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Bibliometric Analysis of Scholarly Publications on the Zika Virus, 1952-2016

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Bibliometric Analysis of Scholarly Publications on the Zika Virus, 1952-2016

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Bibliometric Analysis of Zika literature

Bibliometric Analysis of Scholarly Publications on the Zika Virus, 1952-2016**Abstract**

The 2015-2016 epidemic in the Americas caused by the Zika Virus (ZIKV) triggered a dramatic increase in the number of scholarly publications on this topic. In an effort to understand and characterize this body of literature, a bibliometric study was conducted on all articles found in PubMed that were published on the Zika virus between 1952 and 2016. Study parameters included publication date, source journal, subject and category of source journal, and country of first author. The data was frequency-ranked, enabling identification of the most highly productive journal titles, subject areas, and countries. The study concluded with a comparison between the number of opinion pieces versus research articles published on ZIKV and five other emerging infectious diseases. Results of the study will be of interest to students, researchers, and librarians & information science professionals, and will serve as a baseline for subsequent analyses.

Keywords:

Bibliometrics

Journal Productivity

Scholarly Literature

Zika Virus

ZIKV

Bibliometric Analysis of Zika literature

Bibliometric Analysis of Scholarly Publications on the Zika Virus, 1952-2016**Introduction**

When the Zika Virus (ZIKV) was first identified in 1947 during a sylvatic yellow fever study in Uganda (Dick, Kitchen, and Haddock 1952, Zhou *et al.* 2016), few could have anticipated that nearly seventy years later it would trigger an epidemic resulting in over 810,000 cases throughout the western hemisphere (Pan American Health Organization 2017).

ZIKV is a mosquito-borne (+)ssRNA virus belonging to the family *Flaviviridae*, which includes the yellow fever, dengue, Japanese encephalitis, and West Nile viruses (Oxford, Kellam, and Collier 2016).

The virus was initially thought to be relatively benign, causing only sporadic cases across Africa and Asia in the sixty years following its discovery (Vasconcelos and Calisher 2016). During that time, limited research was conducted on ZIKV, much of which focused on its serologic and taxonomic relationships with other arthropod-borne viruses.

In 2007, the first substantial outbreak of ZIKV occurred on Yap Island in the Federated States of Micronesia, producing illness in over 900 people (Duffy *et al.* 2009). In 2013-2014, a far larger outbreak occurred in French Polynesia that sickened 28,000 people, closely followed by outbreaks in New Caledonia, the Cook Islands, and Easter Island (Musso, Nilles, and Cao-Lormeau 2014). In early 2015, ZIKV emerged in the western hemisphere, with hundreds of cases cropping up in northeast Brazil, accompanied by a troubling spike in the incidence of microcephaly among newborns and Guillain-Barre Syndrome. Over the course of the next eighteen months, the number of suspected and confirmed cases of ZIKV in the Americas increased dramatically, triggering a concomitant upsurge in the number of scholarly journal articles published on the topic.

In an effort to characterize and understand this rapidly growing body of literature, the field of bibliometrics was consulted. Bibliometrics is the study of the scientific literature of a given field through

Bibliometric Analysis of Zika literature

1
2
3 the use of methods such as descriptive analyses, measures of author and journal productivity, and
4
5 identification of scientific collaborations and research networks (Andres 2009). Bibliometric studies have
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7 been conducted in the humanities, social sciences, mathematics, engineering, physical sciences, and life
8
9 sciences, including medicine and nursing. Several viral infectious diseases have been the subject of
10
11 bibliometric studies, including Chikungunya (Vera-Polania *et al.*), Dengue (Zyoud 2016), Ebola (Cruz-
12
13 Calderon 2015, Garg and Kumar 2016), and Oropouche (Culquichicon *et al.* 2017). Bibliometrics have
14
15 been widely used in library & information science, especially for collection management and resource
16
17 access (Schloman 1997, Lascar and Mendelsohn 2001, Davis 2002, Crawley-Low 2006, Rethlefsen and
18
19 Livinski 2013).
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21

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23 To date, four bibliometric studies on ZIKV have been identified. A letter-to-the-editor published
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25 in early 2016 examined 325 articles published before June 2015, as obtained from three databases:
26
27 Science Citation Index, Scopus, and GoPubMed (Martinez-Pulgarin *et al.* 2016). Among other
28
29 parameters, the article reported on the top countries publishing on ZIKV, correlating those findings to
30
31 major research networks. Another study published at about the same time examined 242 articles on
32
33 ZIKV published before January 2016, which were obtained from five databases: LILACS (Literatura
34
35 Latino Americana em Ciências da Saúde), PubMed, SciELO (Scientific Electronic Library Online), Scopus, and
36
37 Web of Knowledge (Martins 2016). Study parameters included the number of articles from each
38
39 database, a publication timeline, a frequency-ranked journal list, and the number of articles by topic.
40
41 This was followed by a “short communication” that examined 567 articles on ZIKV found in Scopus at
42
43 the end of March 2016 (Singh 2016). This study examined authorship patterns and author productivity
44
45 using Lotka’s Law, and the distribution of source journals using Bradford’s Law of Scattering. The five
46
47 most productive journals were identified, as well as the most productive countries. In January 2017, a
48
49 “viewpoint” article was published describing the ZIKV literature found in Web of Science and Scopus
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51 from 1952 through August 2016 (Albuquerque *et al.* 2017). This article provided information on the total
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Bibliometric Analysis of Zika literature

1
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3 number of articles from each database, countries of publication, publication types, research areas, and
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5 patent applications. Finally, though not a bibliometric study, it is worth mentioning the 2016 scoping
6
7 review by Waddell and Greig that analyzed 233 primary research studies published on ZIKV as of March
8
9 2016 (Waddell and Greig 2016).
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Objective

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16 The aim of this study was to conduct a bibliometric analysis of the scholarly journal literature on
17
18 ZIKV through use of a well-documented, reproducible methodology. Questions the study sought to
19
20 answer were what was published, when and where was it published, and by whom. Though it would not
21
22 be possible to provide definitive answers to all those questions, it was hoped the study would provide
23
24 baseline information about the nature of scholarly publishing on ZIKV and Zika Virus Infection, as we
25
26 know it now. In addition to being of interest to scholars and researchers, this information will assist
27
28 librarians in making collection management decisions in support of ZIKV scholarship and research, and
29
30 enhance the efforts of public services librarians who provide consultation and instruction in this subject
31
32 area.
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Methods

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40 The parameters selected for this study included publication date, source journal, subject and
41
42 category of source journal, country of first author, and publication type. The bulk of the data for the
43
44 study was obtained from the PubMed database. Produced by the United States National Library of
45
46 Medicine (NLM), PubMed is among the world's largest and most popular bibliographic databases for the
47
48 scholarly and professional literature in biomedicine and the preclinical sciences. PubMed was selected
49
50 for use in this study because, though primarily an English-language database, it includes articles
51
52 published in many non-English languages. It also includes articles from journals not indexed for
53
54 MEDLINE, and is freely available worldwide via the Internet. In addition to PubMed records, data for the
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Bibliometric Analysis of Zika literature

1
2
3 study was obtained from the NLM Catalog and through manual review of the full text of selected journal
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5 articles.
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7 The search strategy used for this study consisted of the words (*Zika* OR *ZIKV*) entered into the
8
9 main PubMed search box, followed by execution of the search via PubMed's Automatic Term Mapping
10
11 system. With Automatic Term Mapping, unqualified search terms are searched both as a keyword in all
12
13 fields of the database record and under the **Medical Subject Headings** (MeSH headings) to which the
14
15 terms are mapped. In this search, the term *Zika* mapped to the MeSH headings *Zika Virus* and *Zika Virus*
16
17 *Infection*, both introduced to the MeSH thesaurus in early 2016. The concurrent keyword search served
18
19 as a valuable adjunct because of its ability to retrieve new submissions that have not yet been indexed,
20
21 as well as articles from journals that are not indexed for MEDLINE. The results were limited to articles
22
23 with an Entrez Date (EDAT) range of 01/01/1952 through 12/31/2016, with EDAT defined as the date the
24
25 citation was added to PubMed. In many cases, the EDAT precedes the publication date by several
26
27 months.
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31
32 The PubMed records were converted to the MEDLINE format, and imported into an EndNote
33
34 library. In preparation for the import, the PubMed (NLM) import filter was modified to ensure that data
35
36 elements would be inserted into the desired EndNote fields. The records were then exported into a
37
38 Microsoft Excel spreadsheet, using a customized output style.
39
40

41 Once in Excel, the results were de-duped, and exclusions applied for off-topic articles, errata or
42
43 corrections, and articles from general interest publications. Off-topic articles were identified through
44
45 manual review of the author, author address, investigator name, title, and abstract fields of the PubMed
46
47 records. Many off-topic articles were incidental retrievals due to the occurrence of the word *Zika* as an
48
49 author surname or as a component of an author email address. Errata or corrections were identified via
50
51 the PubMed Publication Type (PT) field, or from the title or full-text of the article. Finally, as this study
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Bibliometric Analysis of Zika literature

1
2
3 was focused on the scholarly/professional literature, articles from general interest publications, such as
4
5 *Consumer Reports* and *Time*, were excluded.
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8 Once the study set was obtained, the results were sorted by publication date, divided into five-
9
10 year increments. This enabled creation of a timeline of the growth of scientific publication on ZIKV. The
11
12 results were then sorted alphabetically by the titles of the source journals in which the articles
13
14 appeared. The total number of source journals was determined, as well as the number of articles
15
16 published by each source journal. The journal list was sorted in descending order of the number of
17
18 articles published, with the journal publishing the most articles listed at the top, followed by the journal
19
20 that published the second most, and so on. Journals publishing the same number of articles were sorted
21
22 secondarily by title from A to Z.
23
24

25
26 The frequency-ranked journal list was divided into three equal sections based on the principles
27
28 of *Bradford's Law of Scattering*, a tool developed for the analysis of journal productivity in a particular
29
30 subject area (Bradford 1950, Andres 2009). According to this law, a frequency-ranked list of source
31
32 journals publishing on a given subject can theoretically be divided into three groups or "zones", each of
33
34 which contributes approximately one-third of the articles. The first and smallest group, referred to as
35
36 Zone 1, represents those journals that are most productive and are therefore considered central to the
37
38 discipline. The second group, Zone 2, includes a substantially larger group of journals that contributes
39
40 the middle third of the articles. Though these journals publish less frequently on the topic compared to
41
42 the first group, they are nevertheless considered important to the discipline. And finally, Zone 3 consists
43
44 of a much larger group of journals, which together contributes the final one-third of the articles. The
45
46 journals in Zone 3 only rarely publish articles on the subject, often only once or twice throughout the
47
48 time frame of the study.
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52 The subject of each source journal was obtained from the Broad Subject Term(s) field of the
53
54 NLM Catalog record for that journal. As only one subject could be used for this analysis, when more than
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Bibliometric Analysis of Zika literature

1
2
3 one subject was listed in the catalog record, the author made a choice following assessment of the
4
5 journal content. When no Broad Subject Terms were listed for a given journal, MeSH headings were
6
7 substituted. When neither was provided, the author determined the subject based on information from
8
9 the journal's website. Each of the subject areas were subsequently assigned to one of four broad
10
11 categories: Basic Science, Medicine/Nursing, Public Health/Epidemiology, and Other. The number of
12
13 articles published in each subject and category was tallied, and the subjects and categories frequency-
14
15 ranked.
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18
19 The country of the first author was obtained from the PubMed Author Address (AD) field.
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21 However, often only the city, state, or institution was listed, rather than the country name, requiring a
22
23 manual determination. When more than one country was listed for a given author, only the first was
24
25 used for this analysis. When no address information was provided by the PubMed record, the
26
27 information was searched for in the full-text of the article. When no country information was available,
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29 it was recorded as "Unable to Determine". Articles written by the editor or editorial staff of a given
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31 journal without a stated country were recorded as "Unable to Determine". The total number of
32
33 contributing countries was determined, and the list of countries was sorted in descending order of the
34
35 number of articles contributed.
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39 Finally, an analysis of the type of articles published on ZIKV was undertaken. Initially, it was
40
41 hoped that this analysis could be conducted through use of the PubMed Publication Type (PT) field.
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43 However, in many of the records, the PT field was not populated. Furthermore, the terms used for this
44
45 field lacked the granularity and specificity necessary for an accurate determination. A wide variety of
46
47 articles, ranging from brief news items to lengthy research reports, were designated simply as "Journal
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49 Articles", while many articles designated as "News" by journal editors were not assigned the "News"
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51 search tag by PubMed. Consequently, categorization of the articles using the PT field was not feasible.
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Bibliometric Analysis of Zika literature

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3 As an alternative, the author conducted a comparison of the number of opinion pieces versus
4 the number of research articles for six infectious diseases: Chikungunya, Dengue, Ebola, Lyme, West
5 Nile, and Zika. The aim was to paint a broad picture of the current research landscape for each of the
6 diseases, under the premise that early in the course of an emerging disease, there would be a greater
7 proportion of editorials and letters-to-the-editor relative to the number of primary research articles.
8 With the passage of time, as more funds, personnel, and resources are directed toward the conduct of
9 rigorous research on the disease, the balance would gradually shift. By comparing the current situation
10 for ZIKV with that of other recently emerged infectious diseases, it was hoped that useful observations
11 could be made.
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23 PubMed searches were conducted for each of the six terms, with the term “West Nile” used in
24 quotes. Filters for Letter, Comment, and Editorial were applied to each search, and the number of
25 results noted. This represented the number of opinion pieces in the database for that topic. The filters
26 were cleared, and filters for Clinical Trial, Meta-analysis, Multi-center Study, and Systematic Reviews
27 were then applied. A search was also run on the exploded MeSH heading *Epidemiologic studies*, which
28 included narrower terms such as cross-sectional studies, case control studies, and prospective and
29 retrospective cohort studies. Combined, these provided a rough estimate of the number of research
30 articles that had been published for each topic. It was now possible to make a comparison between the
31 number of opinion pieces and research articles published on each of the six diseases. Though this
32 method did not guarantee to pick up all articles in the respective categories, it did identify the majority
33 of them, and the method’s reproducibility will allow it to be used in future studies.
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Results

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52 The PubMed search was initially conducted on 05/09/2017, and updated on 11/14/2017. The
53 update was conducted well after the end of calendar year 2016 so as to pick up any late submissions
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Bibliometric Analysis of Zika literature

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3 that lacked the search terms in the PubMed record, but which were eventually assigned either the Zika
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that lacked the search terms in the PubMed record, but which were eventually assigned either the Zika Virus or Zika Virus Infection MeSH headings. Though a few records satisfying the search criteria may have been added to PubMed after 11/14/2017, their omission would have a negligible effect on the results. Upon limiting to EDAT = 01/01/1952 – 12/31/2016, and application of exclusion criteria, a final set of 1961 results was obtained.

< Fig. 1. PubMed records included in the study >

Analysis of the publication date of the articles showed that 61 articles were published on ZIKV between 1952 and 2011, constituting 3.1% of the total. Many of these included ZIKV in the context of a larger discussion of medically important arboviruses; only 10 of the 61 articles were primarily about ZIKV infections in humans. There was a minor increase in publishing activity between 1972 and 1986 due to several reports on yellow fever in various African countries, a yellow fever epizootic in the Zika Forest of Uganda in 1972, and several serological surveys of multiple arboviruses in Africa. One might be tempted to discount these articles as irrelevant, but it is useful to recall that ZIKV was discovered during a sylvatic yellow fever study in Uganda, emphasizing the close relationship between the two viruses. Another small increase in the number of publications occurred in the 2007-2011 period, boosted by the 2007 outbreak on Yap Island.

< Table 1. Publication date of articles, in 5-year increments >

At nearly 97% of the total, the 2012-2016 period encompasses the 2013-2015 outbreaks in French Polynesia and the Pacific Islands, as well as the widespread epidemic in the Americas of 2015-2016. But the trend had a sluggish beginning, with only 6 articles published in 2012, 3 in 2013, 27 in 2014, and 42 in 2015. Within the first three months of 2016, however, there was a greater than five-fold increase, from 31 articles in January 2016 to 157 articles in March 2016. At the time of this study, a total of 1822 articles had been published in 2016, a substantial proportion of which focused specifically on

Bibliometric Analysis of Zika literature

ZIKV and/or the ongoing outbreak in the Americas. The mid-year dip in publications was possibly due to routinely scheduled publisher down-times in mid-summer.

< Fig. 2. Articles published between January 2015 and December 2016, by month >

When the journals were ranked by title according to the number of articles they published on ZIKV, it was found that the literature emanated from 593 unique journal titles. Of these, 14 (2.4%) journals contributed twenty or more articles, and 38 (6.4%) journals contributed ten or more. In contrast, 481 (81.1%) contributed three or fewer articles; 435 (73.4%) contributed one or two articles; and 327 (55.1%) contributed only one article.

The frequency-ranked journal list was divided into the three Bradford zones, each of which contributed approximately one-third of the articles. With a total of 1961 articles in the study, Zone 1 consisted of 657 articles, Zone 2 of 653 articles, and Zone 3 of 651 articles, with the cut-off between Zone 2 and 3 occurring midway through the alphabetical list of journals contributing three articles.

The first zone consisted of 19 (3.2%) journals, and included titles in medicine, science, infectious diseases, tropical medicine, microbiology, and epidemiology. The highest-ranking journal in Zone 1 contributed 81 articles and the lowest-ranking journal contributed 15 articles. The middle group, Zone 2, included 103 (17.4%) journals, with the number of contributed articles ranging from 3 to 14 articles. The largest group, Zone 3, included 471 (79.4%) journals, each if which contributed 3 or fewer articles.

< Table 2. Zone 1 journals, frequency-ranked (N=19) >

Analysis of the subject content of the source journals showed that they stemmed from 71 unique subject areas. Nearly every basic science discipline was represented on the list, as were most of the medical specialties. When the subjects were sorted according to frequency, journals in medicine were shown to have contributed the greatest number of articles at 374 (19.1%), closely followed by communicable diseases at 369 (18.8%) articles. Public health was a distant third with 158 (8.1%) articles, followed by virology, science, microbiology, and tropical medicine.

Bibliometric Analysis of Zika literature

< Table 3. Top 20 subjects of source journals, sorted by frequency >

When the subjects of the source journals were assigned to broad categories, Medicine/Nursing was found to be the most frequent category by a large margin, at 1,199 (61.1%) articles. The Basic Science category claimed 536 (27.3%) articles, followed by Public Health/Epidemiology with 188 (9.6%) articles. The Other category, which included dentistry, veterinary medicine, physics, and other subjects, included 38 (2.0%) articles.

The country of the first author was available from the PubMed record for 1,597 (81.4%) of the articles. Of the remaining articles, the country information for 156 (8.0%) articles was obtained by reviewing the full text, and for 208 (10.6%) articles, the country could not be determined. Analysis of the participating countries revealed a widely dispersed, global effort, with articles emanating from 82 countries. Leading the list was the United States, followed by Brazil, the United Kingdom, China, and France. There were strong contributions from several western European countries, Colombia, India, Canada, Thailand, and Australia. However, just as articles on ZIKV were published in journals on a wide range of subjects, so too were they written by authors working out of locations around the globe.

< Table 4. Country of first author (top 20) >

Finally, the searches to determine the number of opinion pieces versus research articles for the six infectious diseases were run in PubMed on 05/04/2017. The total number of articles retrieved for each disease varied widely, from a low of 2,733 for ZIKV to a high of 17,200 for Dengue, making evaluation of the percentages more useful than the raw figures.

At 16.7%, the number of opinion pieces on ZIKV clearly exceeded the number of articles that fit the criteria used here for research articles, which came in at 2.9%. However, these figures are difficult to interpret in isolation, making a comparison with other infectious diseases particularly useful. The two diseases with the highest percentages of opinion pieces were found to be Ebola and ZIKV, at 13.1% and 16.7% respectively. This can be contrasted with a low of 3.7% for West Nile, followed by 5.5% for

Bibliometric Analysis of Zika literature

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3 Dengue. As for research articles, again Ebola and ZIKV were the standouts, with ZIKV ranking lowest at
4
5 2.9% and Ebola slightly higher at 3.9%. In comparison, Lyme disease showed the highest percentage of
6
7 research articles at 12.5%, followed closely by Dengue at 11.3%.

8
9 < Table 5. Comparison of “opinion pieces” versus “research articles” for six infectious diseases >

10 11 12 13 14 Discussion

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16 At the end of 2016, the corpus of published journal literature on ZIKV was still relatively small,
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18 with fewer than 2000 articles in PubMed. With the massive 2015-2016 outbreak in the Americas, the
19
20 scientific, medical, and global health communities, in partnership with the scholarly journal publishing
21
22 enterprise, launched a remarkably timely and robust response to the emerging crisis. With the
23
24 declaration on 02/01/2016 by the World Health Organization of a Public Health Emergency of
25
26 International Concern (PHEIC), many journals instituted a shortened publication cycle to fast track
27
28 manuscripts on ZIKV, helping to further accelerate the flow of knowledge (Albuquerque 2017).

29
30
31 An examination of the list of most productive journal titles of this study shows similarities and
32
33 differences with the findings reported by Singh (Singh 2015) and Martins (Martins 2016). Whereas the
34
35 Singh study's Zone 1 consisted of 6.8% (20/293) of the journal titles, the present study's Zone 1
36
37 consisted of 3.2% (19/593) of the journals. Though it is premature to infer much from this, it does
38
39 suggest that the list of journals comprising Zone 1 may be becoming more consolidated. Four of the five
40
41 most productive journals reported by Singh were included in Zone 1 in the present study, although their
42
43 rankings in the list were different, usually lower. Similarly, eleven of the fourteen titles on Martins' list of
44
45 most productive journals appeared in Zone 1 of the present study, though with differing rankings. The
46
47 discrepancies between the present and previous studies may be due to differences in the databases
48
49 used as the source of raw data, inclusion/exclusion criteria, sample sizes, and date ranges. It should be
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51 noted that the Singh and Martins studies were conducted much earlier in the course of the 2015-2016
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Bibliometric Analysis of Zika literature

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3 ZIKV outbreak in the Americas. As the literature on ZIKV evolves, the list of most productive journals can
4
5 be expected to experience continuous fluctuations.
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9 Like the journals themselves, the subject areas of the journals reflected an extraordinarily broad
10
11 range. Given the symptoms and complications of ZIKV infections, it was no surprise that neurology,
12
13 allergy/immunology, pediatrics, nursing, gynecology/obstetrics, and ophthalmology all ranked in the top
14
15 twenty subjects, along with general medicine and science. But even journals in specialty areas such as
16
17 anesthesiology, psychiatry, gerontology, and oncology found aspects of this emerging infectious disease
18
19 to be of interest to their reading audience. As a microcosm of the whole, the subjects of the nineteen
20
21 Zone 1 journals reflected a high degree of interdisciplinary interest, including four prominent general
22
23 medicine journals and two general science journals. At the category level, the relatively low percentage
24
25 of articles published in Public Health/Epidemiology journals compared with Medicine/Nursing and Basic
26
27 Science journals may be due to a reduced emphasis on scholarly publication among public health
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29 practitioners.
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34 With contributions from scholars and clinicians working in over eighty countries, it is clear that
35
36 efforts to combat ZIKV has become a worldwide endeavor. Since PubMed is a product of the United
37
38 States National Library of Medicine, it was not unexpected that the top ranking country was the United
39
40 States. PubMed is the preeminent bibliographic database for biomedical research in the US, and
41
42 manuscripts resulting from US National Institutes of Health (NIH) grant-funded projects are required to
43
44 be deposited into PubMed Central. That the second highest ranking country was Brazil is also no
45
46 surprise, given that it was at the epicenter of the evolving epidemic. Since PubMed's coverage of non-
47
48 English publications is limited, it is likely that the scholarly output on ZIKV by countries outside the
49
50 United States was substantially higher than was represented in PubMed.
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54 The results of this study's country analysis differed considerably from those by Martinez-
55
56 Pulgarin *et al.* (Martinez-Pulgarin *et al.* 2016), but correlated well with the study by Albuquerque *et al.*
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Bibliometric Analysis of Zika literature

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2
3 (Albuquerque *et al.* 2017), despite the latter's use of different databases as the source of raw data. The
4
5 ranking of the top five countries in the present study exactly matched those of Albuquerque *et al.*, and
6
7 all but one of the top fifteen countries they listed were also in the top fifteen of the current study,
8
9 although some of their positions shifted. Neither of the earlier studies described how the country
10
11 information was determined.
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14 Finally, the comparison of the number of opinion pieces versus primary research for the six
15
16 infectious diseases provided a hint as to the current state of knowledge on these topics. It is notable
17
18 that the two diseases with both the highest percentages of opinion pieces and the lowest percentages
19
20 of research articles were Ebola and ZIKV. Despite their low strength-of-evidence, it is evident that for
21
22 emerging diseases, publication types such as letters, brief communications, and case studies, are
23
24 important tools for disseminating information as it becomes known. Follow-up studies using the method
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26 described herein will provide greater insight into the long-term trends of scholarly output on such
27
28 diseases as the pace and progress of research accelerates.
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Limitations

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36 Since it drew its raw data from only one database, this study does not purport to be a
37
38 comprehensive analysis of all published scholarship on ZIKV. Rather, it is an attempt to provide a
39
40 description of the literature of ZIKV as it exists now, using the data found in PubMed as a representative
41
42 sample. Owing to the scope and widespread availability of PubMed, it is likely that the study's findings
43
44 provide a fairly accurate representation of the nature of formal scholarly publication on ZIKV. It must be
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46 noted that the sample size used in the study was relatively small, which forced an arbitrary cut-off
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48 between Zones 2 and 3 in the journal frequency list.
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52 In addition, use of the country of the first author for the country analysis may have yielded an
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54 incomplete representation of each country's output by failing to take into account the international
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Bibliometric Analysis of Zika literature

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3 collaborations that occurred, as evidenced by the large number of articles published by multiple
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5 authors, working out of multiple countries. Still, the decision as to who to list as first author is one that is
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7 not taken lightly by authors and collaborators, and therefore is felt to hold some significance. In
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9 addition, multiple countries were sometimes listed for the first author, or different countries were listed
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11 for a given author on multiple articles published at approximately the same time. Nevertheless, it was
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13 felt this method provided a sufficient approximation of the situation until such time as detailed author
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15 metrics can be performed.
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Conclusion

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22 As a snapshot of the published scholarly journal literature on ZIKV through calendar year 2016,
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24 this study provided convincing evidence that an emerging epidemic is a powerful catalyst for the
25
26 generation of scientific knowledge. The number of articles published in the last year of the study was
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28 found to be over thirteen times greater than the number published in the preceding 64 years combined.
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30 The articles included in this study were published by nearly 600 journals, but fully one-third of the
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32 articles were published by fewer than twenty highly productive journals. Mirroring the breadth of
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34 journals publishing on the topic, scholarship on ZIKV emanated from researchers working around the
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36 globe, writing in journals that spanned dozens of disciplines.
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41 The study's findings have important implications for students, faculty, researchers, and
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43 clinicians. Those wishing to remain abreast of the field of ZIKV research may wish to use the list of
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45 journals included in Zone 1 to guide their current awareness activities. More importantly, the ranked
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47 journal list in its entirety, along with the subject and country lists, serves as a clear reminder of the
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49 necessity for reading beyond one's favorite publications, even beyond one's own discipline, in order to
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51 discover the full range of scholarly literature on the topic.
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Bibliometric Analysis of Zika literature

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3 Librarians working in academic, hospital, and special libraries, especially those involved in
4 collection management, may also find the study useful. "Analysis of journal productivity [via Bradford's
5 Law] has ... been used as a tool for collection management in libraries by identifying core journals in
6 subject areas, thereby providing evidence for journal subscription decision making." (Wolfram 2003).
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8 The long-running Mapping the Literature of Allied Health project of the Medical Library Association,
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10 which produced 21 published papers between 1997 and 2016, listed collection management as one of
11 the primary uses of the studies (Schloman 1997). In an era of tight budgets, the results of this study may
12 help librarians estimate the importance of specific journal titles to patrons working in the area of ZIKV
13 research, and thus can be used to guide purchasing, swapping, and/or cancellation decisions. Finally,
14 research and instruction librarians can draw on the evidence provided by the long tail of the journal
15 distribution to convey to their patrons and students the importance of conducting comprehensive
16 literature searches across multiple databases.
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30 Updates to the study are expected to show a rapidly expanding body of research on ZIKV, with
31 continuously fluctuating journal and country productivity rankings, as well as a shift toward increased
32 levels of rigorous research. For a more comprehensive analysis, the study could be expanded to
33 incorporate data from additional databases, such as EMBASE, Google Scholar, LILACS, SciELO, Scopus,
34 Web of Science, and others. A more granular look at author metrics, publication types, and institutional
35 and country productivity would likewise provide additional insights. Finally, in this age of real-time
36 communications, it would be useful to assess the continuing role of the formally published scholarly
37 journal article in the dissemination of information during and following global health crises.
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48 Having at last revealed its capacity to wreak havoc on mankind, ZIKV will no doubt continue to
49 attract the interest of researchers and clinicians across the spectrum of biomedical disciplines, leaving in
50 its wake an ever expanding body of literature waiting to be explored.
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Fig. 1. PubMed records included in the study

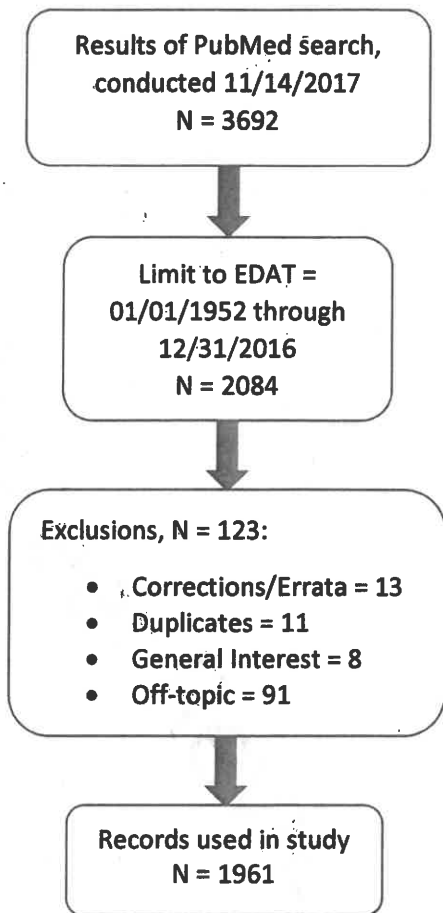


Table 1. Publication date of articles, in 5-year increments

Year range	# articles	% of total
1952-1956	8	0.4
1957-1961	1	0.1
1962-1966	2	0.1
1967-1971	3	0.1
1972-1976	6	0.3
1977-1981	10	0.5
1982-1986	7	0.4
1987-1991	5	0.2
1992-1996	3	0.1
1997-2001	4	0.2
2002-2006	1	0.1
2007-2011	11	0.6
2012-2016	1900	96.9
TOTAL	1961	100.0

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Fig. 2. Articles published between January 2015 and December 2016, by month.

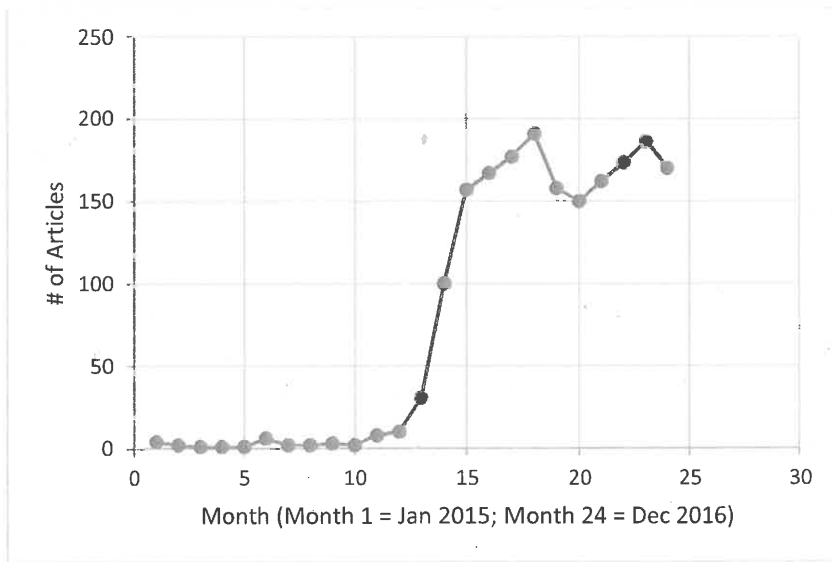


Table 2. Zone 1 journals, frequency-ranked (N=19)

Rank	Journal	# of articles
1	BMJ	81
2	PLoS Neglected Tropical Diseases	59
3	Lancet	57
4	Emerging Infectious Diseases	56
5	MMWR. Morbidity and Mortality Weekly Report	51
6	Euro Surveillance	43
7	Lancet. Infectious Diseases	41
8	Nature	33
9	New England Journal of Medicine	33
10	Science	33
11	Travel Medicine and Infectious Disease	26
12	JAMA	22
13	American Journal of Tropical Medicine and Hygiene	21
14	Cell Host & Microbe	20
15	International Journal of Infectious Diseases	17
16	Scientific Reports	17
17	Transactions of the Royal Society of Tropical Medicine and Hygiene	17
18	Bulletin of the World Health Organization	15
19	Clinical Infectious Diseases	15

Table 3. Top 20 subjects of source journals, sorted by frequency

Rank	Subject	Number	Category
1	Medicine	374	Medicine/Nursing
2	Communicable Diseases	369	Medicine/Nursing
3	Public Health	158	Public Health/Epidemiology
4	Science	91	Basic Science
5	Virology	91	Basic Science
6	Microbiology	83	Basic Science
7	Tropical Medicine	81	Medicine/Nursing
8	Neurology	56	Medicine/Nursing
9	Cell Biology	43	Basic Science
10	Allergy and Immunology	35	Basic Science
11	Nursing	35	Medicine/Nursing
12	Pediatrics	35	Medicine/Nursing
13	Gynecology and Obstetrics	33	Medicine/Nursing
14	Reproductive Medicine	32	Medicine/Nursing
15	Biology	29	Basic Science
16	Biomedical Research	27	Basic Science
17	Molecular Biology	21	Basic Science
18	Biochemistry	20	Basic Science
19	Ophthalmology	20	Medicine/Nursing
20	Epidemiology	18	Public Health/Epidemiology

Table 4. Country of first author (top 20)*

Rank	Country	# references
1	USA	629
2	Brazil	236
3	UK	98
4	China	95
5	France	85
6	Italy	49
7	Colombia	42
8	India	41
9	Canada	41
10	Thailand	36
11	Spain	30
12	Germany	28
13	Australia	27
14	Switzerland	27
15	French Polynesia	26
16	Singapore	26
17	Mexico	18
18	Pakistan	15
19	Netherlands	14
20	Japan	10

* Excludes 208 articles for which the country not be determined

Table 5. Comparison of “opinion pieces” versus “research articles” for six infectious diseases

	1	2	3	4	5	6	7
Search Term	Comments, Editorials, and Letters (#)	Comments, Editorials, and Letters (%)	Clinical Trial, Meta-analysis, Multicenter Study, and Systematic Reviews (#)	Epidemiologic Studies (#)	Sum of results from columns 3 and 4	% of results from columns 3 and 4	TOTAL
Chikungunya	252	7.4	51	226	277	8.2	3399
Dengue	951	5.5	439	1512	1951	11.3	17200
Ebola	852	13.1	104	148	252	3.9	6418
Lyme	1230	9.9	326	1229	1555	12.5	12431
“West Nile”	256	3.7	89	523	612	8.8	6958
Zika	457	16.7	34	45	79	2.9	2733

Column:

1. Number of records retrieved when PubMed filters for Comment, Editorial, and Letter applied to search term.
2. Percent of records retrieved when PubMed filters for Comment, Editorial, and Letter applied to search term.
3. Number of records retrieved when PubMed filters for Clinical Trial, Meta-analysis, Multicenter Study, and Systematic Review applied to search term.
4. Number of records retrieved when search run in PubMed on (search term) AND exp Epidemiologic Studies[MeSH]
5. Sum of columns 3 and 4.
6. Percent of Clinical Trial, Meta-analysis, Multicenter Study, Systematic Review, and Epidemiologic Studies.
7. Total number of results retrieved when PubMed search ran on the search term. Searches conducted 05/04/2017.