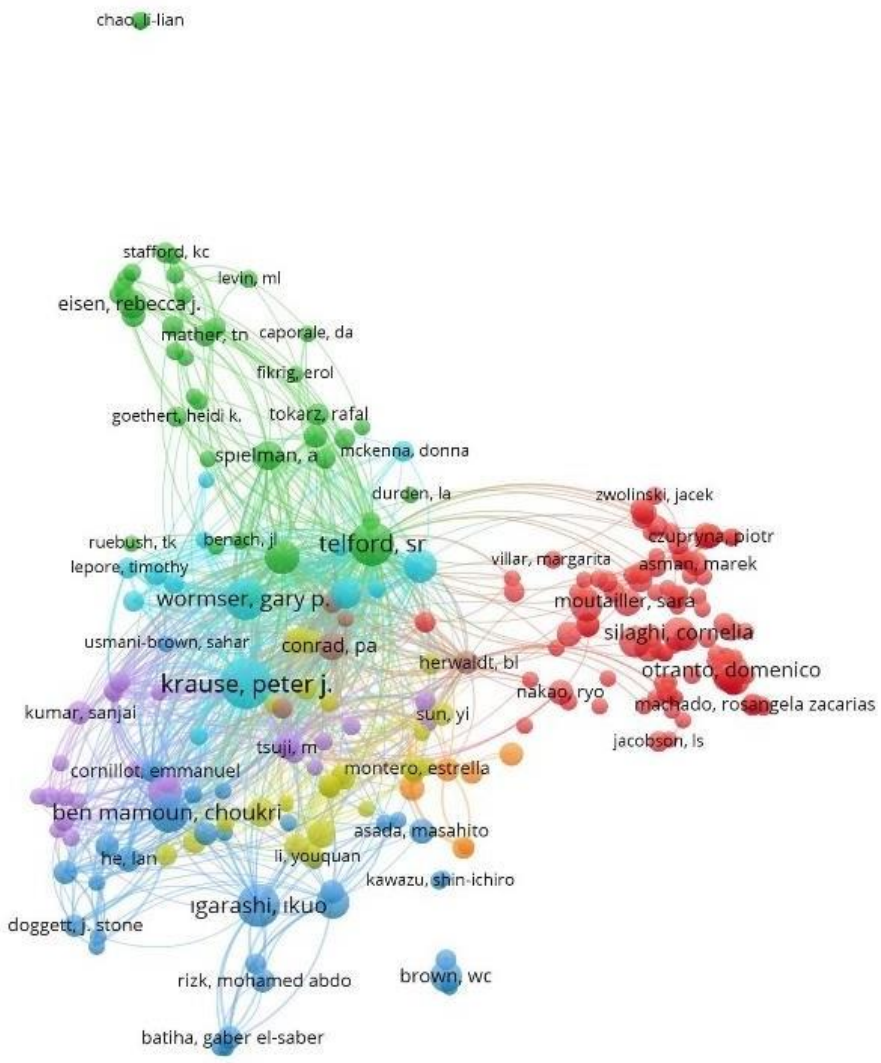

Figure 3: Authors with at least 5 publications and 50 citations are shown on the map (Citations are shown by lines linking authors. Authors with a greater circle size had a higher number of citations)

Table 1. The list of mostly publishing countries on Human babesiosis.

Ranking	Countries/Regions	n	% of 1805
1	America	851	47.15
2	People Republic of China	122	6.76
3	France	118	6.54
4	Japan	107	5.93
5	Poland	102	5.65
30	Türkiye	30	1.66

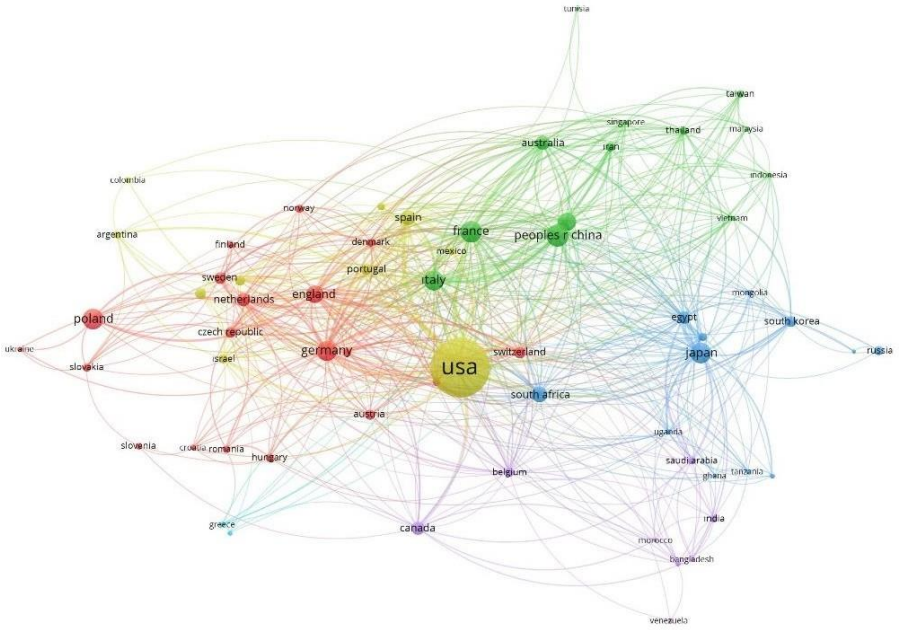

Figure 4: International collaboration network map. Collaboration is shown with lines linking nations. Strongercooperation is indicated by thicker lines. Countries with a bigger circle had a higher level of international cooperation

Figure 5 show the maps of the keyword co-occurrence networks. 218 different keywords were used at least five times in the publications. The first five most used keywords are babesia, babesiosis, ticks, babesia microti, and anaplasma phagacytophilum anisakiasis, fish and allergy, respectively.

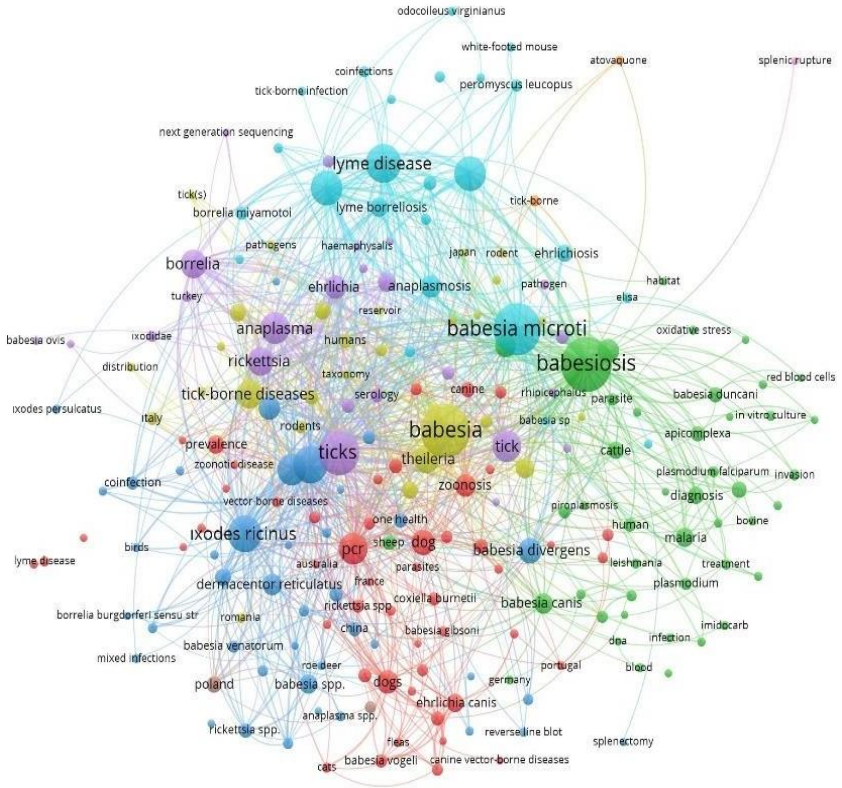

Figure 5. Keyword visualization map of articles with at least 5 occurrences. Lines connecting are indicative of occurrence relations in the articles. Keywords represented with larger circle size had a relatively higher occurrence in the articles

3. Conclusion

The global count of infected individuals has been steadily increasing in recent years, emphasizing the growing public health concern posed by human babesiosis. Hence, it is imperative to take more robust measures to curb the further transmission and progression of this disease. To establisheffective control strategies for human babesiosis, research collaboration should be fostered between researchers in developed countries and those in developing nations.

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