ORIGINAL ARTICLE

A Bibliometric Analysis of Dengue Vector-related Publications in the Science Citation Index Expanded

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ABSTRACT

Introduction: Dengue fever is known to be the most widely spreading mosquito-borne infectious disease in the world. It is also the most serious human condition in terms of global morbidity and mortality. The focus of this research was to classify the characteristics of dengue vector-related articles published in terms of author, year publications, paper's origin and citation in the Science Core Collection Web from 2010 to 2020. **Methods:** Scientific publication data for articles indexed in the Science Citation Index Expanded (SCI-EXPANDED) were used and the following characteristics were recorded; area, year of publication, citation per publication, authors, institutions, countries, journals, research categories, and leading article with citation analysis. **Results:** The results showed that the highest number of dengue vector-related articles were published between 2014 and 2016. The USA was the most productive nation, while Liverpool University, England and the University of California, USA were the main institutions with the highest number of publications. Research articles have been found in a wide range of disciplines, especially in parasitology and tropical medicine. PLOS Neglected Tropical Disease has the highest number of publications reported overall compared to other journals. Citation for the last year and the cumulative number of citations since its publication created a different 'star' of the highly cited paper. **Conclusion:** The results of this study indicate that the bibliometric analysis method can be a guide for specific researchers to understand the global dengue vector study panorama and to provide guidance for further study.

Keywords: Aedes mosquito, Bibliometric, Dengue vector related article, SCI-EXPANDED

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INTRODUCTION

Dengue fever (DF) is an acute systemic arbovirus disease transmitted between humans and mosquitoes and has been established worldwide in both endemic and epidemic transmissions (1). DF is a chronic virus that presents a serious threat to around half of the world's population. DF is a rapidly spreading arbovirus infection across regions and countries, especially in tropical countries with mild to serious reactions, including high fever, myalgia, arthralgia, malaise and eye pain (2). About 3.6 billion people have been infected annually by dengue fever in 124 different countries (3). The WHO reports that dengue fever will infect approximately 50-100 million people a year. In addition, recent analyses have shown that the number of DF cases can be as high as 400 million per year, of which 96 million are symptomatic (4). However, only 3.2 million cases were reported to the WHO worldwide in 2015. (5). DF cases have gradually risen due to different factors such as climate variability, viral evolution, human mobility and land use (6).

The Asia-Pacific region has the greatest burden among all the regions of the world, followed by Southeast Asia and Latin America. Fewer cases have been reported in Europe and Africa and some in the USA (1). Patterns of infection have shown growing patterns across semi-urban areas. This problem has escalated with cooperation in vector control activities, unplanned urban growth, unsatisfactory sanitary conditions and inadequate water storage practises that could cause the spread of DF. While the global effect of DF is difficult to quantify due to misdiagnosis, disease monitoring and low occurrence reporting, it has shown a major potential impact on public health around the world as it is a national epidemic and a national pandemic outside national borders (5).

DF infection occurs with the primary vectors of dengue viruses, namely *Aedes aegypti*, as the urban-adapted mosquito has become widely distributed across tropical and subtropical regions. This mosquito originated from Africa in the 15th to 19th centuries and spread across Asia during commercial exchanges in the 18th to 19th centuries, then spread throughout the world with the rapid movement of travellers in the last 50 years. In addition, the geographic range of the secondary vector Aedes albopictus has increased significantly in recent years through globalization and the trade in used cars, causing the dispersal of eggs and immature forms into new habitats (7). *Aedes aegypti* is an important vector of the dengue virus due to its ability to adapt to the human environment, i.e. its distinct preference for human environments and oviposition. This anthropophilic propensity is thought to be a factor that makes Aedes aegypti more competent to transmit the dengue virus compared to *Aedes albopictus*, which feeds both human and animal host blood (8). Currently, action have been taken to reduce the transmission of DF by concentrating on vectors utilizing combinations of chemical and biological targeting of Aedes mosquitoes and maintaining the breeding site properly. Unfortunately, these control measures seem to have failed to reduce the growing occurrence of DF epidemics and the spread of endemic transmission beyond the geographical range (9).

A detail on dengue research and publication is accessible in the bibliographic database. Study data based on bibliometric studies have been performed around the world to chart dengue research and development activities. An overall evaluation of patterns in dengue research may also be carried out using bibliometric profiling. This approach can be a 'bird's-eye' viewpoint of the history, environment and pattern of a region and the subject of study (10). Despite the numerous studies that have been performed to treat dengue, none of them have benefited from concentrating solely on dengue vector science (11, 12, 10). The goal of this analysis was to evaluate the bibliographic patterns and outcomes of dengue vector related papers from 2010 to 2020. From this perspective, the mapping of the scientific scenario and the dengue vector-related study is combined with the process of bibliometric analysis. In this review, all dengue vector-related journal articles in the Science Citation Index Expanded (SCI-EXPANDED) from 2010 to 2020 were selected and evaluated for the following characteristics: area, year of publication, citations by publication, writers, institutions, countries, journals, web science categories, and leading article with citations analysis. Six bibliometric metrics namely total publications, independent publications, collaborative publications, first-authored publications, corresponding-authored publications and single-authored publications have been used to test publications from specific countries and practitioners.

MATERIALS AND METHODS

Study design

This is a retrospective review that analyses bibliometric data using a secondary data analysis approach as indicated in previous studies (11, 12, 10). Bibliometric analysis is a statistical tool for literary analysis to display trends in knowledge and other material (e.g. citation information, authorship, and keyword co-occurrence). It is also useful to provide progress or measures of advances in scientific publications.

Data Retrieval

Publication data has been obtained from the online database server of the Science Citation Index Expanded (SCI-EXPANDED) in the Science Core Collection Web by Thomson Reuters, which is the most widely used database for various analysis sources of scientific achievements (updated from 1 December 2020). According to the Journal Citation Reports (JCR) in 2020, the Science Core Collection website contains 12,171 journals with citations across 236 web-based science categories in its science edition. Several steps have been taken to classify dengue vector-related articles published throughout 2010 and 2020. First, the review was carried out in advanced search mode using the Topics (TS) search area, which also included tittle, abstract and keywords. Thomson Reuters' WoS database enables online users to search for the publication of the theme keywords that include author's keywords and keywords plus, which are attributes of the papers by WoS editors after checking the names of the article's references; thereby broadening the search results. The search process used was: [TS=('dengue vector*')] and Document Types: (Articles), Indexes = SCI-EXPANDED, Timespan = 2010-2020. In this analysis, only original papers were considered among the different types of documents, because the original articles were double-blind peer-reviewed (periodicals) and were more likely to suggest new ideas or present substantive results. Not only are they considered to be more complete, they also refer to more advanced stages of study compared, for example, with documents published in the meeting proceedings (13).

Standardisation and Data Cleaning

A total of 1,019 articles met the selection criteria. For further review, all information from the bibliometric search results for all posts has been downloaded to Microsoft Excel 2015. The full data period from 2010 to 2020 had the specific objective of highlighting the evolution of dengue vector publishing since the beginning of the SCI-EXPANDED index. However, keywords plus includes additional search terms derived from the titles of papers quoted by writers in their bibliographies and footnotes in the database and significantly improves author-keyword indexing and title-word indexing (14). The filtering results would possibly show that a number of papers is insignificant. Since the electronic database

of WoS does not allow researchers to handle keyword search without including keyword plus, 'front-page criteria' has been created to fulfil the filtering process (15). This form of approach only recognises papers with the term "dengue vector" on the front page (title, abstract and keywords). Articles which have only been searched using keywords plus have been omitted. The filtering processes were carried out in Microsoft Excel 2015. The method revealed 1,014 dengue vector-related papers for further bibliometric analysis.

Data Analysis

The processing of data from the downloaded records was carried out manually using additional coding. Since the details on author affiliation did not follow the specified format and some countries changed their names, such affiliations had to be changed manually by category. For eg, articles published in England, Scotland, Wales and Ireland were classified as UK, while Hong Kong was classified as the Republic of China. Impact factors (IFs) have been taken from the Journal Citation Reports (JCR) released in 2020, (IF_{2020}). After processing the data, six bibliometric variables were used to clarify the bibliometric profile of institutions or countries; a total of papers, independent articles, collaborative articles, first-authored articles, single-authored articles and corresponding articles. In the SCI-EXPANDED dataset, the corresponding author is referred to as the "reprint author," but in this analysis this individual is known as the corresponding author. The contribution of a country or institution was specified on the basis of whether at least one author was a member of a country or institution. If an article had authors from a variety of countries or organisations, it was categorised as a country or institution of collaborative articles. If the article was composed of researchers from the same country or institution, the article was defined as 'single country article' or 'single institution article.' On the other hand, the terms 'international collaborative article' and 'inter-institutional collaborative article' were used to categorise papers co-authored by scholars from various countries or institutions. Since the papers are always co-authors, the sum of the country articles recorded would be more than the sum of the articles in the database. For geographical study, five categories were used to define the root of the paper, based on the affiliation of the authors; Africa, America, the Eastern Mediterranean, Europe and the Western Pacific. Several citation indicators have been developed in this review. The frequency of quotes for each of the to-cite posts has been collected. The total number of quotations (TC) from the WoS that were assembled by the end of 2020 (TC_{2020}) was used. Because information on TCs will be updated regularly in the WoS database, the number of citations will vary from time to time. This measure was an invariant element that could be replicated by other researchers. The other indicator used for the study was year. It reflects the number of times the article is quoted in the WoS Core Set for a specific year. C_{2020} reveals the total number of times the article was cited in 2020 only. In addition, the total number of citations in the publication year (C0) and the total number of citations per year (TCPY) from WoS for the article were also used in this analysis.

RESULTS

Bibliometric Profile

From 2010 to 2020, there were 1,014 of dengue vector related articles were found in the SCI-EXPANDED. Ninety-eight percent (993 out of 1,014) of all publications have been written in English. The rest of the articles were Spanish (11 articles), Indonesian (7 articles), Portuguese (2 articles) and French. In order to understand the distribution and pattern of dengue vector-related articles published worldwide from 2010 to 2020, this study created a data graph spanning a continuous 11-year period. Figure 1A demonstrates the history of publication papers linked to dengue vectors worldwide. The graph shows the global distribution of dengue vector related articles by region based on the affiliation of the authors. The graph is divided into five regions, namely Africa, America, the Eastern Mediterranean, Europe and the Western Pacific, coded in black, white, grey, green, blue and purple. The diagram shows a comparison of the distribution of articles between each year on the basis of the cumulative number of articles for all regions. A few important trends can be seen from the charts. In general, this study has shown that there is a substantial increase in the trend in all regions. The countries in America have shown the highest publishing pattern followed by Europe and South-East Asia relative to other regions.

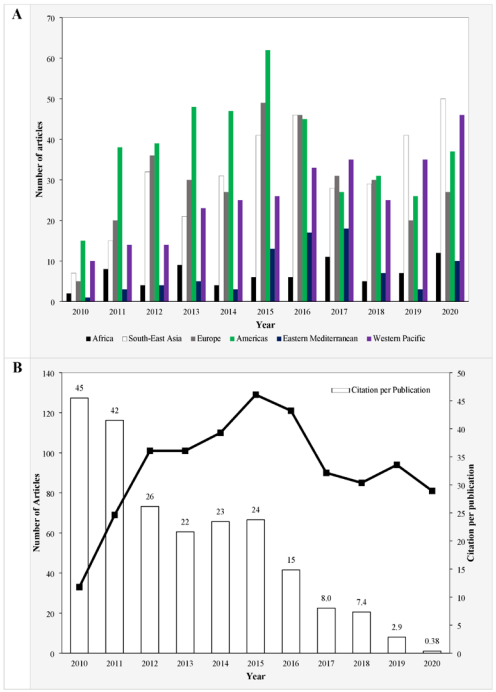

Figure 1: A. The trends of publication by region; B. Number of articles and average citations per article by publication year

Table I shows the annual statistics of articles published between 2010 and 2020. It was clear from the results obtained that the average number of authors per article increased slightly from 5.1 to 6.2 and that the number of references cited for each article also increased from 35 to 51. The number of dengue vector-related articles also showed a fluctuating trend with a significant difference in the exponential growth rate for each year. The number of articles was 33 in 2010 and the number doubled in 2011, i.e. 69 in 2011. In the following three years, the growth rate increased to about 110 articles in 2014. The total number of articles reached an all-time high in 2015 with 129 but showed signs of decline in 2016 to 2018 with 80 and 95 articles respectively. Statistics and distribution patterns of articles consisting of the number of articles with average citations per article by year of publication as shown in Figure 1B. Generally, the total number of articles and average citations per article showed different trends in distribution based on data plotted annually from 2010 to 2020. The results

Table I: Bibliometric statistics of articles from 2010 to 2020

Year	TP	AU	AU/ TP	NR	NR/ TP	PG	PG/ TP
2010	33	169	5.1	1165	35	298	9.0
2011	69	399	5.8	2599	38	575	8.3
2012	101	562	5.6	4250	42	914	9.0
2013	101	594	5.9	4562	45	977	9.7
2014	110	610	5.5	5545	50	1113	10.1
2015	129	914	7.1	5892	46	1311	10.2
2016	121	799	6.6	6283	52	1278	10.6
2017	90	587	6.5	4476	50	989	11.0
2018	85	629	7.4	4794	56	998	11.7
2019	94	635	6.8	4613	49	1039	11.1
2020	81	506	6.2	4128	51	956	11.8
Total	1014	6404		48307		10448	
Average			6.3		48		10.3

AU: Total number of authors; AU/TP: Average number of authors per article; NR: Number of references listed; NR/TP: Average number of references listed per article; PG: Total number of pages printed; PG/TP: Average number of pages printed per article;
TP: Total number of articles.

clearly showed a pattern of moderate growth followed by rapid growth and a decline in growth. The graph also shows the average number of citations received per publication (CPP = TC2020/total publication). The use of CPP as an indicator rather than other measurements such as citations during the first year or for the first 5 years of publication was because CPP is more stable and indicates the impact of the articles. Citation during the first year or for the first 5 years of publication could generally fluctuate, as some of the articles did not begin to receive a quotation. Analysis showed that articles published between 2010 and 2011 had the highest citations of 45 and 42 CPPs, respectively. On the other hand, the articles published after 2016 showed a marked decrease in the CPP trend. The average number of citations per article was quite similar for 2012 and 2015, but showed a marked decline compared to the previous two years, despite having sufficient time to obtain more citations.

Distribution Output in Subjects Categories and Journals

Dengue vector-related articles have been distributed to 76 of the 236 subject categories in the JCR SCI-EXPANDED since 2020. Table II(A) shows the top 20 subject categories in the Science Web, with at least 14 articles published. The leading categories were parasitology with 333 articles (33 per cent of 1,014 articles), tropical medicine with 332 articles (33 per cent), entomology with 191 (19 per cent) articles, infectious disease with 157 (15 per cent) articles and the public, and Environmental & Occupational Health with 136 (13 per cent) articles. There were only 18 journals in the parasitology and a total of 35 journals in

Table II (A): Correlation Between Behaviour Problems and Parental Stress

A

Web of Science Category	TP	Per-cent (%)	Jour-nal (n)
Parasitology	333	33	18
Tropical Medicine	332	33	22
Entomology	191	19	35
Infectious Diseases	157	15	19
Public, Environmental & Occupa-tional Health	136	13	34
Multidisciplinary Sciences	91	9.0	21
Veterinary Sciences	55	5.4	4
Environmental Sciences	43	4.2	15
Biochemistry & Molecular Biology	33	3.3	18
Biotechnology & Applied Micro-biology	25	2.5	12
Genetics & Heredity	22	2.2	10
Zoology	20	2.0	6
Biology	19	1.9	11
Ecology	19	1.9	13
Evolutionary Biology	17	1.7	10
Medicine, Research & Experimental	17	1.7	7
Toxicology	17	1.7	7
Physiology	15	1.5	4
Chemistry, Medicinal	14	1.4	8
Medicine, General & Internal	14	1.4	7
Plant Sciences	14	1.4	5

the entomology.

Figure 2A indicates the number of publications each year in the top five categories of more than 100 publications. These growth trends of the five groups varied slightly from each other. For example, the number of publications in the Entomology, Infectious Disease and Public Health and Environmental and Occupational Health categories showed steady growth with no period of rapid growth, whereas all other categories showed a period of rapid and decreasing growth. In addition, the categories of

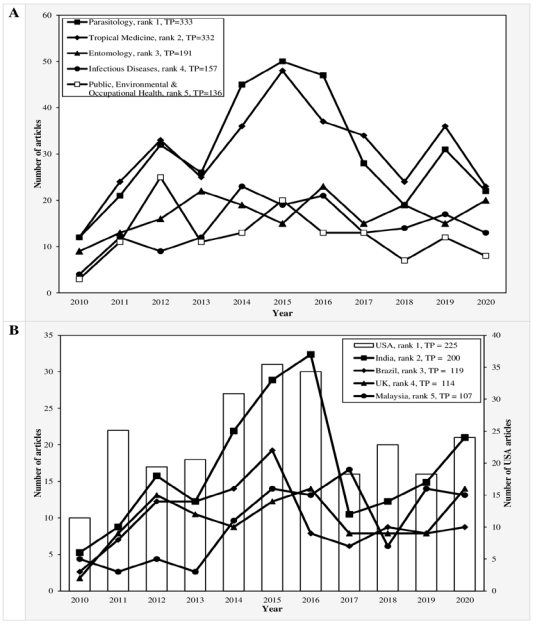

Figure 2A: Growth trend of the number of articles in the five leading subject categories by publication year; B. Annual publication of top six countries during 2010 – 2020 (TP > 100). TP: Total number of articles

parasitology and tropical medicine showed a rapid increase in the number of publications published before 2015 but entered a period of decline after 2016.

Dengue vector-related articles were published in a total of 262 journals from 2010 to 2020. From this, 11 journals with the highest number of published dengue vector related papers are shown in Table 2B. This table shows the major scientific journal publishing research and its impact factor (IF). Journals is ranked on the basis of the frequency or number of published papers. This suggests that these journals have been selected predominantly by the dengue scientific community to disseminate science. Each of the journals had at least 15 papers. PLOS Neglected Tropical Disease had the largest number of publications reported with 79 papers (7.8%) followed by Parasites & Vectors, Journal of Parasitology Science, PLOS One and Journal of Medical Entomology with 66 articles (6.5%), 54 articles (5.3%), 54 articles (5.3%) and 47 articles (4.6%) respectively. PLos Neglected Tropical Disease also had the highest IF2020 of 3.885 followed by Parasites & Vectors, PLOS One, Acta Tropica Journal and the American Journal of Tropical Medicine and Hygiene IF2020 of 2.824, 2.74, 2.555 and 2.162 respectively. The top five out of ten leading journals belonged to the five leading topic groups, with the exception of PLOS One (a group of multidisciplinary sciences) and Journal of Medical Entomology (category of veterinary sciences).

Table II(B): The top 10 most productive journals with the number of articles, impact factor (IF) in 2020 and category of journals during the period of 2010 to 2020

B

Journal	TP	%	IF_{2020}	Web of Science Category
PLos Neglected Tropical Disease	79	7.8	3.885	Infectious Diseases, Parasitology, Tropical Medicine
Parasites & Vectors	66	6.5	2.824	Parasitology, Tropical Medicine
Journal of Parasitology Research	54	5.3	1.641	Parasitology
PLoS One	54	5.3	2.74	Multidisciplinary Sciences
Journal of Medical Entomology	47	4.6	1.925	Entomology, Veterinary Sciences
Acta Tropica Journal	34	3.4	2.555	Parasitology, Tropical Medicine
Tropical Biomedicine Journal	26	2.6	0.509	Parasitology, Tropical Medicine
American Journal of Tropical Medicine and Hygiene	24	2.4	2.162	Public, Environmental & Occupational Health, Tropical Medicine
Journal of the American Mosquito Control Association	23	2.3	0.942	Entomology
Journal of Vector Borne Diseases	16	1.6	1.127	Infectious Diseases, Parasitology, Tropical Medicine
Southeast Asian Journal of Tropical Medicine and Public Health	16	1.6	0.245	Public, Environmental & Occupational Health, Infectious Diseases, Tropical Medicine

%: The percentage of articles of journals in total articles; IF2020: Impact factor in 2020; N/A: Not available in 2014; TP: Total number of articles.

Publication Performances: Countries and Institutions Contribution

Information on papers published during the study period was evaluated. In order to understand the importance of publication contributions from countries and organisations, Table 3 displays the top 20 countries with the highest number of published papers. Six metrics were used to measure research output, including total

publications, independent publications, international collaborative publications, first-authored publications, corresponding publications and single-authored publications. Of the 1,014 posts, there were only two with no affiliations in the Science Network. The remaining 1,012 papers had author affiliations from 94 nations. Among them, 298 (29.4 per cent of 1,012) were single-country articles representing 35 countries and 571 (56.4 per cent) were multinational collaborative articles representing 59 countries. The study also shows that the USA published 226 articles (22.3 per cent of 1,012), followed by India, Brazil, the United Kingdom and Malaysia, with a number of published articles of 200 (19.8 per cent), 119 (11.8 per cent), 114 (11.3 per cent) and 107 (10.6 per cent) respectively. The study also indicated that India has been the most productive

Table III: The top 20 most productive countries with the highest total number of articles

Country	TP	TPR %		IPR %		CPR %		FPR %		RPR %		SPR %	
USA	226	1	22	2	3.7	1	14.5	2	12.7	2	13.2	2	0.002
India	200	2	20	1	7.5	3	7.3	1	18.3	1	15.5	3	0.001
Brazil	119	3	12	4	2.2	8	4.0	3	10.1	3	10.0		N/A
UK	114	4	11	8	0.89	2	8.8	6	4.0	7	3.8	3	0.001
Malaysia	107	5	11	3	2.9	5	5.0	4	8.4	4	8.1		N/A
Australia	75	6	7.4	6	1.2	10	3.8	5	4.8	5	5.0	3	0.001
Italy	65	7	6.4	14	0.10	4	6.1	20	0.79	6	3.9		N/A
Thailand	61	8	6.0	7	0.99	9	3.9	7	3.5	8	3.5	3	0.001
France	52	9	5.1	11	0.39	6	4.2	8	2.9	10	2.9	3	0.001
Mexico	45	10	4.4	13	0.20	13	3.2	10	2.8	9	3.2		N/A
Indonesia	44	12	4.3	5	1.5	18	1.8	9	2.9	11	2.8	1	0.004
Saudi Arabia	44	13	4.3	14	0.10	7	4.1	19	0.89	21	0.69	3	0.001
China	44	11	4.3	13	0.20	11	3.7	11	2.8	12	2.6		N/A
Japan	42	14	4.1	12	0.30	12	3.6	17	1.4	18	1.4	3	0.001
Taiwan	39	15	3.8	11	0.39	14	3.0	15	1.7	15	1.7	2	0.002
Pakistan	31	16	3.1	9	0.79	20	1.2	12	2.4	13	2.4		N/A
Switzerland	27	17	2.7		N/A	16	2.5	22	0.39	22	0.30	3	0.001
Colombia	26	18	2.6	10	0.49	19	1.8	16	1.5	17	1.5	3	0.001
Germany	26	19	2.6		N/A	15	2.6	21	0.59	20	0.79		N/A
Canada	24	20	2.4		N/A	17	2.1	18	0.99	19	0.89		N/A
Argentina	23	21	2.3		N/A	22	0.49	13	2.2	14	2.2		N/A
Sri Lanka	22	22	2.2	10	0.49	21	0.69	14	1.8	16	N/A		N/A

CPR (%): Rank and percentage of international collaborative articles; FPR (%): Rank and percentage of first-authored articles; IPR (%): Rank and percentage of independent articles; N/A: Not available; RPR (%): Rank and percentage of corresponding-authored articles; SPR: Rank and percentage of single-authored articles; TP: Total number of articles; TPR (%): Rank and percentage of total articles.

country for three indicators; independent articles, the first authored article and the corresponding authored article, while the USA led the international collaborative article among all the countries mentioned. Indonesia was the largest contributor to single-authored papers.

In order to have a better understanding of the findings, the graph analysis was divided into five countries with the highest number of publications. Each represented the USA, rank 1, total publications (TP) = 225; India, rank 2, TP = 200; Brazil, rank 3, TP = 119; United Kingdom, rank 4, TP = 114; and Malaysia, rank 5, TP = 107. In an effort to classify and assess the pattern of publication for each country from 2010 to 2020, the values of published papers were calculated on the basis of the annual number of articles. In order to determine the difference between these distributions, a comparison of the profile of the total published papers was made between the USA and the other four nations. Figure 2B shows the patterns in the annual number of publications for the five leading countries TP > 100. The growth pattern was very similar before 2013, but then started to diverge. The US and India showed a much faster growth rate, but slowed down after 2016, while Brazil and Malaysia showed a slower growth pattern relative

to other countries. The United Kingdom also displayed slow but steady growth until the end of the study period. Research data on dengue vector-related articles were further analysed on the basis of the author's affiliation institutions. Table 4 shows the top 20 organisations ranked by the highest number of publications with more than 20 papers. Liverpool University, England topped the list with 59 articles (5.8% of 1,014), followed by the University of California, USA (53 articles, 5.2%), Bharathiar University, India (48 articles, 4.7%), University of Pisa, Italy (44 articles, 4.3%), and Universiti Sains Malaysia, Malaysia (40 articles, 3.9%) respectively. Malaysia had the highest number of institutions (four), followed by Australia (three), the United Kingdom, the United States, India and Italy (two). Mexico, Saudi Arabia, Thailand, and Taiwan each had a single article with at least 20 articles written. The University of Liverpool published 59 of the 114 articles (52 per cent) from the United Kingdom, while the University of Pisa published 48 of the 65 articles (68 per cent) from Italy and Universiti Sains Malaysia published 40 of the 107 articles (37 per cent) clearly indicating that these institutions were very influential in their respective countries. The percentage of single-institution papers in total articles (SIPR) for each country was also analysed. Universiti Sains Malaysia and Cornell University, USA, had the highest percentage of single institution posts. As far as foreign collaborative articles are concerned,

Table IV: The top 20 institutions with the highest number of articles

Institution	TP	TPR %	SIPR %	ICPR %	NCPR %	FPR %	RPR %	SPR %	SP %	ICP %	NCP %
University of Liverpool, England	59	1 5.8	8 0.3	1 5.4	12 1.1	2 1.6	8 1.7	N/A	3 5.1	55 93	11 19
University of California, USA	53	2 5.2	9 0.3	2 4.5	1 3.2	6 1.1	2 2.1	N/A	3 5.7	46 87	32 60
Bharathiar University, India	48	3 4.7	4 0.6	4 4.1	7 1.5	1 3.6	9 1.2	N/A	6 12.5	42 88	15 31
University of Pisa, Italy	44	4 4.3	N/A	3 4.3	2 2.5	N/A	1 4.0	N/A	N/A	44 100	25 57
Universiti Sains Malaysia, Malaysia	40	5 3.9	1 0.9	10 2.1	4 2.1	5 1.2	3 2.0	N/A	9 22.5	21 53	21 53
University of Autonoma Yucatan, Mexico	38	6 3.7	13 0.1	5 3.0	5 1.8	3 1.6	4 1.8	N/A	1 2.6	30 79	18 47
World Health Organization (WHO)	30	7 3.0	N/A	7 2.6	14 0.9	12 0.6	16 0.5	N/A	N/A	26 87	9 30
University Roma La Sapienza, Italy	29	8 2.9	N/A	6 2.7	3 2.3	18 0.1	N/A	N/A	N/A	27 93	23 79
King Saud University, Saudi Arabia	26	9 2.6	N/A	8 2.3	15 0.7	N/A	N/A	N/A	N/A	23 88	7 27
Mahidol University, Thailand	26	9 2.6	10 0.3	12 1.9	13 1.0	14 0.5	11 1.0	N/A	3 11.5	19 73	10 38
James Cook University, Australia	25	10 2.5	14 0.1	14 1.4	5 1.8	17 0.4	15 0.6	1 0.1	1 4.0	14 56	18 72
Universiti Malaya, Malaysia	24	11 2.4	3 0.8	18 0.8	11 1.2	7 0.9	5 1.8	N/A	8 33.3	8 33	12 50
Annamalai University, India	23	12 2.3	5 0.6	13 1.6	12 1.1	4 1.3	6 1.8	1 0.1	6 26.1	16 70	11 48
University of Melbourne, Australia	23	12 2.3	6 0.4	15 1.2	8 1.4	10 0.7	10 1.1	N/A	4 17.4	12 52	14 61
University of London, England	23	12 2.3	N/A	9 2.2	11 1.2	15 0.5	17 0.5	N/A	N/A	22 96	12 52
Cornell University, USA	22	13 2.2	2 0.9	17 1.0	11 1.2	9 0.8	7 1.8	N/A	9 40.9	10 45	12 55
Universiti Kebangsaan Malaysia, Malaysia	22	13 2.2	11 0.3	16 1.2	10 1.3	11 0.7	12 1.0	N/A	3 13.6	12 55	13 59
Institute Medical Research, Malaysia	21	14 2.1	12 0.3	20 0.6	9 1.4	8 0.9	13 1.0	N/A	3 14.3	6 29	14 67
National Taiwan Ocean University, Taiwan	21	14 2.1	N/A	11 2.1	16 0.5	13 0.6	18 0.5	N/A	N/A	21 100	5 24
University of Queensland, Australia	21	15 2.1	7 0.4	19 0.6	6 1.7	16 0.5	14 0.8	N/A	4 19.0	6 29	17 81

FPR (%): Rank and percentage of first-author articles; ICP (%): Number and the percentage of internationally collaborative articles in total articles within each institution; ICPR (%): Rank and percentage of internationally collaborative articles; N/A: Not available; NCP (%): Number and percentage of nationally collaborative articles in total articles within each institution; NCPR (%): Rank and percentage of nationally collaborative articles; RPR (%): Rank and percentage of corresponding-authored articles; SIPR (%): Rank and percentage of single-institution articles; SP (%): Number and percentage of single-institution articles in total articles within each institution; SPR (%): Rank and percentage of single-author articles; TP: Total number of articles; TPR (%): Rank and percentage of total articles.

Liverpool University had the highest number of articles compared to the other institution with 55 articles (93 percent of 59), while the University of California had the highest percentage in national collaborative articles with 32 (60 percent of 53) of the number of articles written.

Leading Article

A high number of citations for an article that could have a high impact or prominence in the research field, hence dengue vector-related papers published between 2010 and 2020 were further analysed by determining the quotation number for each article. This analysis examined four metrics in terms of citations, namely: (i) citations in the last year (C_{year}); (ii) the number of citations in the year of publication (C0); (iii) the number of citations after publication to the end of the year (TC_{year}); and (iv) TC_{years} per year (TCPY). Table 5 displays the top 10 most commonly cited papers in 2020 with a number of citations greater than 20 selected. The total number of citations was derived from SCI-EXPANDED, which revealed the total number of times that a single article was cited in the database. The most widely cited paper in 2020 was 'The effective establishment of the population of Wolbachia in Aedes to suppress dengue transmission,' published in Nature by Hoffmann et al. in 2011. It was cited 81 times in 2020 (C_{2020} = 81). The paper also had the highest all-time quotation (TC_{2020} = 756 times) since its publication at the end of 2020 every year (TCPY = 76 times) compared to the other papers. The article with the largest number of citations in the year of publication (C_0 = 21 times) was 'Eugenol, alpha-pinene and beta-caryophyllene from Plectranthus barbatus essential oil as eco-friendly larvicides against malaria, dengue and Japanese encephalitis mosquito vectors,' as published in Parasitol Research by Govindrajan et al. in 2016. The majority of publications (8 out of 10) received less citations in the first year of publication, with less than 10 (2 out of 8) not earning any citations in the year of publication. With the exception of the article by Hoffman et al. (2011), in 2020 the remaining three of the five publications with the most cited article were listed among the top five in terms of the overall quotation (TC_{2020}).

Table V: Top 10 the most frequently cited papers in 2020

Rank (C_{2020})		Rank (C_0)		Rank (TC_{2020})		Rank ($TCPY_{2020}$)		TITLE	Ref
1	81	2	7	1	756	1	76	Successful establishment of *Wolbachia* in Aedes populations to suppress dengue transmission	(34)
3	41	4	3	2	415	3	38	The Endosymbiotic *Bacterium Wolbachia* Induces Resistance to Dengue Virus in *Aedes aegypti*	(35)
4	39	1	21	3	203	2	41	Eugenol, alpha-pinene and beta-caryophyllene from *Plectranthus* barbatus essential oil as eco-friendly larvicides against malaria, dengue and Japanese encephalitis mosquito vectors	(36)
5	29	4	3	4	190	5	32	Suppression of a Field Population of *Aedes aegypti* in Brazil by Sustained Release of Transgenic Male Mosquitoes	(37)
8	26		N/A	5	183	7	20	Insecticide resistance in the major dengue vectors *Aedes albopictus* and *Aedes aegypti*	(38)
6	29	4	3	7	147	6	21	Vectorial Capacity of *Aedes aegypti*: Effects of Temperature and Implications for Global Dengue Epidemic Potential	(39)
9	23	3	5	6	150	8	19	Impact of environment on mosquito response to pyrethroid insecticides: Facts, evidences and prospects	(40)
2	50	4	3	9	96	4	32	Improved reference genome of *Aedes aegypti* informs arbovirus vector control	(41)
7	28	4	3	8	114	9	16	Essential oils and their compounds as *Aedes aegypti* L. (Diptera: Culicidae) larvicides: review	(42)
10	21		N/A	10	83	10	10	Dengue Vector Dynamics (*Aedes aegypti*) Influenced by Climate and Social Factors in Ecuador: Implications for Targeted Control	(43)

C_{2020}: Number of citations in 2020; C_0: Number of citations in the publication year; TC_{2020}: Number of citations since its publication to the end of 2020; TCPY: TC_{2020} per year.

DISCUSSIONS

The analysis from this study shows the rapid expansion in dengue vector related articles worldwide. Based on the findings, the growth patterns showed a period of decline growth. It could not be concluded if this was due to a real slow-time in research or a lag in indexing or publication time. Although some publications numbers could probably be updated, the number will likely be very small. Overall, the results clearly showed the significance increase in the number of publication from 2011 to 2015, which could be due to increase in funding which would have led to increase in publication. Other studies have revealed a positive correlation between funding with publication outputs in public health related

research (16). In the last few decades, research funding of dengue related project have arisen across the world (17). Dengue research fields are typically mostly funded by government sectors, but recently private sector have also began to take part on research funding for dengue in developing countries (18). Moreover, an increment in funding also affects the development of research topics and research category to represents a recent issues.

Citation frequency and time since publication have a strong correlation and it has been a topic in earlier research; articles published earlier accumulated more citations (19). This situation is not surprising, as it takes time to gain citations (20). Recently, more articles had shorter time to produce a high number of citations and because of the high number of articles published per year, citations per article show a declining trend. This finding is similar to what was observed from the study in the field of arts (21) and science (22).

Research categories were designated to each article in index of WoS and show the subjects assigned to them. Research categories are also the based on the article and more than one research category can be designated for each article. A network of research categories can be built based on their connections in the same article and can provide insight into the knowledge system involved in dengue research (12). There were 76 research categories involved in dengue vector related articles. The top five categories with the highest number of publication indicate the most relevant research subjects over the past 10 years. Parasitology and tropical medicine had the highest degree of publications, indicating they were the most associated research categories in dengue vector articles. In terms of publication pattern of dengue-vector related articles, the trends of articles shifted over time. At early stage of the study period, the outcome revealed the most frequent research topics based on Aedes mosquito vector. However, in the last period of the study, new topics based on virus structure, epidemiological studies related to dengue vector and dengue vaccines started to emerge. Further analysis can be developed in the future in order to assess the relationship between dengue virus structure and the development of dengue vaccines or antiviral agents. This approach need to strengthen from other authors since this type of study was limited.

Although the number of publications in the bibliometric analysis has increased rapidly, there are still weaknesses in the assessment of the quality of publications. Impact Factor (IFyear) is appropriate to explain the quality of the journal, but it is less important to indicate the quality of the published article. Journal IF commonly has the advantages of easy accessibility and is widely used, especially in the Journal Citation Report (JCR) for SCI-EXPANDED. It does not, on the other hand, reflect the quality of each article in the journal. In addition, the quotation number for each article sometimes does not reflect the quality of the article (23).

Interestingly, this study revealed that the leading countries in dengue vector related research is quite different from the leading countries presented in most bibliometric studies of bio-medical fields where the leading countries comprised of G7 countries (24,25). This present study showed that, among the top ten countries in dengue vector study were countries from the region of America (Brazil), South-east Asia (India) and Western Pacific (Malaysia) which are unpopular in bio-medical field studies. This trend could probably be due to the regional specificity of dengue vector research since dengue fever is endemic in these country and is a public health concern. (26). We summarized that with the higher disease burden more efforts are needed to combat the disease; hence leading to a high number of articles published.

From the analysis, collaboration in dengue vector research has involved 1,119 institutions approximately. International co-authorship collaboration between one country and another or a different region occurred frequently based on the data represented. This scenario was likely due to the prior education of authors from developing countries who received education in developed countries or authors in need for highly advanced facilities or technology owned by institutions or universities originating from developed countries (27). The global organisational networks between institutions or countries showed the trend of high collaborative network for dengue vector research. Countries with a high number of articles also published but low reported cases probably can collaborate with countries with high reported cases in order to complement each other. This situation may increase research output in a short period of time and enhance the publication research capacity for counties with low resources or unable to establish their own independent research (28).

The use of citation analysis in order to gain a better article is sometimes ineffective, as some of the recently published articles have a lower probability of accumulation of citation. Furthermore, total number of citations of the articles only indicate the usefulness of those articles to the authors of other papers for writing their own papers rather than to be considered as form of impact. However, the citation analysis can show from the published articles what can be considered the most relevant recent dengue studies. In addition, a high quotation for an article can be considered to have a high impact or high visibility in the field of research. The number of accumulative citations of the articles may indicate that the articles were basic knowledge in order to build a wide range of field investigations and public health interventions (12). It also provides a judgement as to which authors, topics and research categories can be considered to be highly influential in the research discipline over time (29). Due to the increase in the number of published articles related to dengue vectors, it is almost impossible to evaluate a good paper using standard bibliometric tools, particularly 'total number of citations' (TC_{year}) (30). Another indicator that is the number of 'citations in the last year' (C_{year}) can be used instead to identify the top articles (31). The combination

of 'total citation' ($TC_{yea}r$) and 'last year citation' (C_{year}) may indicate the leading theme in these research fields (32, 33).

CONCLUSION

In conclusion, this research reviewed the dengue vector related papers and gained some valuable insights into the study of related patterns and the output of the studies from 2010 to 2020. This research provided systematic structural hints, impact images on various dengue vector related papers. Dengue vector-related papers showed an exponential rise in the years 2014 to 2016. Compared to other research areas, dengue vector-related papers tended to be regionally relevant. The number of foreign collaborative papers was therefore high. Developing countries as well as countries with a heavy caseload were among the leaders of the research publication. Published articles have been found in a wide range of categories, especially in parasitology and tropical medicine, comprising 60 per cent of the total articles. PLOS Neglected Tropical Disease has the largest number of publications published in total relative to other journals. Citation in the last year and the cumulative number of citations since its publication created a different 'star' of the highly cited paper. The findings of this method of bibliometric analysis can be a reference for other related researchers to understand the global dengue vector study and to provide guidance for further study. The findings of the bibliometric analysis along with other Research and Development (R&D) extension methodologies such as Social Network Analysis (SNA) techniques can be used in order to combine the bibliometric indicators and shows connection of these elements in a knowledge domain.

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