RESEARCH NOTE

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

Alfonso J. Rodriguez-Morales1,2, D. Katterine Bonilla-Aldana3, Juan Pablo Escalera-Anteza2,4, Lucia Elena Alvarado-Arnez2

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

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.

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

This article is included in the Disease Outbreaks gateway.
Corresponding author: Alfonso J. Rodriguez-Morales (ajrodriguezm_md@hotmail.com)

Author roles: Rodriguez-Morales AJ: Conceptualization, Data Curation, Formal Analysis, Methodology, Writing – Original Draft Preparation, Writing – Review & Editing; Bonilla-Aldana DK: Conceptualization, Data Curation, Formal Analysis, Writing – Original Draft Preparation, Writing – Review & Editing; Escalera-Antezana JP: Formal Analysis, Writing – Original Draft Preparation, Writing – Review & Editing; Alvarado-Arnez LE: Formal Analysis, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: The author(s) declared that no grants were involved in supporting this work.

Copyright: © 2018 Rodriguez-Morales AJ et al. This is an open access article distributed under the terms of the Creative Commons Attribution Licence, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.


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\(^1\). 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\(^2\). The vector role of ticks for these parasites was discovered by Smith and Kilbourne in 1893, who were the first to demonstrate its transmission\(^3\). The first case was described by Skaraballo and occurred in 1957 in Zagreb, Croatia\(^4\).

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\(^5\). Research is fundamental to better comprehending this disease. The relevance of bibliometric evaluations on emerging and reemerging disease has been previously described\(^6\)–\(^7\) as they can contribute in the understanding on how the global scientific and health communities respond to outbreaks\(^8\). 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

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Number of articles</th>
<th>Database with highest number of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States of America</td>
<td>1594</td>
<td>Scopus</td>
</tr>
<tr>
<td>2</td>
<td>Japan</td>
<td>536</td>
<td>Scopus</td>
</tr>
<tr>
<td>3</td>
<td>United Kingdom</td>
<td>456</td>
<td>Scopus</td>
</tr>
<tr>
<td>4</td>
<td>Australia</td>
<td>424</td>
<td>Scopus</td>
</tr>
<tr>
<td>5</td>
<td>Germany</td>
<td>324</td>
<td>Scopus</td>
</tr>
<tr>
<td>6</td>
<td>Brazil</td>
<td>319</td>
<td>Web of Sciences</td>
</tr>
<tr>
<td>7</td>
<td>China</td>
<td>284</td>
<td>Web of Sciences</td>
</tr>
<tr>
<td>8</td>
<td>France</td>
<td>256</td>
<td>Scopus</td>
</tr>
<tr>
<td>9</td>
<td>South Africa</td>
<td>254</td>
<td>Web of Sciences</td>
</tr>
<tr>
<td>10</td>
<td>India</td>
<td>195</td>
<td>Scopus</td>
</tr>
<tr>
<td>11</td>
<td>Poland</td>
<td>189</td>
<td>Web of Sciences</td>
</tr>
<tr>
<td>12</td>
<td>Spain</td>
<td>178</td>
<td>Scopus</td>
</tr>
<tr>
<td>13</td>
<td>Argentina</td>
<td>178</td>
<td>Medline</td>
</tr>
<tr>
<td>14</td>
<td>Italy</td>
<td>172</td>
<td>Scopus</td>
</tr>
<tr>
<td>15</td>
<td>Netherlands</td>
<td>136</td>
<td>Scopus</td>
</tr>
<tr>
<td>16</td>
<td>Turkey</td>
<td>119</td>
<td>Web of Sciences</td>
</tr>
<tr>
<td>17</td>
<td>Mexico</td>
<td>116</td>
<td>Medline</td>
</tr>
<tr>
<td>18</td>
<td>Switzerland</td>
<td>101</td>
<td>Scopus</td>
</tr>
<tr>
<td>19</td>
<td>Kenya</td>
<td>98</td>
<td>Scopus</td>
</tr>
<tr>
<td>20</td>
<td>Israel</td>
<td>93</td>
<td>Scopus</td>
</tr>
<tr>
<td></td>
<td>Egypt</td>
<td>82</td>
<td>Web of Sciences</td>
</tr>
</tbody>
</table>
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 Sciences, 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 OSP®.

**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 USA. In countries in Asia, such as Japan, human babesiosis was not reported until recently (1999), when a symptomatic case was describe in Kobe City, Hyogo Prefecture, Japan; 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 dogs.

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 quinine. 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 utility, 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.
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/ER9UP.

**Grant information**

The author(s) declared that not grants were involved in supporting this work.

---

### References


---

Page 7 of 8
The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com