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A review analysis of global Bluetongue virus-related research articles from 2000 to 2020

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Abstract

Bluetongue virus (BTV) is an arbovirus, causes bluetongue (BT) disease of ruminants responsible for mortality and trade limitation. The objective of this study was to provide a descriptive review analysis of global research activity for the period 2000 to 2020. The number of articles, temporal evolution, geographical distribution, countries, funding agencies, authors, research theme, and the source was analysed and presented in visualization maps. Search query resulted in 3878 documents from 5681 authors, and 2017 articles were analysed. The annual number of publications showed a steep increase from 2005 to 2020 related to attention to BT as an exotic disease in Europe, as well as the interest in vector over-distribution due to climate change. Most of the studies were performed in Europe, followed by Asia and North America. The top active countries in article production were the United Kingdom and the United States. A considerable international collaboration network of the UK with the USA and European countries was observed. However, the collaboration was weak with Asian and African countries. The major research themes are genomic viral studies, the role of *Culicoides* as a vector, serological and molecular epidemiology, and vaccination. In conclusion, an increase in scientific production and international collaboration was noticed during the last two decades. However, international collaboration needs more attention to African, and South American countries. The current study provides useful references for the policymaker, academics, animal health professionals, and funding agencies to follow the past and except the future BTV themes.

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Introduction

Bluetongue (BT) is an infectious, non-contagious disease of ruminants (1). BT causes a great economic loss as a result of reducing international trade, high morbidity, mortality rates, abortion, stillbirth, and neonatal death (2-4). The World Organization for Animal Health (OIE) listed BT as multiple species, notifiable disease (5).

Besides, the Food and Agriculture Organization (FAO) established a special program known as the Emergency Prevention System (EMPRES) to control transboundary animal disease including BT (6). BT is caused by the *bluetongue* virus (BTV), a double-stranded RNA (dsRNA) of the *Orbivirus* genus within the Reoviridea family (7). Currently, BTV has been listed in 28 different serotypes distributed around the world based on the genomic sequence (8).

The arbovirus is an (arthropod-borne virus) is transmitted by an insect vector known as *Culicoides* biting midges (9) as well as transplacental transmission resulting in severe congenital malformations (10).

The disease is reported worldwide, commonly located in developing country particularly Asia, the Middle East, and Africa (1,11,12); where resources for scientific research and control measures and are inadequate. The global review analysis describes the trend of scientific activities, research outputs, publications, and analyzes professional collaboration (13). Currently, it is widely used as a powerful tool to measure the flow of publication among countries, research institutes, authors, disciplines, and other groups to assess the global strategic alliance and the coordination of research productivity. Analysis of various animal viruses has been published (14,15).

Very few global reviews of studies have been published related to BTV research activity, therefore, the current study was designated to provide a descriptive assessment of the global scientific articles on BTV. A better understanding of the state of research on BT is required to assist efforts when initiating a project, find collaborations, and financial sponsors.

Materials and methods

Data source

In the current study, data retrieved on January 1, 2021, from the Scopus database. Scopus affords basic and advanced search options. Its content covers more than 75 million records, >23,000 golden impact journals worldwide including Open Access journals (16).

All documents published in Scopus have an English title and abstract; allow publication searching without a language restriction. Besides, Scopus is allowing retrieve documents from other database sources e.g. Pubmed (17).

Inclusion and exclusion criteria

The study question was set as 'What is the global distribution of published scientific articles related to the Bluetongue virus?'. The search query was adopted after reviewing scientific publications to set of relevant keywords to be used in the search (18,19).

In this study, the search strategy was based on a search joined by the Boolean operator "OR" to retrieve documents on BTV: "*Bluetongue* virus" OR "Bluetongue disease". The resulting of all articles were manually reviewed. Publications indexed either as review, conference, editorial, theses, posters, or errata were removed. EndNote program was used to check for article duplication (20).

The retrieved publications were closely looking at the temporal evolution of publication, geographical location, countries, international research collaboration, funding agencies, institutions, authors, research theme, and journal source. VOSviewer program was used to construct the visualization maps and assess the international research collaboration between countries, the author's collaboration, and research theme (21).

Results

The search query implemented in the Scopus database retrieved 3878 research documents from 5681 authors. The majority of the retrieved articles (n = 3302; 85.14 %) were research articles. Review articles (n = 294; 7.58%), conference papers (n = 41; 1.06%), notes (n = 58, 1.49%), letter (n = 76, 1.96%), book chapter (n = 41, 1.06%), editorial (n = 31, 0.79%), short survey (n = 14, 0.36%) and book (n = 3, 0.08%) were removed. Additionally, erratum (n = 18, 0.46%) was excluded. Articles were limited to the published period 2000-2020 (n = 2017).

Temporal evolution

The temporal analyses of the 2017 documents, originated from different sources published between 2000 and 2020 (20 years) are shown in Figure 1. The annual scientific production has been increasing since 2003, with marked growth since 2005, reaching a peak between 2010 and 2014 (Figure 1).

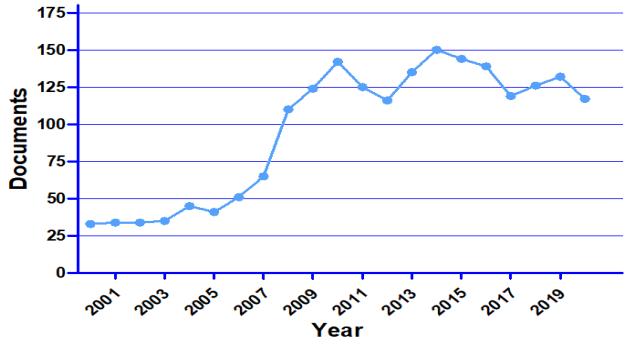

Figure 1: The number of publications on BTV by year from 2000 to 2020.

Geographical distribution

Most of the articles were performed in Europe (n = 1719), followed by Asia (n = 495), North America (n = 370), Africa (n = 255), South America (n = 78), Oceania (n = 63), and 54 articles not identify the study location.There is an overlapping of articles between geographical location and countries. The top ten active countries on the BTV article production were listed in table 1.

International research collaboration

Countries with a minimum co-author contribution of 30 documents were visualized to assess international research collaboration among active countries (Figure 2). Link strength is represented by the thickness of the line between the counties. Three clusters with 18 countries appeared on the map. The first cluster (green) is composed of UK, USA, Canada, China, Australia, Brazil, and India. The UK has 368 total link strength, collaborated with all countries on the map, and with 435 articles; 60 with France and 58 with

the USA. The USA in second place with collaborated with 15 countries and 328 articles. Brazil has the lowest international collaboration among these countries with 7 connections, 36 articles, and total link strength of 10. The second cluster (red) includes France, Spain, Belgium, Poland, Sweden, Germany, Italy, Turkey, and Switzerland. France is the leading country in this cluster with a collaboration with 15 countries, 294 total link strengths, and 276 articles. Most of the French collaboration was with UK, Belgium, and Germany (total link strength = 60, 48, and 30 respectively). This last cluster (blue) includes South Africa and The Netherlands (13 and 12 international collaborations respectively). Most of the international collaboration of South Africa was with the UK and Netherlands (total link strength = 37 and 30 respectively). The link strength was higher than 30 for most countries indicative of adequate international research collaboration (Figure 2).

Table 1: List of top ten active countries in BTV article publication from 2000 to 2020

Country	No. of articles
United Kingdom	437
United States	329
France	277
India	199
Italy	172
Spain	160
Germany	144
South Africa	132
Netherlands	123
Belgium	114

Funding agencies

Of all retrieved publications, 159 funding agencies were found, supported 873 articles (20.03%). Table 2 shows the top ten agencies and the article's numbers. United Kingdom is the leading country that supports BTV research, with three out of the top ten funding agencies. This is also clear with the number of research articles and international collaboration (Figure 2). Asian countries also contributed through the Indian Council of Agricultural Research India and the National Natural Science Foundation of China. Two funding agencies from the USA: National Institutes of Health and the U.S. Department of Agriculture. No African and South American funding agency appears in the top 10 list (Table 2).

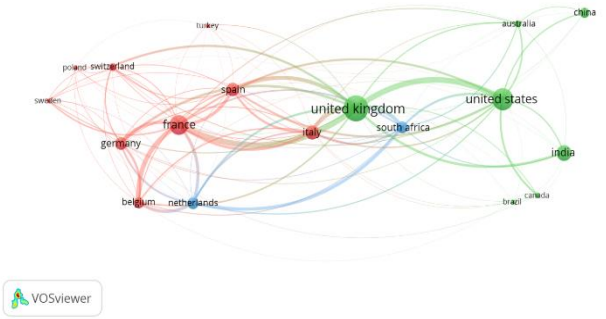

Figure 2: Network visualization map of international co-authorship research among countries with minimum research output of 30 documents on Bluetongue virus. The thickness of the connecting lines represents the strength of research collaboration between any two countries. The connecting line between the USA and the UK represents the strongest research collaboration due to its thickness relative to other lines.

Authors

In this study, 5681 authors' contributions to the 2017 articles were analyzed. The top ten active authors are shown in table 3. The first nine are from the European region and the last one from India. The leading author is Zientara, S. from the ``Agence Française de Sécurité Sanitaire des Aliments- France was the leading author with 95 articles, 17 links, and total link strength of 248.

Table 2: Top ten funding agencies in BTV articles from 2000 to 2020

Funding agencies	Country	No. of Articles
Biotechnology and Biological Sciences Research Council	UK	118
Seventh Framework Programme	EU	61
European Commission	EU	54
Indian Council of Agricultural Research	India	36
Dept for Environment, Food and Rural Affairs, UK Government	UK	28
National Institutes of Health	USA	28
National Natural Science Foundation of China	China	24
Wellcome Trust	UK	24
U.S. Department of Agriculture	USA	22
European Food Safety Authority	EU	11

Table 3: Top ten authors in BTV article research from 2000 to 2020

Author	Institute	Country	
Zientara S	AgenceFrançaise de Sécurité Sanitaire des Aliments	France	96
Roy P	Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine,	UK	78
Sailleau C	AgenceFrançaise de Sécurité Sanitaire des Aliments	France	69
Savini G	IstitutoZooprofilatticoSperimentaledell'Abruzzo e Molise "G. Caporale".	Italy	65
Mertens PC	School of Veterinary Medicine and Science, University of Nottingham.	UK	60
Mellor PS	The Pirbright Institute, Pirbright,	UK	59
Carpenter S	The Pirbright Institute, Pirbright,	UK	55
Bréard E	Laboratoire de Santé Animaled'Alfort, ANSES, ENVA, INRA, UMR 1161 VIROLOGIE, Université Paris Est	France	47
Viarouge C	Laboratoire de Santé Animaled'Alfort, ANSES, ENVA, INRA, UMR 1161 VIROLOGIE, Université Paris Est	France	46
Maan S	College of Veterinary Sciences, LLR University of Veterinary and Animal Sciences.	India	45

The co-authorship between authors with a minimum of 30 articles is shown in Figure 3. Five clusters of authors with 119 links reflect the good collaborations between the participants in this field (Figure 3). The strength of collaborative work with authors in different institutes in the same countries frequently co-occurred together as shown from clusters in Figure 3. However, collaborative work with researchers, from different countries also is clear.

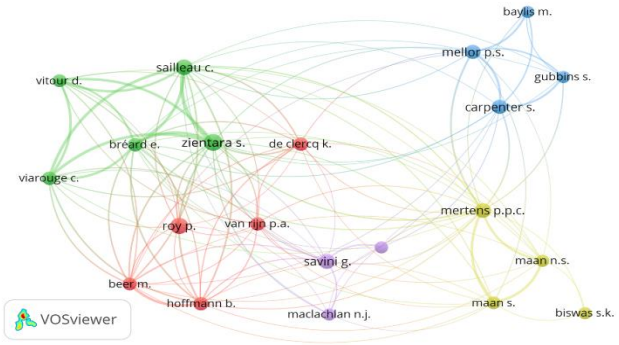

Figure 3: Network visualization map of co-authorship research among authors with minimum research output of 30 documents on *Bluetongue* virus. The thickness of the connecting lines represents the strength of research collaboration between authors.

Research themes

Figure 4 shows the network visualization map of the most frequent 20 keywords with more than 30 times occurrence in articles of the retrieved literature on BTV during the study period from 2000 to 2020. The four clusters represent the major research themes in the retrieved literature. The most linked term is ``bluetongue`` (red) represented research on the basic viral studies, with 19 links and 382 total link strength (articles number = 430). Cluster1 includes 6 keywords: African Horse Sickness (AHS), *blue*tongue, surveillance, *Culicoides*, and vector. This cluster concerns the role of Culicoides as the vector for transmission and risk factors of BT and the related disease in the horse. Cluster 2 (green), with 17 links and 151 total link strength (n = 103) includes 6 keywords: cattle, sheep, goat, seroprevalence, vaccine, and vaccination represent articles on serological epidemiological assessments of the disease and hosts response to vaccination. The third cluster (blue) shares 19 links, 312 total link strength (n = 437) includes 4 keywords: *bluetongue* virus, enzyme-linked immunosorbent assay (ELISA), Reverse transcription-polymerase chain reaction (RT-PCR), and epidemiology. These words are connected to serological and molecular epidemiology identification and differentiation of BTV serotypes. The last cluster (yellow) with 15 links, total link strength 73 (n = 61) includes 4 keywords: Orbivirus (the genus of BTV), arbovirus, BTV, and vector. The words match the concern of the research on the evolutionary dynamics and characterization of BTV in the vector (Figure 4).

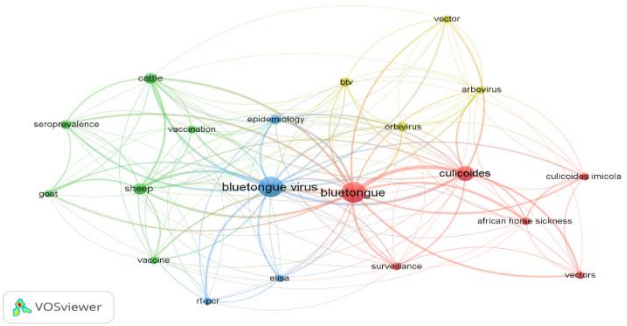

Figure 4: Network visualization map of most frequent 20 keywords with more than 30 times occurrence in articles of the retrieved literature on BTV from 2000 to 2020. The four clusters represent the major research themes in the retrieved literature.

Journal source

The top ten journals are listed in table 4. The top ten sources are located in Europe (Netherlands and UK) and the USA. The top five journals in the field of BTV publishing are: Veterinary Microbiology (n = 91), Veterinary Record (n = 90), PLOS ONE (n = 87), Transboundary And Emerging Diseases (n = 81) and Medical And Veterinary Entomology (n = 65).

Table 4: Top ten journal sources in BTV article research from 2000 to 2020

Article Source	No	Country
Veterinary Microbiology	91	Netherlands
Veterinary Record	90	UK
PLOS ONE	87	USA
Transboundary Emerging Diseases	81	UK
Medical Veterinary Entomology	65	UK
Journal Of Virology	64	USA
Preventive Veterinary Medicine	64	Netherlands
Journal Of Virological Methods	61	Netherlands
Parasites And Vectors	56	UK
Vaccine	55	Netherlands

The temporal trend of publication of these journals over the study period is presented in figure 5. . Journal of Veterinary Microbiology shows a predominance until 2011, then, PLOS ONE appeared as the major publisher. This could be explained by the current focus of Veterinary Microbiology on the basic, genomics, and virological research topics, while PLOS ONE has a broader coverage of animal health topics. Starting from 2015, the increase of applied animal BTV epidemiology, diagnostics, genomics, vaccine development, and reporting of new outbreaks; cause directed the publication toward high interest to journals with these topics, mainly Journal Transboundary And Emerging Diseases and Journal of Veterinary Records to increase (Figure 5). The number of articles in other journals decreased dramatically.

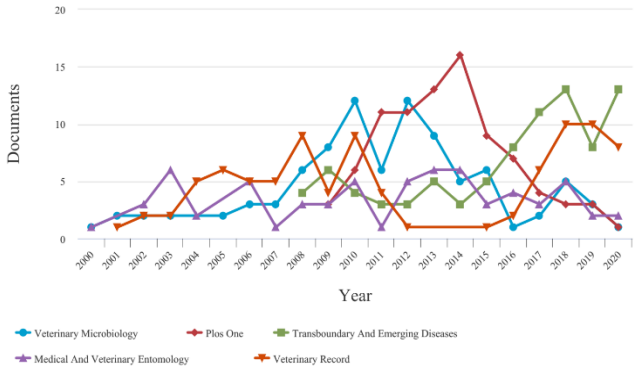

Figure 5: Temporal trend of BTV article sources by year from 2000 to 2020.

Discussion

The present study provides a global review analysis of scientific articles related to the *Bluetongue* virus in the last two decades. The research has aroused during this period as BT emerged as an exotic disease for most countries (22), (23). Climate change and increase vector distribution pay attention to the BTV as arboviruses (24). In 2006, BTV serotype 8 (BTV-8) emerged unexpectedly in the North of Europe, affecting Belgium, France, Germany, Luxembourg, and the Netherland, encourage the vaccine development industry and scientific research efforts (25). The large majority of Research and Development (R&D) spending and foreign direct investment (FDI) takes place in the three major economic regions of the world, North America, the EU, and Asia place in the three major economic regions of the world, North America, the EU, and Asia (26). European countries came out with high productivity in BTV articles, indicating the abundance of BTV serotypes, vector, and virus re-assortment in domesticated and wildlife populations (27). Besides, the role of industry supporting vaccine production and R&D expenditure is strongly funded by governmental and non-governmental organizations in these countries. The findings of the current study indicated the presence of good collaboration networks, with a marked number of collaborations of the UK with the USA and European countries. With exception of South Africa, the collaboration of leading countries (UK, USA, and France) is weak with Asian and African countries, even though BTV is spreading so quickly, can re-assortment and emerge of novel serotypes, which has the potential to cause great economic damage in livestock worldwide (28). For this, more connections should be made between developing (particularly in Asia and Africa) and developed countries.The considering of BT disease by the OIE and FAO and as potentially devastating, growing, and potentially economically important disease of livestock worldwide (29), funding agencies should be contributed to greater support in the future to enhance healthcare and reducing extreme poverty globally, especially for poor countries.

The global aspect of BTV and funded projects enhance the partners in disseminating and sharing knowledge in practice. For example, BTV-GLUE is a collaboration between the MRC-University of Glasgow Centre for Virus Research, the University of Nottingham, the Pirbright Institute, and the PALE-Blu (Pathogen Livestock Environment interaction involving bluetongue) project (30). Another example is the research project co-funded by the Biotechnology and Biological Sciences Research Council (BBSRC) (a part of UK Research and Innovation) and the Department for International Development (DFID) is supporting a collaboration between UK and Indian researchers investigating *bluetongue* virus in India (31). Despite the wide distribution of BT and the vector in

Africa; no funding agency, author, institute, were appearing in the top 10 list. The international collaboration should be improved toward the developing countries in Africa and South America.

Authors tend to publish in journals with scope to veterinary disease reporting rather than basic science journals, presenting an increased interest of the scientific community with BTV epidemiology, vector, and serotyping topics. Also, a cumulative increase in virus-vector interactions related publications was noticed, being more aware of the role of important climate change in vector overgrowth and distribution. Furthermore, RT-PCR, ELISA, and vaccine methods were more current diagnosis tools.

Conclusion

This study demonstrates the importance of global review analysis of BTV research trends, providing a helpful reference for the policymaker, R&D at the industrial company, animals health professional, one health system, and funding agencies to follow the past and expect the future BTV themes. During the last two decades, progress in trends of BTV publication has occurred. Increase the awareness of the role of climate change and vector overgrowth and distribution is important in BT control. Furthermore, the international collaboration between developed and developing countries, sharing the resources, transferring ideas, and ensuring satisfying financial support from countries and foundations are required to successfully struggle against BTV.

Funding

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Conflict of Interest

The author declares that this study was performed without any financial support could perceive a conflict of interest.

References

1. Maclachlan NJ. Bluetongue: History, global epidemiology, and pathogenesis. Prev Vet Med. 2011;102:107-111. DOI: 10.1016/j.prevetmed.2011.04.005
2. Rushton J, Lyons N. Economic impact of Bluetongue: A review of the effects on production. Vet Ital. 2015;51:401-406. DOI: 10.12834/VetIt.646.3183.1
3. Rojas JM, Rodriguez-Martin D, Martin V, Sevilla N. Diagnosing bluetongue virus in domestic ruminants: Current perspectives. Vet Med. 2019;10:17-27. DOI: 10.2147/VMRR.S163804
4. Saegerman C, Bolkaerts B, Baricalla C, Raes M, Wiggers L, de Leeuw I, Vandenbussche F, Zimmer JY, Haubruge E, Cassart D, De Clercq K, Kirschvink N. The impact of naturally-occurring, trans-placental bluetongue virus serotype-8 infection on reproductive performance in sheep. Vet J. 2011;187:72-80. DOI: 10.1016/j.tvjl.2009.11.012
5. OIE. OIE-Listed diseases, infections and infestations in force in 2016. Vienna: World Organization of Animal Health; 2016.
6. Cheneau Y, Roeder PL, Obi TU, Rweyemamu MM, Benkirane A, Wojciechowski KJ. Disease prevention and preparedness: The food and agriculture organization emergency prevention system. Rev Sci Tech. 1999;18:122-134. DOI: 10.20506/rst.18.1.1153
7. Roy P. Functional mapping of bluetongue virus proteins and their interactions with host proteins during virus replication. Cell Biochem Bioph. 2008;50:143-157. DOI: 10.1007/s12013-008-9009-4
8. Bumbarov V, Golender N, Jenckel M, Wernike K, Beer M, Khinich E, Zalesky O, Erster O. Characterization of bluetongue virus serotype 28. Transbound Emerg Dis. 2020;67:171-182. DOI: 10.1111/tbed.13338
9. Sperlova A, Zendulkova D. Bluetongue: A review. Vet Med. 2009;54:430-452. [available at]
10. van der Sluijs MT, de Smit AJ, Moormann RJ. Vector independent transmission of the vector-borne bluetongue virus. Crit Rev Microbiol. 2016;42:57-64. DOI: 10.3109/1040841X.2013.879850
11. Mahmoud MA, Ghazy AA, Shaapan RM. Review of diagnostic procedures and control of some viral diseases causing abortion and infertility in small ruminants in Egypt. Iraqi J Vet Sci. 2021;35(3):513-521. DOI: 10.33899/ijvs.2020.127114.1461
12. Taylor WP, Sellers RF, Gumm ID, Herniman KA, Owen L. Bluetongue epidemiology in the Middle East. Prog Clin Biol Res. 1985;178:527-530. [available at]
13. Aria M, Cuccurullo C. A brief introduction to bibliometrix. J Informet. 2017;11:959-975. DOI: 10.1016/j.joi.2017.08.007
14. Chen L, Dou Y, Cai X. A bibliometric analysis of Peste Des Petits ruminants. J Anim Vet Adv. 2012;11:4389-4393. DOI: 10.3923/javaa.2012.4389.4393
15. Ducrot C, Gautret M, Pineau T, Jestin A. Scientific literature on infectious diseases affecting livestock animals, longitudinal worldwide bibliometric analysis. Vet Res. 2016;47:42. DOI: 10.1186/s13567-015-0280-2
16. Burnham JF. Scopus database: A review. Biomed Digit Libr. 2006;3:1. DOI: 10.1186/1742-5581-3-1
17. Falagas ME, Pitsouni EI, Malietzis GA, Pappas G. Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and weaknesses. FASEB J. 2008;22:338-342. DOI: 10.1096/fj.07-9492LSF
18. Walton TE. The history of bluetongue and a current global overview. Vet Ital. 2004;40:31-38. [available at]
19. Rathinasabapathy G. Bluetongue research: A scientometric Profile Based on CAB Direct Online. Asian J Lib Informat Sci. 2015;5:47-54. [available at]
20. Bramer WM, Giustini D, de Jonge GB, Holland L, Bekhuis T. De-duplication of database search results for systematic reviews in EndNote. J Med Libr Assoc. 2016;104:240-243. DOI: 10.3163/1536-5050.104.3.014
21. van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientomet. 2010;84:523-538. DOI: 10.1007/s11192-009-0146-3
22. Alkhamis MA, Aguilar-Vega C, Fountain-Jones NM, Lin K, Perez AM, Sanchez-Vizcaino JM. Global emergence and evolutionary dynamics of bluetongue virus. Sci Rep. 2020;10:21677. DOI: 10.1038/s41598-020-78673-9
23. Mellor PS, Carpenter S, Harrup L, Baylis M, Mertens PP. Bluetongue in Europe and the Mediterranean Basin: History of occurrence prior to 2006. Prev Vet Med. 2008;87:4-20. DOI: 10.1016/j.prevetmed.2008.06.002
24. Purse BV, Mellor PS, Rogers DJ, Samuel AR, Mertens PP, Baylis M. Climate change and the recent emergence of bluetongue in Europe. Nat Rev Microbiol. 2005;3:171-181. DOI: 10.1038/nrmicro1090
25. Toussaint JF, Vandenbussche F, Mast J, De Meester L, Goris N, Van Dessel W, Vanopdenbosche E, Kerkhofs P, De Clercq K, Zientara S, Sailleau C, Czaplicki G, Depoorter G, Dochy JM. Bluetongue in northern Europe. Vet Rec. 2006;159:327. DOI: 10.1136/vr.159.10.327-a

مراجعة تحليل المقالات البحثية العالمية المتعلقة بفيروس اللسان الأزرق للفترة من ٢٠٠٠ إلى ٢٠٢٠

إبراهيم محمود الزهير

فرع الطب البيطري، كلية الزراعة والطب البيطري، جامعة النجاح الوطنية، نابلس، فلسطين

الخلاصة

ينتقل فيروس اللسان الأزرق للمجترات عن طريق المفصليات يؤدي للنفوق ولخسائر اقتصادية. تهدف هذه الدراسة لتقديم مراجعة تحليلية وصفية للنشاط العالمي المتعلق بأبحاث مرض وفيروس اللسان الأزرق للفترة من ٢٠٠٠ إلى ٢٠٢٠. تم تحليل عدد المقالات والتطور الزمني والتوزيع الجغرافي والدول ووكالات التمويل والمؤلفين وموضوع البحث والمصدر وعرضها في خرائط للتوضيح. كانت نتائج البحث استخلاص ٣٨٧٨ ورقة علمية من ٥٦٨١ مؤلفًا، وتم تحليل ٢٠١٧ مقالة بحثية. أظهر العدد السنوي للمنشورات زيادة حادة من ٢٠٠٥ إلى ٢٠٢٠ فيما يتعلق بالاهتمام باللسان الأزرق كمرض دخيل في أوروبا، بالإضافة إلى الاهتمام بزيادة الانتشار للمفصليات كناقل للمرض بسبب تغير المناخ. أجريت معظم الدراسات في أوروبا، تليها آسيا وأمريكا الشمالية. كانت الدولتان الأكثر نشاطًا في إنتاج المقالات هي المملكة المتحدة والولايات المتحدة. لوحظ وجود شبكة تعاون دولية كبيرة للمملكة المتحدة مع الولايات المتحدة الأمريكية والدول الأوروبية. ومع ذلك، كان التعاون ضعيفًا مع الدول الآسيوية والأفريقية. موضوعات البحث الرئيسية هي الدراسات الفيروسية الجينومية، ودور البعوض كناقل، وعلم الأوبئة المصلية والجزيئية، والتلقيح. في الختام، لوحظت زيادة في الإنتاج العلمي والتعاون الدولي خلال العقدين الماضيين. ومع ذلك، يحتاج التعاون الدولي إلى مزيد من الاهتمام بالدول الأفريقية وأمريكا الجنوبية. توفر الدراسة الحالية مراجع مفيدة لصانعي السياسات والأكاديميين ومهني صحة الحيوان ووكالات التمويل لمتابعة البحث العلمي في الماضي ومواكبة الموضوعات المتعلقة باللسان الأزرق في المستقبل.

26. Huggins R, Demirbag M, Ratcheva VI. Global knowledge and R&D foreign direct investment flows: Recent patterns in Asia Pacific, Europe, and North America. Inter Rev Appl Econom. 2007;21:437-451. DOI: 10.1080/02692170701390437
27. Mayo C, McDermott E, Kopanke J, Stenglein M, Lee J, Mathiason C, Carpenter M, Reed K, Perkins TA. Ecological dynamics impacting bluetongue virus transmission in North America. Front Vet Sci. 2020;7:186. DOI: 10.3389/fvets.2020.00186
28. Maclachlan NJ, Mayo CE. Potential strategies for control of bluetongue, a globally emerging, Culicoides-transmitted viral disease of ruminant livestock and wildlife. Antiviral Res. 2013;99:79-90. DOI: 10.1016/j.antiviral.2013.04.021
29. MacLachlan NJ, Osburn BI. Impact of bluetongue virus infection on the international movement and trade of ruminants. J Am Vet Med Assoc. 2006;228:1346-1349. DOI: 10.2460/javma.228.9.1346
30. Singer JB, Nomikou K, Hughes J, Mertens P, Gifford R, Palmarini M. BTV-GLUE: A new bioinformatic resource for genomic studies of Bluetongue virus. Access Microbiol. 2019;1:648. DOI: 10.1099/acmi.ac2019.po0399
31. Rao P, Krishnajyoth Y, Reddy V, Susmitha B, Reddy H, Sreenivasulu D, Hegde N, Reddy N. A decade of research on Bluetongue virus in Andhra Pradesh, a Southern state of India. Vet Ital. 2016;52:299-304. DOI: 10.12834/VetIt.563.2691.4