

A Bibliometric Study of Research Output on White-Nose Syndrome

Sonia Bansal

Assistant Librarian, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India
E-mail: soniapta@gmail.com

Abstract - This study presents bibliometric analysis of research publications on white-nose syndrome. A total of 171 articles published during 2007-2016 were retrieved from PubMed database by inputting the keyword white-nose syndrome. Results of the study indicated a high degree of authorship collaboration on WNS. PLoS ONE journal has published maximum number of articles (33) on white-nose syndrome. Blehert from National Wildlife Health Center, USA is the most prolific author on the subject with 25 publications.

Keywords: Bibliometric, White-Nose Syndrome, Bats

I. INTRODUCTION

White-nose syndrome (WNS) is an epizootic disease that was first documented in a photograph taken in 2006 at Howes caves, west of Albany, New York^{1,2}. It has caused precipitous decline in hibernating North American bats since its emergence³. WNS is caused by recently discovered fungus *Pseudogymnoascus destructans* (previously known as *Geomyces destructans*) that thrives in cold and humid conditions and grows optimally at temperatures between 4 and 15 °C (39.2 and 59 °F) with humidity levels of 90 percent or higher, approximately the same temperature and humidity range as that found in bat hibernacula^{4,5,6}. *P. destructans*, the causative fungal agent of WNS in bats is native to Europe but its presence in Asia has not been documented^{7,8,9}. WNS can be transmitted from infected bats to healthy bats through direct contact⁷. Once this infection gains a foothold in a bat colony, the mortality rate can reach 99 percent¹⁰.

The disease is named for striking white fungal growth on muzzles, ears, and/or wing membranes of affected bats². The symptoms of this disease include cutaneous fungal infection, depleted fat reserves abnormal behavior, increased frequency of arousal from torpor during hibernation in affected bats^{2, 11,12}. This deadly disease affects nongame species and poses no known direct threats to humans, pets or other animals¹³. The species affected by WNS include, endangered gray and Indiana bats (*Myotis grisescens* and *M. sodalis*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*M. septentrionalis*), tricolored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*) and eastern small-footed bat (*M. leibii*)^{13,14}. The little brown myotis (*Myotis lucifugus*), a once widespread and common bat species in North America may become regionally extinct due to this deadly disease¹⁵. A National Plan for Assisting States, Federal Agencies, and Tribes in Managing White-Nose Syndrome in Bats was released by United States Fish and Wildlife Service (USFWS) in May 2011 which details the elements that are

critical to the investigation and management of WNS, identifies key action items to address stated goals, and outlines the role(s) of agencies and entities involved in this continental effort¹⁶.

II. OBJECTIVES

The following are the objectives of the study:

1. To study year-wise publications on white-nose syndrome.
2. To ascertain authorship pattern.
3. To find out country-wise contribution of journals.
4. To find out most prolific authors and journals on the subject.

III. METHODOLOGY

PubMed, a free search engine accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics, maintained by United States National Library of Medicine (NLM) at the National Institutes of Health was accessed to retrieve bibliographical information of research publications on white-nose syndrome¹⁷. The data of research publication for 10 years from 2007-2016 were downloaded from PubMed by inputting the keyword white-nose syndrome. A total of 171 articles were retrieved for 10 years on WNS.

IV. RESULTS AND DISCUSSION

A. Year-wise Publications on White-Nose Syndrome

TABLE I YEAR-WISE PUBLICATIONS

Year	No. of Papers	Percentage
2009	3	1.76
2010	11	6.43
2011	19	11.11
2012	19	11.11
2013	20	11.69
2014	26	15.21
2015	40	23.39
2016	33	19.30
Total	171	100.00

The above table reveals that a total of 171 articles were published on white-nose syndrome from 2007-2016. During 2009-2012, 52 (30.41%) articles were published on this

deadly diseases and remaining 119 (69.59%) were published from 2013-2016. In the year 2015, 40 (23.39%) articles were published on WNS followed by 33 (19.30%) in 2016, 26 (15.21%) in 2014, 20 (11.69%) in 2013, 19 (11.11%) in 2011 and 2012, 11 (6.43%) in 2010 and 3 (1.76%) articles in 2009. No article was published on white-nose syndrome in 2007 and 2008.

B. Authorship Pattern

TABLE II AUTHORSHIP PATTERN

Year	Authorship Pattern					
	Single Author	Two Authors	Three Authors	Four Authors	Five Authors	More than Five Authors
2009	-	-	-	-	1	2
2010	-	-	1	3	1	6
2011	1	3	-	4	1	10
2012	2	4	1	5	1	9
2013	1	6	-	3	2	8
2014	1	2	3	2	3	13
2015	2	5	8	3	4	18
2016	-	2	6	4	3	17
Total	7	22	19	24	16	83
%age	4.09	12.86	11.11	14.04	9.36	48.54

The below table depicts that out of 171 articles, 83 (48.54%) were contributed by more than five authors. About 24 (14.04%) articles had been published by four authors, followed by 22 (12.86%) publications by two authors. Around 19 (11.11%) articles were written by three authors and 16 (9.36%) by five authors. Only 7 (4.09%) articles had been contributed by single authors.

TABLE III DEGREE OF COLLABORATION

Year	No. of Papers	Nm	Ns	C=Nm/Nm+Ns
2009	3	3	0	1
2010	11	11	0	1
2011	19	18	1	0.95
2012	19	17	2	0.89
2013	20	19	1	0.95
2014	26	25	1	0.96
2015	40	38	2	0.95
2016	33	33	0	1
Total	171	164	7	0.959

The formula given by Subramanyam¹⁸ is used to calculate degree of authorship collaboration

$$C = \frac{Nm}{Nm + Ns} = \frac{164}{164 + 7} = \frac{164}{171} = 0.959$$

C = degree of collaboration

Nm = number of multiple authored research papers and

Ns = number of single authored research papers

The degree of collaboration in white-nose syndrome is 0.959 which indicates a high degree of authorship collaboration on the subject.

C. Country-wise Contribution of Journals

The above table depicts that 171 articles on white-nose syndrome were published in 75 journals from 5 countries. It

is clear from the table that the United States has contributed highest number of journals (39) followed by United Kingdom with 17 journals. Netherland has contributed 12 journals. Switzerland and Germany have contributed 4 and 3 journals respectively.

TABLE IV COUNTRY-WISE CONTRIBUTION

Country	Number of Journals
United States	39
United Kingdom	17
Netherlands	12
Switzerland	4
Germany	3

D. Most Prolific Journals

All the 171 articles on white-nose syndrome were published in journals and of these 49.71% articles were published in top 5 journals listed in above table. The ‘PLoS ONE’ journal is on top of the list with maximum number of articles (33), followed by ‘Journal of Wildlife Diseases’ (14), ‘Emerging Infectious Diseases’ (7), ‘Ecology and Evolution’ (6), ‘EcoHealth’ (4), ‘Mycopathologia’ (4), ‘Journal of Veterinary Diagnostic Investigation’ (4), ‘Biology Letters’ (4), ‘Ecological Applications’ (4), ‘Proceedings of the National Academy of Science of the United States of America’ (4) and ‘Conservation Biology’ (4).

TABLE V MOST PROLIFIC JOURNALS

Journal Title	No. of articles	Rank
PLoS One	33 (19.30%)	1
Journal of Wildlife Diseases	14 (8.19%)	2
Emerging Infectious Diseases	7 (4.09%)	3
Ecology and Evolution	6 (3.51%)	4
EcoHealth	4 (2.34%)	5
Mycopathologia	4 (2.34%)	5
Journal of Veterinary Diagnostic Investigation	4 (2.34%)	5
Biology Letters	4 (2.34%)	5
Ecological Applications	4 (2.34%)	5
Proceedings of the National Academy of Science of the United States of America	4 (2.34%)	5
Conservation Biology	4 (2.34%)	5

E. Most Prolific Authors

TABLE VI MOST PROLIFIC AUTHORS

Name of Author	Affiliation
Blehert, D. S.	US Geological Survey, National Wildlife Health Center, Madison, Wisconsin, USA
Frick, W. F.	Boston University, Boston, USA
Meteyer, C. U.	US Geological Survey, National Wildlife Health Center, Madison, Wisconsin, USA
Foster, J. T.	University of New Hampshire, Durham, New Hampshire, USA
Kilpatrick, A. M.	University of California, California, USA
Reeder, D. M.	Bucknell University, Lewisburg, Pennsylvania USA
Kunz, T. H.	Boston University, Boston
Langwig, K. E.	University of California, Santa Cruz, California, USA
Willis, C. K. R.	University of Winnipeg, Canada
Bandouchova, H.	University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic
Chaturvedi, S	Mycology Laboratory, Wadsworth Center, New York State Department of Health, Albany, New York, USA
Chaturvedi, V	Mycology Laboratory, Wadsworth Center, New York State Department of Health, Albany, New York, USA
Pikula, J.	University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic
Turner, G. G.	Pennsylvania Game Commission, Harrisburg, USA
Wibbelt, G.	Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany
Hicks, A.C.	Endangered Species Unit, New York State Department of Environmental Conservation Broadway, Albany, New York, USA
Rudd, R. J.	New York State Department of Health, Albany, New York, United States of America
Hoyt, J. R	University of California, EE Biology/EMS, Santa Cruz, USA
Reynolds, H. T	University of Akron, Akron, Ohio, USA
Behr, M. J.	Wisconsin Veterinary Diagnostic Laboratory, Madison, Wisconsin, USA
Boyles, J. G.	University of Pretoria, South Africa
Gargas, A	Symbiology LLC, Middleton, Wisconsin, USA
Johnson, J. S.	Bucknell University, Lewisburg, Pennsylvania, USA
Turner, J. M	University of Winnipeg, Canada
Warnecke, L	University of Winnipeg, Canada
Verant, M. L.	University of Wisconsin-Madison, USA

The most prolific authors on white-nose syndrome are listed in Table 6. Blehert from National Wildlife Health Center, USA had contributed 25 article out of which 1 article was contributed by him as sole author and remaining 24 articles in collaboration. Frick from Boston University had contributed 17 articles in collaboration, followed by Meteyer from National Wildlife Health Center, USA (14 articles). Foster, Kilpatrick and Reeder have contributed 13 articles each in association and occupied 4th rank. 12 articles each in collaboration had been contributed by Kunz, Langwig and Willis. Out of 12 articles, Willis had contributed 1 paper as single author. Bandouchova, Chaturvedi, S, Chaturvedi, V, Pikula, Turner and Wibbelt had written 9 articles each on WNS. Wibbelt had written 1 article as single author and 8 in partnership. 8 articles each were published by Hicks and Rudd. 8th rank is occupied by Hoyt, Reynolds and Behr with 7 articles each. Boyles, Gargas, Johnson, Turner and Warnecke had published 6 articles each. Verant from University of Wisconsin-Madison is on 10th rank with 5 articles. Majority of the most prolific authors are from USA, followed by Canada, Czech Republic, Germany and South Africa.

V. CONCLUSION

From the findings of the study it is evident that WNS didn't get the attention of the scientific community immediately after its emergence. The research on this deadly disease increased from 2013. About 95% articles were published in collaboration on WNS which indicates a high degree of authorship collaboration on the subject. PLoS ONE journal has published maximum number of articles (33) on WNS. Blehert from National Wildlife Health Center, USA is the most prolific author on the subject. Efforts must be made to generate a toolkit of mitigation strategies and to educate public to avoid inadvertent spread of the fungus, minimize reactive and ineffective killing and avoid disturbance of hibernacula^{3,13}. To succeed in tackling this threat, the size of scientific community that is involved must increase significantly, with concomitant increase in funding³.

REFERENCES

- [1] Coleman, J.T.H., & Reichard, J.D. (2014). Bat white-nose syndrome in 2014: a brief assessment seven years after discovery of a virulent fungal pathogen in North America. *Outlooks on Pest Management*. 25, 374–77.
- [2] Blehert, D.S., Hicks, A.C., Behr, M., Meteyer, C.U., Berlowski-Zier, B.M., & Buckles, E.L. (2009). Bat white-nose syndrome : an emerging fungal pathogen. *Science*. 323, 227.
- [3] Turner, G.G., Reeder, D.M., & Coleman, J.T. H. (2011). A five-year assessment of mortality and geographic spread of white-nose syndrome in North American bats and a look to the future. *Bat Research News*. 52, 13–27.
- [4] Wiedemann, K. (2016). The White-Nose Syndrome and the rampant use of pesticides in North America: an environmental risk management challenge. Retrieved from <https://www.linkedin.com/pulse/pesticides-linked-white-nose-syndrome-environmental-kenia-wiedemann>
- [5] Minnis, A.M., & Lindner, D.L. (2013). Phylogenetic evaluation of *Geomyces* and allies reveals no close relatives of *Pseudogymnoascus destructans*, comb. nov., in bat hibernacula of Eastern North America. *Fungal Biology*. 117(9), 638-649.
- [6] Rogers, K., 'White-nose syndrome'. Retrieved from <https://www.britannica.com/science/white-nose-syndrome>
- [7] Lorch, J.M., Meteyer, C.U., Behr, M., Boyles, J.G., Cryan, P., Hicks, A.C., & et al. (2011). Experimental infection of bats with *Geomyces destructans* causes white-nose syndrome. *Nature*. 480, 376–78.
- [8] Puechmaile, S.J., Wibbelt, G., Korn, V., Fuller, H., Forget, F., & Muhlendorfer, K. (2011). Pan-European distribution of white-nose syndrome fungus (*Geomyces destructans*) not associated with mass mortality. PLoS ONE. Retrieved from <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0019167>
- [9] Hoyt, J.R., Sun, K., Parise, K.L., Lu, G., Langwig, K.E., Jiang, T., & et al. (2016). Widespread bat white-nose syndrome fungus, Northeastern China', *Emerging Infectious Diseases*, vol. 22, no.1, pp. 140-142
- [10] Peterson, J. (2016). White-nose syndrome comes to the West. Retrieved from <http://www.hcn.org/articles/white-nose-syndrome-comes-to-the-west>
- [11] Verant, M.L., Meteyer, C.U., Speakman, J.R., Cryan, P.M., Lorch, J.M., & Blehert, D.S. (2014). White-nose syndrome initiates a cascade of physiologic disturbances in the hibernating bat host. *BMC Physiology*. 14, 10.
- [12] Cryan, P.M., Meteyer, C.U., & Blehert, D.S. (2010). Wing pathology of white-nose syndrome in bats suggests life-threatening disruption of physiology. *BMC Biology*. 8, 135.
- [13] Foley, J., Clifford, D., Castle, K., Cryan, P., & Ostfeld, R. S. (2011). Investigating and managing the rapid emergence of white-nose syndrome, a novel fatal, infectious disease of hibernating bats. *Conservation Biology*. 25(2). 223–231.
- [14] White-nose syndrome: question and answers. Retrieved from https://www.biologicaldiversity.org/campaigns/bat_crisis_white-nose_syndrome/Q_and_A.html
- [15] Frick, W.F., Pollock, J.F., Hicks, A.C., Langwig, K.E., Reynolds, D.S. & Turner G.G. (2010). An emerging disease causes regional population collapse of a common North American bat species. *Science*. 329, 679–82.
- [16] Fish U.S. & Wildlife Service. (2011). A National Plan for Assisting States, Federal Agencies, and Tribes in Managing White-Nose Syndrome in Bats Retrieved from https://www.whitenosesyndrome.org/sites/default/files/white-nose_syndrome_national_plan_may_2011_0.pdf
- [17] <https://en.wikipedia.org/wiki/PubMed>
- [18] Subramanyam, K. (1983). Bibliometric studies of research collaboration: a review. *Journal of Information Science*. 6, 33–38.