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RESEARCH NOTE

REVISED Research on *Babesia*: A bibliometric assessment of a neglected tick-borne parasite [version 2; peer review: 2 approved, 1 not approved]

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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
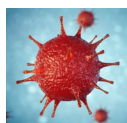
This article is included in the Disease Outbreaks gateway.

Open Peer Review

Reviewer Status ✔ ✖ ✔

	Invited Reviewers		
	1	**2**	**3**
REVISED **version 2** published 18 Jul 2019	✔ report		
version 1 published 30 Dec 2018	? report	✖ report	✔ report

1 **Stalin Vilcarromero** 🆔, Stony Brook University, New York, USA
Universidad Nacional de la Amazonía Peruana, Iquitos, Peru

2 **Jeremy S. Gray**, University College Dublin, Dublin, Ireland

3 **Cristina Casalone**, Liguria and Valle D'Aosta, Turin, Italy

Any reports and responses or comments on the article can be found at the end of the article.

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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

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Introduction

Babesiosis is a zoonotic disease with a global distribution; it is mainly transmitted by ticks from different genera (e.g. *Rhipicephalus* spp., *Dermacentor* spp., and *Ixodes* 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 Piroplasmmiidea 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 human case was described by Skaraballo and occurred in 1957 in Zagreb, Croatia[4]. As a zoonotic disease, animal reservoirs and their distribution contribute, as the presence of vectors, in the maintenance of the transmission cycle and the risk of transmission to humans.

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[3]. Research is fundamental to better understanding this disease. The relevance of bibliometric evaluations on emerging and reemerging disease has been previously described[5–7] 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 – Web of Knowledge), Scopus, Medline, LILACS, SciELO and Google Scholar.

For the search pipeline we used the following combination of keywords (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. We searched for the 233 countries of the UN list. 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 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 until 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).

Analyzing by areas of research according to Scopus, we found that most of the studies belong to the area of immunology and microbiology (28.7%), followed by medicine (26.4%) and veterinary (21.8%) (Figure 7). Also in Scopus, by revising the funding sponsors for the published research on *Babesia* (Figure 8), we found that the Ministry of Education, Culture, Sports, Science, and Technology from Japan, is the main funder (127, 23.7% of Japanese studies), followed by the Japan Society for the Promotion of Science (113, 21.1%) and the National Institutes of Health (108, 6.8%), amongst other funding institutions (Figure 8).

At Web of Science, we found that the areas with more importance for research in Babesia were parasitology (39.2%), veterinary sciences (37.7%), and infectious diseases (13.8%), among others (Figure 9). Consistent with Scopus, at Web of Science, the National Institutes of Health of USA (138, 8.7%), and the Ministry of Education, Culture, Sports, Science, and Technology of Japan (54, 10.1% of Japanese studies), were the main funders (Figure 10).

The scientific production in USA during 2011-2015 was apparently not influenced significantly by the increasing number of babebiosis cases that were reported by surveillance (Figure 11).

Table 1. The 20 countries with the highest number of scientific articles on *Babesia* research that are available in Web of Science, Scopus and Medline.

Rank	Country	Number of articles	Database with highest number of articles	Population in 2018	Number of articles per 10 million inhabitants
1	United States of America	1594	Scopus	327,096,265	4.87
2	Japan	536	Scopus	127,202,192	4.21
3	United Kingdom	456	Scopus	67,141,684	6.79
4	Australia	424	Scopus	24,898,152	17.03
5	Germany	324	Scopus	83,124,418	3.90
6	Brazil	319	Web of Science	209,469,323	1.52
7	China	284	Web of Science	1,427,647,786	0.20
8	France	256	Scopus	64,990,511	3.94
9	South Africa	254	Web of Science	57,792,518	4.40
10	India	195	Scopus	1,352,642,280	0.14
11	Poland	189	Web of Science	37,921,592	4.98
11	Spain	178	Scopus	46,692,858	3.81
12	Argentina	178	Medline	44,361,150	4.01
13	Italy	172	Scopus	60,627,291	2.84
14	Netherlands	136	Scopus	17,059,560	7.97
15	Turkey	119	Web of Science	82,340,088	1.45
16	Mexico	116	Medline	126,190,788	0.92
17	Switzerland	101	Scopus	8,525,611	11.85
18	Kenya	98	Scopus	51,392,565	1.91
19	Israel	93	Scopus	8,381,516	11.10
20	Egypt	82	Web of Science	98,423,598	0.83
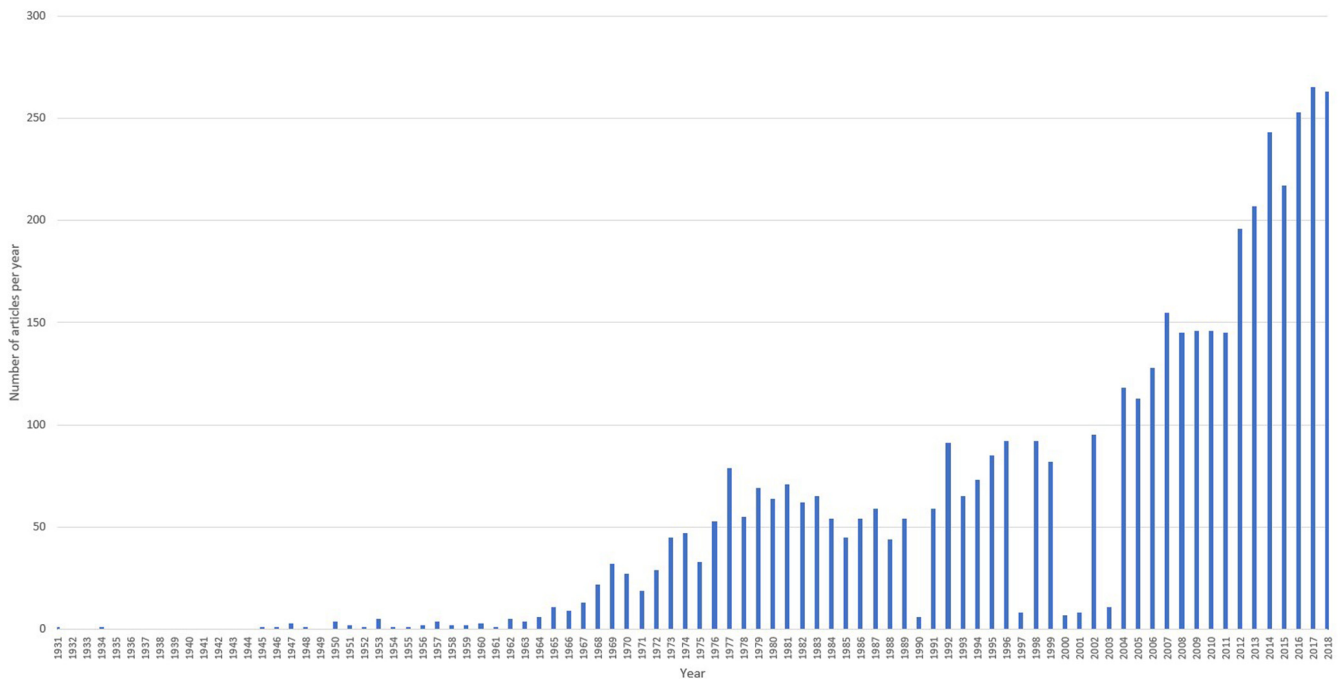
Figure 1. Research trends quantified by the number of published articles on *Babesia* from 1931 to 2018, Medline.
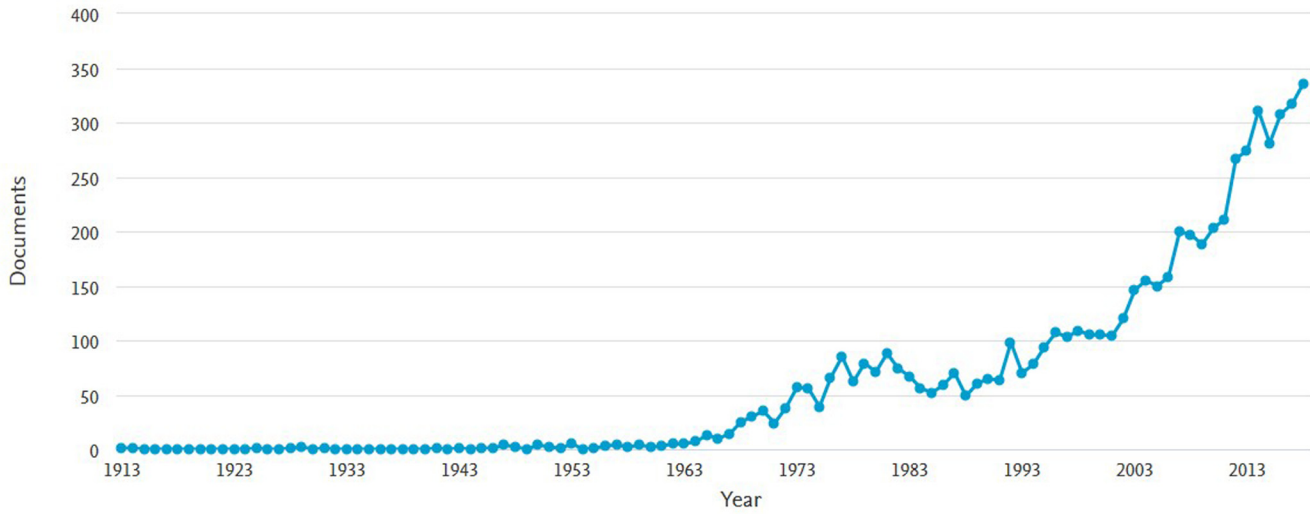
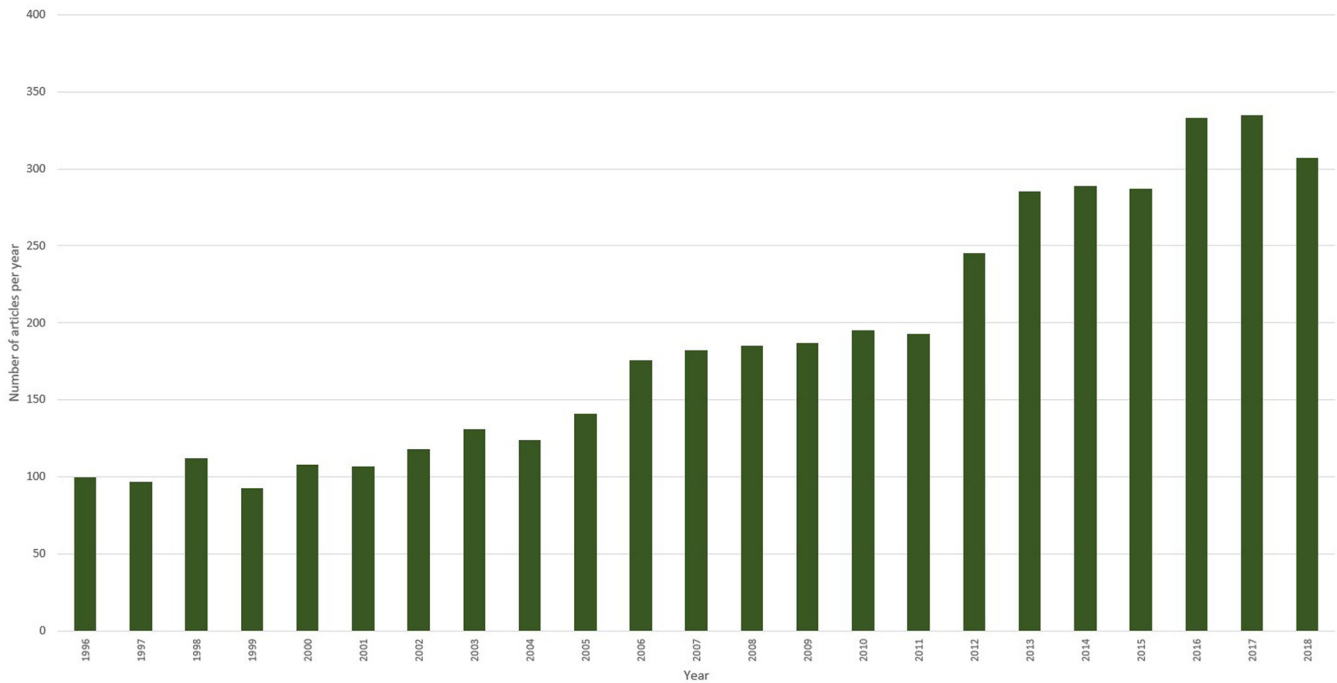**Figure 2. Research trends on *Babesia* from 1931 to 2018, Scopus.**

Figure 3. Research trends on *Babesia* from 1996 to 2018, Web of Science.

However, in Wisconsin, probably the sustained increased observed by the surveillance since 2001, led to an increase in babesiosis research after 2010 (Figure 12).

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). However, when we calculated the number of articles per million of inhabitants, we found that Australia publish 3.49 more times than USA (and 4.04 times than Japan), followed by Switzerland, Israel, Netherlands, UK and Poland. 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
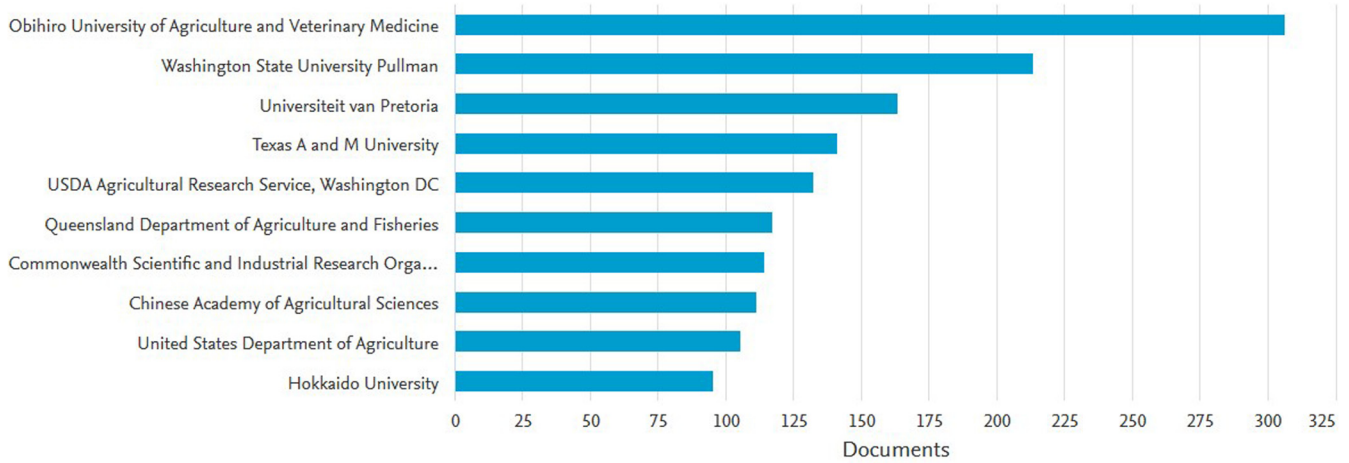
Figure 4. Top research institutions that published scientific literature on *Babesia*, Scopus.

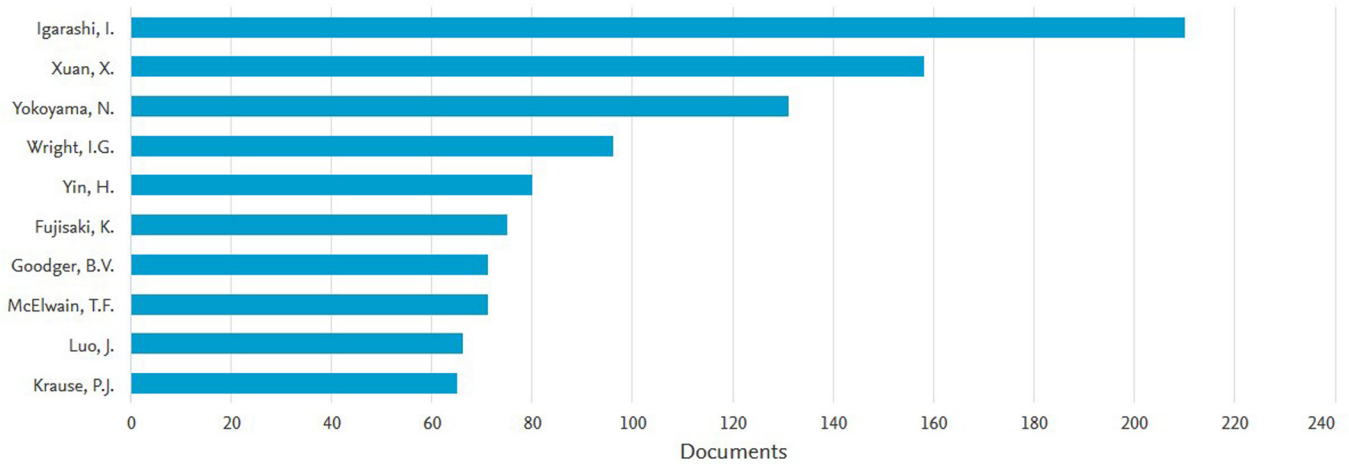**Figure 5. Top research authors that published scientific literature on *Babesia*, Scopus.**
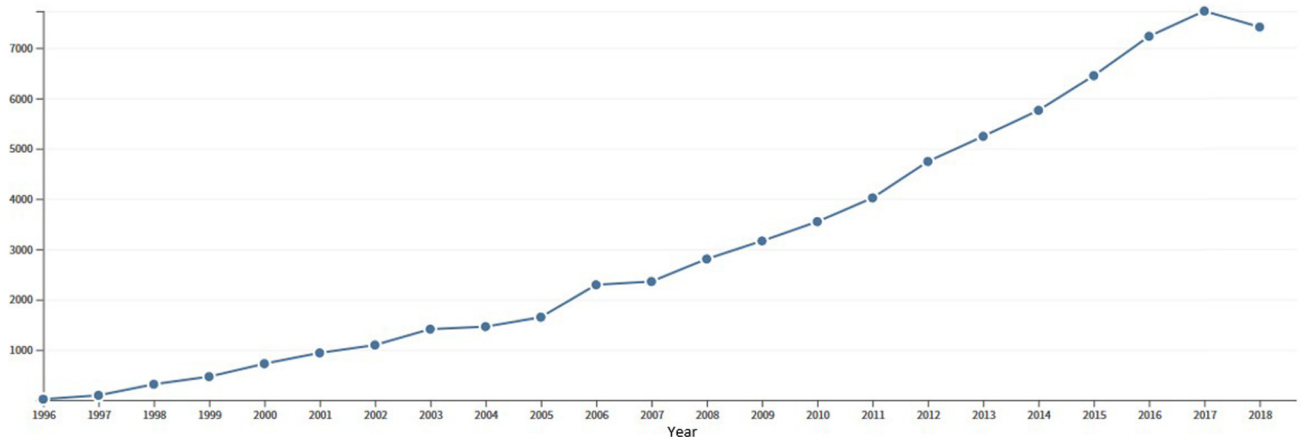
Figure 6. Citation trends on *Babesia* from 1931 to 2018, Web of Science.

Figure 7. Documents by subject area in Scopus.

Figure 8. Documents by funding sponsor in Scopus.

Figure 9. Documents by subject area in Web of Science.

Figure 10. Documents by funding sponsor in Web of Science.

Figure 11. Trends in the number of cases of human babesiosis reported in USA and the number of published articles on babesiosis at Scopus, Web of Science (Wos) and PubMed, 2011–2015.

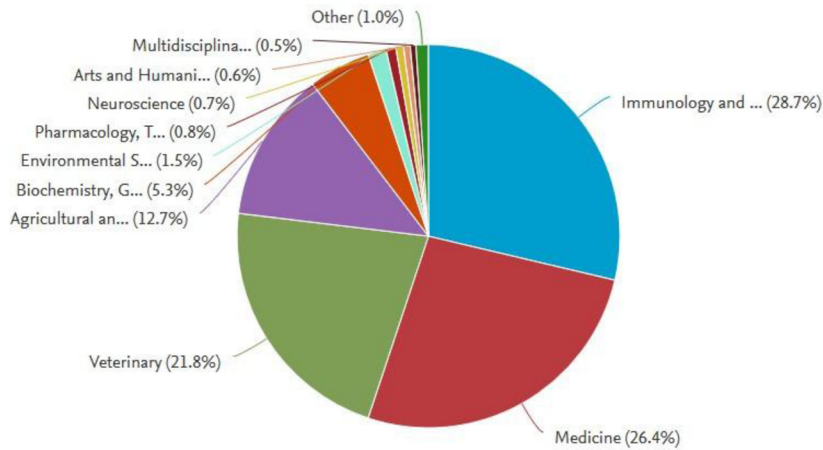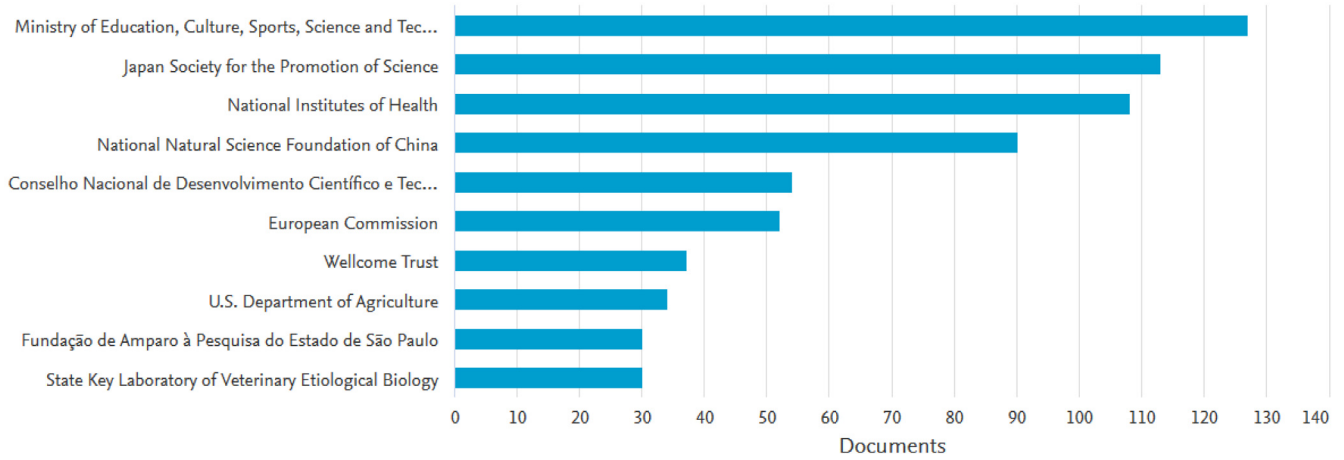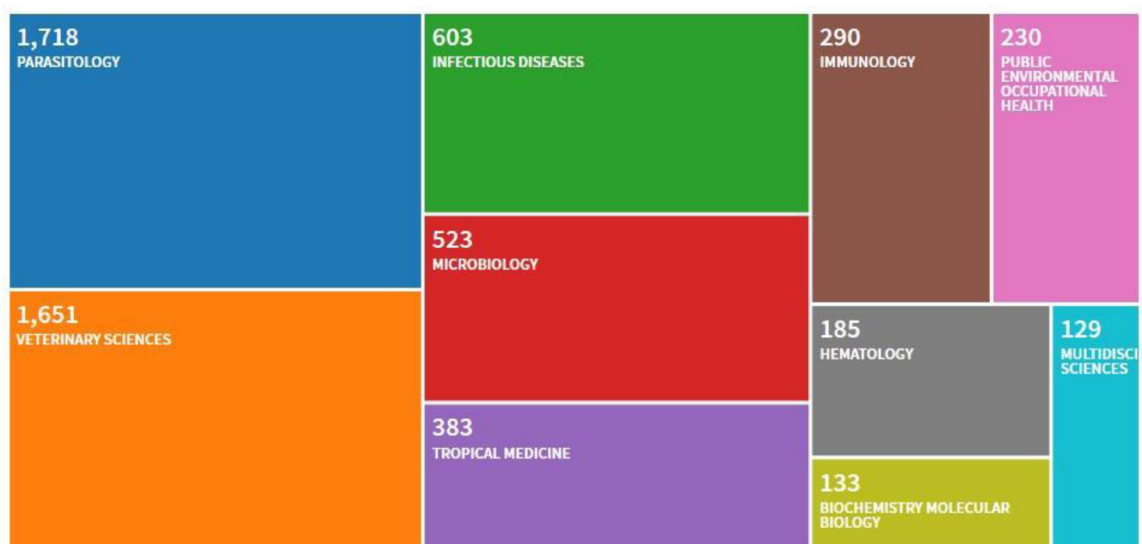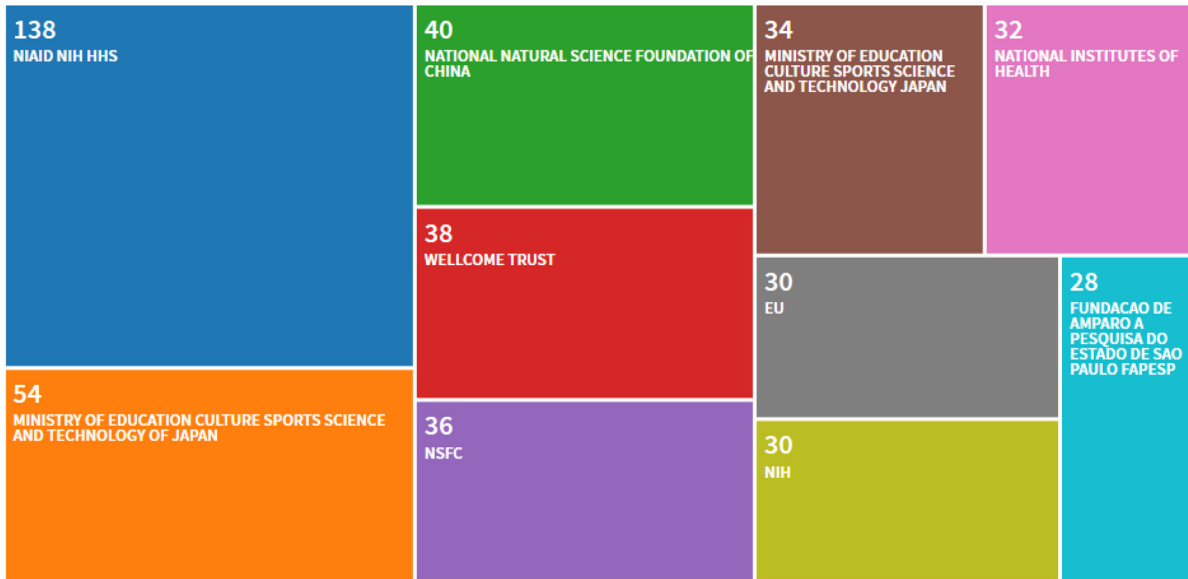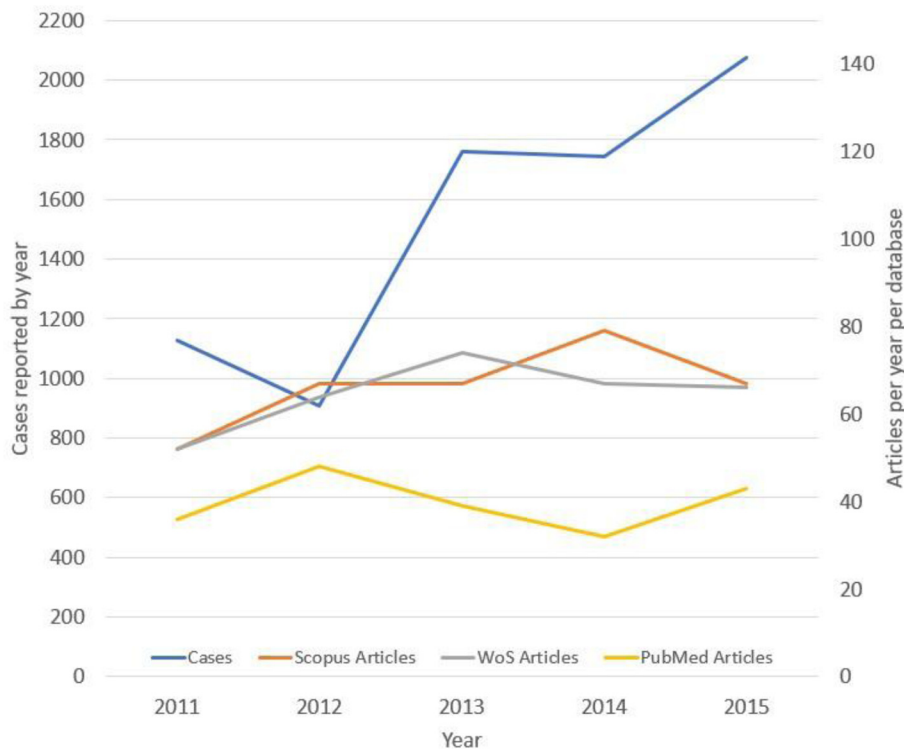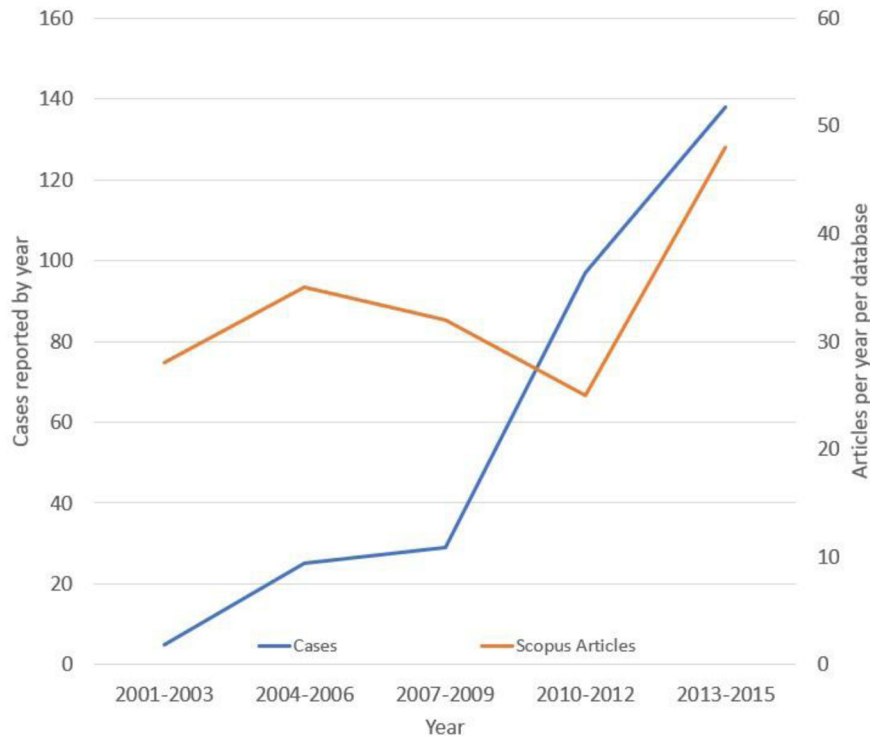**Figure 12. Trends in the number of cases of human babesiosis reported in Wisconsin, USA, and the number of published articles on babesiosis at Scopus, Web of Science (Wos) and PubMed, 2001–2015 from Wisconsin, USA.** The raw data generated in this study is available on OSF[9].

upper Midwest, often with higher incidence in summer. In addition, blood transfusions is still a matter of concern, even in the USA[10–13]. 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, Japan[14,15]; 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 dogs[16]. The number of articles published by USA and Japan comes as a result from the considerable funding, reflected in the publications supported by their respective agencies. In addition, in USA, babesiosis is a notifiable disease since 2011 (CDC) and most human cases have been reported. Of interest the strong research activity of institutions and countries as Japan and UK, in which *Babesia* represents a new emerging problem in both animals and humans. The findings highlight the increased research activity on this neglected zoonosis, considered of growing importance in several countries and the need of further studies addressed to preventive and therapeutic aspects.

One of the relevant aspects surrounding babesiosis is that there are not yet licensed human prophylactic vaccines, and treatment

alternatives remain limited. Two commonly used antimicrobial regimes are highly effective: the combination of atovaquone and azithromycin and the combination of clindamycin and quinine[17]. Thus, more preventive measures are needed to reduce the risk of infection from ticks and wild and domestic reservoirs (e.g. rats).

The vision of zoonoses should be one. All integrated. Then, having separated human and animal babesiosis, to us, is not rationale today. Babesiosis is one zoonotic disease, no matter the host. The work on babesiosis, including research, should be together between veterinarians and human physicians, working in the interphase that zoonosis, such as babesiosis, provide. One World, One Health. However, as reflected from this bibliometric study, there is a predominance of studies from human medicine compared to veterinary medicine. There is a need for increase of integration with veterinary sciences, given the relevance of babesiosis as a zoonosis.

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[5–8], especially in emerging infectious diseases[18–20], 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[21].

No previous bibliometric studies about babesiosis or *Babesia* have been found in the consulted scientific databases.

It would be ideal to have epidemiological data, such as incidence by active surveillance, but unfortunately such data is not available in most countries, in order to correlate the level of research with the epidemiological relevance of babesiosis. Again, babesiosis is a neglected disease, of importance in several countries, the topic, certainly deserves still more research. Even, in USA, where human babesiosis is now notifiable, only available data is from 2011 to 2015[22], and we retrieved that in order to see if there was a relationship between the number of cases and the number of articles, but this was not apparently influenced, given that during that period, the number of articles from USA did not increased at Scopus, Web of Science and PubMed. However, in Wisconsin, its Department of Health Services, Division of Public Health, in 2001 defines a confirmed case of babesiosis as the occurrence of fever, anemia, or thrombocytopenia in a patient with confirmatory laboratory findings, and its surveillance begun[23]. Analyzing the number of reported cases from Wisconsin and the number of articles of babesiosis from 2001 to 2015, especially after 2010, epidemiology appears to have influenced an increase in the publications in 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[9].

Grant information

References

1. Rodriguez-Morales AJ: **Epidemiología de la Babesiosis: Zoonosis emergente.** *Acta Cient Estud.* 2007; **5**(4): 132–8.
   Reference Source

2. Beugnet F, Moreau Y: **Babesiosis.** *Rev Sci Tech.* 2015; **34**(2): 627–39.
   PubMed Abstract | Publisher Full Text

3. Gray JS, Estrada-Peña A, Zintl A: **Vectors of Babesiosis.** *Annu Rev Entomol.* 2018.
   PubMed Abstract | Publisher Full Text

4. Brasseur P, Gorenflot A: **Human babesial infections in Europe.** *Rocz Akad Med Bialymst.* 1996; **41**(1): 117–22.
   PubMed Abstract

5. Almeida-Guerrero A, Olaya-Gómez JC, Sánchez-Ramírez N, *et al.*: **Mitigation of the global impact of Lassa fever: Have we investigated enough about this Arenavirus? - A bibliometric analysis of Lassa Fever research.** *Travel Med Infect Dis.* 2018; **24**: 13–4.
   PubMed Abstract | Publisher Full Text

6. Ballabeni A, Boggio A: **Publications in PubMed on Ebola and the 2014 outbreak.** *F1000Res.* 2015; **4**: 68.
   PubMed Abstract | Publisher Full Text | Free Full Text

7. Rodríguez-Morales AJ, Ramírez-Jaramillo V, Patiño-Barbosa AM, *et al.*: **Severe fever with thrombocytopenia syndrome - A bibliometric analysis of an emerging priority disease.** *Travel Med Infect Dis.* 2018; **23**: 97–8.
   PubMed Abstract | Publisher Full Text

8. Culquichicón C, Cardona-Ospina JA, Patiño-Barbosa AM, *et al.*: **Bibliometric analysis of Oropouche research: impact on the surveillance of emerging arboviruses in Latin America.** *F1000Res.* 2017; **6**: 194.
   PubMed Abstract | Publisher Full Text | Free Full Text

9. Rodriguez-Morales AJ: **Bibliometric Data of Babesia.** *OSF.* 2018.
   http://www.doi.org/10.17605/OSF.IO/ER9UP

10. Hajicharalambous C, Rattu M, Leuchten S: **A Walk in the Park: A Case of Babesiosis in the South Bronx.** *Clin Pract Cases Emerg Med.* 2018; **2**(1): 61–3.
    PubMed Abstract | Publisher Full Text | Free Full Text

11. Jajosky RP, Jajosky AN: **Is babesiosis the most common transfusion transmitted infection in the United States of America? The answer is not simple!** *Transfus Apher Sci.* 2017; **56**(4): 609–10.
    PubMed Abstract | Publisher Full Text

12. Linden JV, Prusinski MA, Crowder LA, *et al.*: **Transfusion-transmitted and community-acquired babesiosis in New York, 2004 to 2015.** *Transfusion.* 2018; **58**(3): 660–8.
    PubMed Abstract | Publisher Full Text | Free Full Text

13. Stein E, Elbadawi LI, Kazmierczak J, *et al.*: **Babesiosis Surveillance - Wisconsin, 2001-2015.** *MMWR Morb Mortal Wkly Rep.* 2017; **66**(26): 687–91.
    PubMed Abstract | Publisher Full Text | Free Full Text

14. Matsui T, Inoue R, Kajimoto K, *et al.*: **[First documentation of transfusion-associated babesiosis in Japan].** *Rinsho Ketsueki.* 2000; **41**(8): 628–34.
    PubMed Abstract

15. Tsuji M, Wei Q, Zamoto A, *et al.*: **Human babesiosis in Japan: epizootiologic survey of rodent reservoir and isolation of new type of *Babesia microti*-like parasite.** *J Clin Microbiol.* 2001; **39**(12): 4316–22.
    PubMed Abstract | Publisher Full Text | Free Full Text

16. Cook S, English K, Humm K: **Autochthonous babesiosis in the United Kingdom.** *J Small Anim Pract.* 2016; **57**(6): 332.
    PubMed Abstract | Publisher Full Text

17. Vannier E, Gewurz BE, Krause PJ: **Human babesiosis.** *Infect Dis Clin North Am.* 2008; **22**(3): 469–88 viii-ix.
    PubMed Abstract | Publisher Full Text | Free Full Text

18. Rodriguez-Morales AJ, Ramirez-Jaramillo V, Sánchez-Carmona D, *et al.*: **Kyasanur forest disease: Another flavivirus requiring more research? Results of a bibliometric assessment.** *Travel Med Infect Dis.* 2017; **19**: 68–70.
    PubMed Abstract | Publisher Full Text

19. Rodriguez-Morales AJ, Sabogal-Roman JA, Alvarez-Moreno CA: **What has been researched about MDR-*Candida auris*? A bibliometric analysis on the 'new kid on the block' in hospital-associated infections.** *J Infect Public Health.* 2018; **11**(2): 295–6.
    PubMed Abstract | Publisher Full Text

20. Vera-Polania F, Muñoz-Urbano M, Bañol-Giraldo AM, *et al.*: **Bibliometric assessment of scientific production of literature on chikungunya.** *J Infect Public Health.* 2015; **8**(4): 386–8.
    PubMed Abstract | Publisher Full Text

21. Vera-Polania F, Perilla-Gonzalez Y, Martinez-Pulgarin DF, *et al.*: **Bibliometric assessment of the Latin-American contributions in dengue.** *Recent Pat Antiinfect Drug Discov.* 2014; **9**(3): 195–201.
    PubMed Abstract | Publisher Full Text

22. Gray EB, Herwaldt BL: **Babesiosis Surveillance - United States, 2011-2015.** *MMWR Surveill Summ.* 2019; **68**(6): 1–11.
    PubMed Abstract | Publisher Full Text

23. Stein E, Elbadawi LI, Kazmierczak J, *et al.*: **Babesiosis Surveillance - Wisconsin, 2001-2015.** *MMWR Morb Mortal Wkly Rep.* 2017; **66**(26): 687–691.
    PubMed Abstract | Publisher Full Text | Free Full Text

Open Peer Review

Current Peer Review Status: ✔ ✘ ✔

Version 2

Reviewer Report 25 July 2019

https://doi.org/10.5256/f1000research.21848.r51373

✔ **Stalin Vilcarromero** (iD)

Sociedad Científica de Estudiantes de Medicina de la Amazonía Peruana (SOCIEMAP), Facultad de Medicina, Universidad Nacional de la Amazonía Peruana, Iquitos, Peru

In the manuscript entitled "Research on Babesia: A bibliometric assessment of a neglected tick-borne parasite", the authors have included the recommendations made by the reviewers and their quality has improved. This bibliometric review is of interest to future researchers in this zoonosis and shows the need to continue studies in a multidisciplinary manner.

It is practically ready for indexing, but first, it would be important to answer one question and one minor observation. The first is regarding the comment and graph made considering the state of Wisconsin, considering that there are other states such as Rhode Island, Massachusetts, Connecticut and Maine that show a marked increase in their incidence rates compared to Wisconsin during the period 2011-2014[1]. Please clarify, if the same does not happen in the other states.

The second observation is regarding the writing in some paragraphs of the discussion. For example: "In countries in Asia ..." would be more appropriate: "In Asian countries .." or the following sentence: "Of interest the strong research activity of institutions and countries as Japan and UK, in which Babesia represents a new emerging problem in both animals and humans" the message is not clear. Another example is the paragraph: "The vision of zoonoses should be one. All integrated. Then, having separated human and animal babesiosis, to us, is not rationale today. Babesiosis is one zoonotic disease, no matter the host. The work on babesiosis, including research, should be together between veterinarians and human physicians, working in the interphase that zoonosis, such as babesiosis, provide. One World, One Health." in which redundancies are observed.

References
1. Surveillance for Babesiosis - United States, 2014 Annual Summary. *U.S. Department of Health and Human Services. [Accessed 25th July 2019]*. 2016. Reference Source

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Clinical and epidemiological research in Vector Borne Disease & Zoonoses.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 28 February 2019

https://doi.org/10.5256/f1000research.19225.r43816

Cristina Casalone
Experimental Institute for Zooprophylaxis in Piedmont, Liguria and Valle D'Aosta, Turin, Italy

The manuscript submitted by Rodríguez Morales et al. represents a bibliometric evaluation on Babesia, in order to contribute to understanding this neglected zoonosis and addressing future research and control strategies. Bibliometric evaluation is an excellent tool to obtain objective information about specific areas of research and support the adoption of strategic decisions. In detail, this study provides and summaries data on the research activity on Babesia worldwide. It shows that the main country involved in the research on Babesia is USA, where babesiosis is a notifiable disease since 2011 (CDC) and most human cases have been reported. Of interest the strong research activity of institutions and countries as Japan and UK, in which Babesia represents a new emerging problem both in animals and humans. This study highlights the increased research activity on this neglected zoonosis, considered of growing importance in several countries and the need of further studies addressed to preventive and therapeutic aspects.
The manuscript, proposed as a research note, is well structured, the statistical analysis and its interpretation is sufficient, results and discussion appropriate. To fulfil *F1000Research* criteria ("Research note … can be reported with one or two illustrations (figures/tables)"), authors could reduce the number of figures/graphs.

I suggest the following minor revisions in the text:

In the Introduction:
- I suggest to add *Ixodes* spp as tick genera involved in the transmission of Babesia to humans. Indeed in USA most reported human cases are attributed to *B. microti* transmitted to people by *Ixodes scapularis.* Moreover, most European human cases are caused by *B. divergens* and *B. venatorum*, primarily transmitted by *Ixodes ricinus*[1].
- The authors should specify that the first case described in Croatia in 1957 by Skaraballo, refers to a "human" case.
- Moreover I suggest adding a sentence regarding the role of animal reservoirs and their distribution that contributes (as the presence of vectors) in the maintenance of the transmission cycle.

In the Methods:
You could clarify which and/or how many countries have been used as keyword for the search pipeline

Figure 6: In the caption: the citation trends is from Web of Science (as reported in the results), not Scopus.

References

1. Gray J, Zintl A, Hildebrandt A, Hunfeld KP, Weiss L: Zoonotic babesiosis: overview of the disease and novel aspects of pathogen identity. *Ticks Tick Borne Dis*. 2010; **1** (1): 3-10 PubMed Abstract | Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Diagnostics on vector borne disease, neuropathology, surveillance program

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 07 Jul 2019
Alfonso Rodriguez-Morales, Universidad Franz Tamayo/UNIFRANZ, Cochabamba, Bolivia

Dear Dr. Casalone

Thanks for your valuable comments. Regards them, we would like to comment and discuss, in the context of the submission a new revised version (version 2).

The manuscript submitted by Rodríguez Morales et al. represents a bibliometric evaluation on Babesia, in order to contribute to understanding this neglected zoonosis and addressing future research and control strategies. Bibliometric evaluation is an excellent tool to obtain objective information about specific areas of research and support the adoption of strategic decisions. In detail, this study provides and summaries data on the research activity on Babesia worldwide. It shows that the main country involved in the research on Babesia is USA, where babesiosis is a notifiable disease since 2011 (CDC) and most human cases have been reported. Of interest the strong research activity of

institutions and countries as Japan and UK, in which Babesia represents a new emerging problem both in animals and humans. This study highlights the increased research activity on this neglected zoonosis, considered of growing importance in several countries and the need of further studies addressed to preventive and therapeutic aspects.

We are thankful for your comments. In this revised version, we have included more information such as, an adjustment per capita of the number of publications per million population of the countries (Table 1). In the case of USA, where data from 2011 to 2015 was available, we analyzed and compared the number of reported cases in that period with the number of publications at Scopus, WoS and PubMed during the same time.

The manuscript, proposed as a research note, is well structured, the statistical analysis and its interpretation is sufficient, results and discussion appropriate. To fulfil F1000Research criteria ("Research note … can be reported with one or two illustrations (figures/tables)"), authors could reduce the number of figures/graphs.

Thank you for the comments. Per request from the other reviewers, we actually have extended on analyses, data and figures in order to respond to their inquiries.

I suggest the following minor revisions in the text:
In the Introduction:
I suggest to add *Ixodes spp* as tick genera involved in the transmission of Babesia to humans.
Done. Included (Second line in Introduction section).

Indeed, in USA most reported human cases are attributed to *B. microti* transmitted to people by Ixodes scapularis. Moreover, most European human cases are caused by *B. divergens* and B. *venatorum*, primarily transmitted by *Ixodes ricinus1*.
Done. Included.

The authors should specify that the first case described in Croatia in 1957 by Skaraballo, refers to a "human" case.

Done. Included (Fifth line in Introduction section).

Moreover, I suggest adding a sentence regarding the role of animal reservoirs and their distribution that contributes (as the presence of vectors) in the maintenance of the transmission cycle.

Done, now included (Final sentence in Introduction section).

In the Methods:
You could clarify which and/or how many countries have been used as keyword for the search pipeline

Now included (In Methods section after keyword specification).

Figure 6: In the caption: the citation trends is from Web of Science (as reported in the

results), not Scopus.

Corrected.

Competing Interests: None.

Reviewer Report 26 February 2019

✗   **Jeremy S. Gray**
UCD School of Biology & Environmental Science, University College Dublin, Dublin, Ireland

This article attempts to assess the bibliographic status of *Babesia* parasites with the declared objective of identifying research priorities in order to achieve effective prevention and control of babesiosis. The authors have produced publication data from various sources showing trends over the years and also by citation, author, institute and country.

Unfortunately the article has major deficiencies. The most obvious of these is that the human and animal versions of the disease have been conflated so that the data are more or less meaningless. The economic impact, research priorities and research constraints are very different in veterinary compared with medical babesiosis. In fact it is possible to argue that even the parasites are different, since the vast majority of human cases are caused by a parasite (*Babesia microti*) that is only distantly related to those prevalent in veterinary babesiosis (*Babesia* sensu stricto), and there are differences in their biology such as presence or absence of transovarial transmission, sensitivity to antibabesials, availability of in vitro cultures etc.

Additionally, it is difficult to see the point of counting numbers of articles published by different countries, authors, institutions etc. Cross comparison of these data is invidious since different interests and time scales are involved. Such data may tell the reader something about where there has been sufficient interest for research funding but nothing about the nature of the research, which is necessary to identify areas of neglect. It would have been much more useful to break the data down by topic. For example, how many articles are in the area of pure immunological research, usually involving rodents, how many address therapeutic issues, how many vaccination, how many epidemiology etc. Only then would it be possible to see where the gaps are, particularly in relation to practical measures, particularly if accompanied by analytical comments. The superficial approach of this article certainly does not, especially when there has been no attempt to explain the trends presented in the figures.

The authors have identified some research areas that require more attention, for example blood transfusion infection in the USA, development of vaccines (presumably molecular), development of new antibabesials, but have not provided the necessary context or evidence for these conclusions.

Some important issues that the authors seem to have ignored completely, include the development and

successful use of live vaccines for cattle babesiosis over a long period of time, the prodigious, but failed efforts, to produce molecular vaccines against cattle babesiosis (which indicates the very great difficulty involved in the development of vaccines for human use), the change in direction and emphasis of babesiosis research in general with the discovery of *B. microti* in the US, and epidemiological issues such as the extension of the geographical range of infections, although briefly touched on in relation to the UK, for reasons that are not clear.

The references make little mention of established authorities in the topic and there are at least five instances of self-citation. Finally there are many examples of poor sentence construction (e.g. the last part of the last sentence in the abstract, inaccurate statements (e.g. the first sentence in the Introduction and the first sentence in the second paragraph), unnecessary sentences (e.g. the third sentence in the second paragraph) etc. There are more of all these in the Discussion.

Overall, the impression gained is that the authors have made use of readily available metrics on the internet, to present data that appear to have no useful meaning and have not attempted to analyze the data to achieve their stated objectives.

Is the work clearly and accurately presented and does it cite the current literature?
No

Is the study design appropriate and is the work technically sound?
No

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Parasitologist, with special interest in babesiosis and tick-borne diseases

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 07 Jul 2019

Alfonso Rodriguez-Morales, Universidad Franz Tamayo/UNIFRANZ, Cochabamba, Bolivia

Dear Dr. Gray

Thanks for your comments. We have revised and improved the manuscript. In regard to your

observations, we would like to comment and discuss, in the context of the submission a new revised version (version 2).

This article attempts to assess the bibliographic status of Babesia parasites with the declared objective of identifying research priorities in order to achieve effective prevention and control of babesiosis. The authors have produced publication data from various sources showing trends over the years and also by citation, author, institute and country.

The objective of this bibliometric study was not to "identifying research priorities in order to achieve effective prevention and control of babesiosis", which would be impossible from this type of study. What we really declared is "The findings of this article would be useful to define research priorities about Babesia and diagnose the important of scientific production on this pathogen" (final line of the abstract)

Unfortunately the article has major deficiencies. The most obvious of these is that the human and animal versions of the disease have been conflated so that the data are more or less meaningless. The economic impact, research priorities and research constraints are very different in veterinary compared with medical babesiosis. In fact it is possible to argue that even the parasites are different, since the vast majority of human cases are caused by a parasite (*Babesia microti*) that is only distantly related to those prevalent in veterinary babesiosis (*Babesia* sensu stricto), and there are differences in their biology such as presence or absence of transovarial transmission, sensitivity to antibabesials, availability of in vitro cultures etc.

We thank the reviewer for the observation, although we consider that today, the vision of zoonoses should be an integrated one. Then, having separated human and animal babesiosis, to us, is not rationale. Babesiosis is one zoonotic disease, no matter the host. The work on babesiosis should be together between veterinarians and human physicians, working in the interphase that zoonoses, such as babesiosis, provide. One World, One Health.

Additionally, it is difficult to see the point of counting numbers of articles published by different countries, authors, institutions etc. Cross comparison of these data is invidious since different interests and time scales are involved. Such data may tell the reader something about where there has been sufficient interest for research funding but nothing about the nature of the research, which is necessary to identify areas of neglect. It would have been much more useful to break the data down by topic. For example, how many articles are in the area of pure immunological research, usually involving rodents, how many address therapeutic issues, how many vaccination, how many epidemiology etc. Only then would it be possible to see where the gaps are, particularly in relation to practical measures, particularly if accompanied by analytical comments. The superficial approach of this article certainly does not, especially when there has been no attempt to explain the trends presented in the figures.

Bibliometric studies quantify and compare the scientific output on specific and general topics. That is the idea and the design, that has been a base consensus in this type of studies. Nevertheless, we have included additional information in regards the areas of research related to Babesia as well as the funding sponsors, from both Scopus and Web of Sciences.

The authors have identified some research areas that require more attention, for example blood transfusion infection in the USA, development of vaccines (presumably molecular), development of new antibabesials, but have not provided the necessary context or evidence for these conclusions.

That would be more related to other kind of studies. If required, a specific study (e.g. review) about that should be designed, to address those specific topics.

Some important issues that the authors seem to have ignored completely, include the development and successful use of live vaccines for cattle babesiosis over a long period of time, the prodigious, but failed efforts, to produce molecular vaccines against cattle babesiosis (which indicates the very great difficulty involved in the development of vaccines for human use), the change in direction and emphasis of babesiosis research in general with the discovery of _B. microti_ in the US, and epidemiological issues such as the extension of the geographical range of infections, although briefly touched on in relation to the UK, for reasons that are not clear.

We agree with the reviewer that such points would be of interest. But our study characterizes as a bibliometric research note, and not a systematic review, or a bibliometric study about vaccines. Therefore, that was not an objective of our study.

The references make little mention of established authorities in the topic and there are at least five instances of self-citation. Finally there are many examples of poor sentence construction (e.g. the last part of the last sentence in the abstract, inaccurate statements (e.g. the first sentence in the Introduction and the first sentence in the second paragraph), unnecessary sentences (e.g. the third sentence in the second paragraph) etc. There are more of all these in the Discussion.

Thank you very much for the observation. In this revised version, we attended several of such issues in order to improve the manuscript.

Overall, the impression gained is that the authors have made use of readily available metrics on the internet, to present data that appear to have no useful meaning and have not attempted to analyze the data to achieve their stated objectives.

As previously indicated, in this revised version the manuscript has been improved. Although we would like to clarify that: i) the metrics presented in this research note were not available on the internet and ii) the databases that were evaluated are significant sources for bibliometric studies, to whom (Scopus and SCI-E Web of Knowledge) the Universidad Tecnológica de Pereira, in Colombia has valid subscriptions.

**Competing Interests:** None.

Reviewer Report 08 February 2019

Stalin Vilcarromero iD

Sociedad Científica de Estudiantes de Medicina de la Amazonía Peruana (SOCIEMAP), Facultad de Medicina, Universidad Nacional de la Amazonía Peruana, Iquitos, Peru

In the manuscript entitled "Research on Babesia: A bibliometric assessment of a neglected tick-borne parasite" the authors try to evaluate the previous bibliometric research regarding babesiosis in the world. It has recognized the value of this type of study because it helps to identify the importance of a country, institution or researcher in solving problems based on scientific evidence. Most of them describe bibliometrics in their papers considering bibliometric variables such as number of citations, author participation in research production, author and co-authorship analysis with VOSviewer[1], the H-index, geographical distribution of that disease by countries, the amount and intensity of their international collaboration, analysis of that research based on the frequency of the words used in the title of the articles [2], number of publications with intra-country collaboration, number of publications with inter-country collaboration[3,4] etc, and usually, the literature was retrieved using only one database (Scopus, Medline, etc) which may give the advantage to let them analyze this in depth.

However, when the number of publications is normalized by population[1], by gross domestic product, and by gross national income per capita[5], health expenditure[6], scientific collaboration[7] or other important variable (epidemiology variables such as prevalence, incidence[8], endemic versus non-endemic, etc) it makes more relevant the study. On the other hand, it is known the capacity of databases such Scopus, Medline, Web of Science and Scielo, and the authors may decide to use only one giving more details to the analysis.

In this case, considering that Babesiosis is a neglected disease, of importance in several countries as it has been described in the manuscript, so this topic deserve still more research, so I consider that this bibliometric analysis would be important for the scientific community. However, it would also be important to normalize the number of publications (including some of those variables mentioned above), include other bibliometric variables such as H-index.

References
1. Hernández-Vásquez A, Alarcon-Ruiz CA, Bendezu-Quispe G, Comandé D, Rosselli D: A bibliometric analysis of the global research on biosimilars.*J Pharm Policy Pract*. 2018; **11**: 6 PubMed Abstract | Publisher Full Text
2. Soosaraei M, Khasseh AA, Fakhar M, Hezarjaribi HZ: A decade bibliometric analysis of global research on leishmaniasis in Web of Science database.*Ann Med Surg (Lond)*. 2018; **26**: 30-37 PubMed Abstract | Publisher Full Text
3. Sweileh WM, Zyoud SH, Al-Jabi SW, Sawalha AF: Public, environmental, and occupational health research activity in Arab countries: bibliometric, citation, and collaboration analysis.*Arch Public Health*. 2015; **73** (1): 1 PubMed Abstract | Publisher Full Text
4. Fakhar M, Soosaraei M, Khasseh AA, Emameh RZ, Hezarjaribi HZ: A bibliometric analysis of global research on toxoplasmosis in the Web of Science.*Vet World*. 2018; **11** (10): 1409-1415 PubMed Abstract | Publisher Full Text

5. Falagas ME, Michalopoulos AS, Bliziotis IA, Soteriades ES: A bibliometric analysis by geographic area of published research in several biomedical fields, 1995-2003.*CMAJ*. 2006; **175** (11): 1389-90 PubMed Abstract | Publisher Full Text

6. Ramos JM, González-Alcaide G, Bolaños-Pizarro M: Bibliometric analysis of leishmaniasis research in Medline (1945-2010).*Parasit Vectors*. 2013; **6**: 55 PubMed Abstract | Publisher Full Text

7. Huamaní C, Romaní F, González-Alcaide G, Mejia MO, Ramos JM, Espinoza M, Cabezas C: South American collaboration in scientific publications on leishmaniasis: bibliometric analysis in SCOPUS (2000-2011).*Rev Inst Med Trop Sao Paulo*. **56** (5): 381-90 PubMed Abstract

8. Ramos JM, Masía M, Padilla S, Gutiérrez F: A bibliometric overview of infectious diseases research in European countries (2002-2007).*Eur J Clin Microbiol Infect Dis*. 2009; **28** (6): 713-6 PubMed Abstract | Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Clinical and epídemiological research in Vector Borne Disease

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 07 Jul 2019

Alfonso Rodriguez-Morales, Universidad Franz Tamayo/UNIFRANZ, Cochabamba, Bolivia

Dear Dr. Vilcarromero

Thanks for your valuable comments. Regards them, we would like to comment and discuss, in the context of the submission a new revised version (version 2).

In the manuscript entitled "Research on Babesia: A bibliometric assessment of a neglected tick-borne parasite" the authors try to evaluate the previous bibliometric

research regarding babesiosis in the world. It has recognized the value of this type of study because it helps to identify the importance of a country, institution or researcher in solving problems based on scientific evidence. Most of them describe bibliometrics in their papers considering bibliometric variables such as number of citations, author participation in research production, author and co-authorship analysis with VOSviewer1, the H-index, geographical distribution of that disease by countries, the amount and intensity of their international collaboration, analysis of that research based on the frequency of the words used in the title of the articles2, number of publications with intra-country collaboration, number of publications with inter-country collaboration3,4 etc, and usually, the literature was retrieved using only one database (Scopus, Medline, etc) which may give the advantage to let them analyze this in depth.

We performed a bibliometric study; we did not evaluate previous bibliometric research. As until the present date, there are no records of previous published bibliometric study in this subject. Regarding the "method", there is still no consensus on reporting or performing bibliometric studies. Some studies analyze only one database, but this would lead to certain bias, as e.g. WoS have a limited geographical coverage, compared to Scopus. Or Medline is limited in number of journals of certain biomedical areas. The advantage of having different databases is to have a wider coverage and avoid geographical bias, as we intended to do. Secondly, we have published a Research Note (a brief article), not an Original Article. Then extension is quite different. In reference to variables, we used the most common ones utilized in bibliometric studies.

However, when the number of publications is normalized by population[1], by gross domestic product, and by gross national income per capita[5], health expenditure[6], scientific collaboration[7] or other important variable (epidemiology variables such as prevalence, incidence[8], endemic versus non-endemic, etc) it makes more relevant the study. On the other hand, it is known the capacity of databases such Scopus, Medline, Web of Science and Scielo, and the authors may decide to use only one giving more details to the analysis.

Although the proposed relationships would be very relevant, this is a research note for a descriptive bibliometric study. Such analysis would result in an extended analytical bibliometric study for a Full-Length Original Article. Even more, some of the suggested variables are not standardized for many countries nor available for the whole period of years and even more publicly available. For example, as we clearly stated, babesiosis is not under surveillance in most countries. Then, this makes highly unlikely to have epidemiological indicators to make such correlations. However, we included in the Table 1 an adjustment per capita of the number of publications per million population of the countries. In the case of USA, where data from 2011 to 2015 was available, we analyzed and compared the number of reported cases in that period with the number of publications at Scopus, WoS and PubMed during the same time. That data from USA, was published this year (May 2019), and was now cited by us, but not previously available, when we performed the bibliometric study. For more years, and other countries, this is not possible. In addition, we have access to data from Wisconsin, USA, which was included and analyzed (Figure 12).

In this case, considering that Babesiosis is a neglected disease, of importance in several countries as it has been described in the manuscript, so this topic deserve still more research, so I consider that this bibliometric analysis would be important for the scientific community. However, it would also be important to normalize the number of publications

(including some of those variables mentioned above), include other bibliometric variables such as H-index.

We are grateful to the reviewer in the appreciation that the bibliometric analysis is of relevance for the scientific community. In reference of the mentioned variables, the H index is already included in the manuscript (third paragraph of the results description).

Competing Interests: None.

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