RESEARCH NOTE

Research on Babesia: A bibliometric assessment of a neglected tick-borne parasite [version 1; referees: awaiting peer review]

Alfonso J. Rodríguez-Morales\textsuperscript{1,2}, D. Katterine Bonilla-Aldana\textsuperscript{3}, Juan Pablo Escalera-Anteza\textsuperscript{2,4}, Lucia Elena Alvarado-Arnez\textsuperscript{2}

\textsuperscript{1}Public Health and Infection Research and Incubator Group, Faculty of Health Sciences, Universidad Tecnológica de Pereira, Pereira, Risaralda, 660001, Colombia
\textsuperscript{2}School of Medicine, Universidad Franz Tamayo/UNIFRANZ, Cochabamba, Cochabamba, 4780, Bolivia
\textsuperscript{3}Grupo de Investigación Sanidad Animal, Fundación Universitaria Autónoma de las Américas, Pereira, Risaralda, 660003, Colombia
\textsuperscript{4}Tongji Hospital & Medical College, Huazhong University of Science & Technology, Wuhan, Hubei, 1037, China

\textbf{Abstract}

Given the emergence and reemergence of tick-borne diseases, here we assessed the publishing patterns of research focused on Babesia. We also discuss the implications for the articles published in the last decade, and how more clinical and epidemiological information concerning Babesia is still required. The findings of this article would be useful to define research priorities about Babesia and diagnose the important of scientific production on this pathogen.

\textbf{Keywords}

Babesia, tick-borne disease, epidemiology, public health, bibliometric

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Corresponding author: Alfonso J. Rodriguez-Morales (ajrodriguezm_md@hotmail.com)

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Introduction
Babesiosis is a zoonotic disease with a global distribution; it is mainly transmitted by ticks of different genera (e.g. Rhipicephalus spp. and Dermacentor spp.) and diverse species. It is caused by infection of the erythrocytes of mammals by Babesia species, which are Apicomplexa protozoa of the suborder Piroplasmidea and the family Babesiidae. The vector role of ticks for these parasites was discovered by Smith and Kilbourne in 1893, who were the first to demonstrate its transmission. The first case was described by Skaraballo and occurred in 1957 in Zagreb, Croatia.

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Human babesiosis is not under surveillance and notification in most countries, including those with autochthonous incidence vector-borne diseases. However, studies show that their vectors are widely distributed in tropical and subtropical areas. Research is fundamental to better comprehending this disease. The relevance of bibliometric evaluations on emerging and reemerging disease has been previously described as they can contribute in the understanding on how the global scientific and health communities respond to outbreaks. Herein, our objective was to use bibliometric approaches to analyze Babesia research.

Methods
A bibliometric evaluation was performed focusing on Babesia scientific bibliography. Six main databases were used for retrieving information: Science Citation Index Expanded (SCI-E), Scopus, Medline, LILACS, SciELO and Google Scholar. For the search pipeline we used the following combination of key words (MeSH, Medical Subject Headings): “Babesia” AND “Latin America”, “Babesia” AND “Argentina”, “Babesia” AND “Colombia”, and this strategy was maintained including the name of each country as a keyword. Also, “Babesiosis” was used as a substitute of Babesia to increase the number of results. Regarding the type of publications, we decided to include original papers, review articles, case reports and editorials, which were further stratified according to publication year and the name and institution to which the main author was affiliated at the time of publishing. This analysis included results obtained up to December 1, 2018.

Data summaries for quantitative variables (number of articles, articles per country, articles per year or periods, citations and H index) were expressed as means and interquartile ranges (IQRs), and for qualitative variables proportions are reported.

Results
Overall, 78,137 Babesia-associated items resulted from the initial screening of publications. From Google Scholar 62,100 articles (25% USA, 24.9% South Africa, 18.5% Japan) were recovered, followed by Scopus, with 6,272 articles (25.4% from USA, 8.5% Japan, 7.2% UK), and Medline with 5,045 articles (13.7% USA, 10.1% Japan and 5.2% China) (Table 1). From Web of Science, 4,330 publications were retrieved (28.06% from USA, 11.4% Japan and 7.37% Brazil), followed by LILACS with 202 articles (29.2% Brazil, 2.4% Mexico, 1.9% USA) and

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<th>Rank</th>
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SciELO with 188 articles (26.6% Brazil, 3.1% Mexico) (Table 1). Considering the Medline database, the number of research articles on Babesia increased above 100 publications per year only after 2004 (Figure 1).

In the case of Scopus, the median number of articles published each year as of 1970 was only one (IQR: 0-3), from 1970 until 1995 this number increased to 64 (IQR: 56-73) and from 1996 till 2018 was 188 (IQR: 115–271) (Figure 2). At Scopus 134 countries contributed a minimum of one paper over the study period. For SCI-E, the annual median number of articles reported from 1996 until 2018 was of 99 (IQR: 96-103) (Figure 3), with at least one article published from 129 countries during the study period.

“Obihiro University” in Hokkaido, Japan, was the institution with the most productive research in Scopus, and “Igarashi, I” was the author with the largest record in Babesia research, with 210 articles (Figure 4 and Figure 5). At Web of Science, the H index for the topic is 88, with 70,950 citations, reaching 7,734 citations in 2017 (Figure 6).

The raw data generated in this study are available on OSP⁹.

Discussion
The results presented here show that the USA and Japan have primary roles in Babesia research, with USA leading the scientific production with nearly quarter of the published articles, followed by Japan and the UK (Table 1). Certainly, in USA, tickborne disease occurrence is frequent especially in certain areas and months over the year. Tickborne diseases such as babesiosis are commonly reported in Northeastern states as well in the upper Midwest, often with higher incidence in summer. In addition, blood transfusions is still a matter of concern, even in the USA¹⁰–¹³. In countries in Asia, such as Japan, human babesiosis was not reported until fairly recently (1999), when a symptomatic case was describe in Kobe City, Hyogo Prefecture, Japan¹⁴,¹⁵; however, since then research has significantly increased in this country. Authors from UK have collaborated with research with others from endemic countries. However, in 2006 and 2016, two cases of autochthonous canine babesiosis were reported in the UK. Since November 2015, there have been at least three more cases of canine babesiosis in untraveled dogs from Essex, all were confirmed B. canis infections by PCR. Dermacentor reticulatus ticks were found on the dogs¹⁶.

One of the relevant aspects surrounding babesiosis is that there are not yet licensed human prophylactic vaccines, and treatment alternative remain limited. Two commonly used antimicrobial regimes are highly effective: the combination of atovaquone and azithromycin and the combination of clindamycin and quinine¹⁷. Thus, most preventive measures are needed to reduce the risk of infection from ticks and wild and domestic reservoirs (e.g. rats).

Bibliometric analyses contribute an objective vision of the scientific activity of a country or a region, in an investigative area. In the particular case of infectious diseases, there are different reports about its utility⁵–⁸, especially in emerging infectious diseases.

Figure 1. Research trends on Babesia from 1931 to 2018, Medline.
Figure 2. Research trends on Babesia from 1931 to 2018, Scopus.

Figure 3. Research trends on Babesia from 1996 to 2018, Web of Science.
Figure 4. Top research institutions that published scientific literature on Babesia, Scopus.

Figure 5. Top research authors that published scientific literature on Babesia, Scopus.

Figure 6. Citation trends on Babesia from 1931 to 2018, Web of Scopus.
diseases\textsuperscript{16–20}, being possible to establish and to compare the amount of scientific production in journals, institutions, and authors publishing about a certain issue; this would allow establishment of a plan in terms of scientific policy as well in other matters\textsuperscript{11}. No previous bibliometric studies about babesiosis or Babesia have been found in the consulted bibliographical scientific databases.

In conclusion, it is time to translate research findings into effective control of babesiosis. As occurs with other emerging diseases, research leading to vaccinal or effective therapeutic options are of utmost importance. Tick-borne pathogens such as Babesia and others with even clearer epidemic potential need to be researched more and to be prioritized with effective interventions to reduce their negative impact.

**Data availability**

Raw bibliometric data generated in this study are available on OSF. DOI: https://doi.org/10.17605/OSF.IO/ER9U\textsuperscript{9}.

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**References**

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