

Coronavirus survey; a bibliometric analysis from 2012-2019.

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Abstract

Background: Coronaviruses have emerged from animal reservoirs over the past decades to create severe illness and death. They are the SARS-CoV, MERS-CoV and more recently, the SARS-CoV2. This study is focused at assessing the characteristics of published works involving SARS-CoV and MERS-CoV at global level; using bibliometric analysis.

Methods: Peer-reviewed publications were retrieved from the Scopus database between 2012 and 2019. Data were analyzed in terms of the year, journal and number of publications, international collaboration patterns, research institutes, impact factor, h-index and number of times cited. Visual presentation and analysis of the data were performed using RStudio, Tableau and Microsoft Excel.

Results: A total of 1707 research publications were published across the world between 2012 and 2019 with the highest and lowest number of publications in 2016 (288) and 2012 (87). USA had 249 articles, followed by South Korea (186) and Saudi Arabia (111). The total number of citations achieved was 39,094 with *Journal of Virology* (133) had the highest number of published articles, followed by *Emerging Infectious Disease* (85) and *PLOS One* (60).

Conclusion: This research showed the international diversity of MERS-CoV and SARS-CoV research with 106 countries. It is also not surprising that United States leads in the number of publications, authors and citations because of its global power and economic strength; this can also be said with the other top countries. Saudi Arabia was among the top rank because of the origination of the MERS-CoV in the middle east.

Background

Coronaviruses are a wide family of enveloped single-stranded RNA viruses that cause mild to severe illnesses in the upper-respiratory tract in mammals and birds; with a high mortality rate [1]. Mild illnesses are cases of common cold predominantly caused by Rhinoviruses, the severe cases cause SARS-CoV, MERS and SARS-CoV-2 [9,10,11]. Coronavirus was first identified by Dr. J. Almeida in 1964 at her laboratory in London St Thomas's Hospital [1,2]. The first severe outbreak of coronavirus (SARS-CoV) occurred in November, 2002 and ended July 31, 2003; infecting 8,096 humans in 29 countries and regions [3,7]. The second severe outbreak involved the MERS which was first discovered in September 2012 and has since spread to 27 countries with 2519 cases and 866 deaths [4,7, 12] the third and most recent/sever outbreak involved the COVID-19 that was discovered in December 2019 and has spread to 210 countries and regions with over 2.2 million cases and 150, 000 deaths as at April 17, 2020 [5]. Bibliometric tool-works have been largely used to explore the global contributions in several infectious diseases [8]. An up-to-date bibliometric research on SARS and MERS have not been reported in other to know the trends of coronavirus; the aim of this study is to perform an up-to-date global qualitative and quantitative bibliometric analysis of publications in Scopus to reveal the properties of global research output involving SARS-CoV and MERS-CoV before the discovery and outbreak of SARS-CoV-2. Findings

from this study will provide a comprehensive view on coronaviruses before the discovery of the recent COVID-19 (SARS-CoV-2). This serves as an important reference for further studies including the research trends on the global pandemic COVID-19. Furthermore, it gives a broad view for editorial journals and authors on future research direction on coronaviruses.

Methods

Publications were retrieved from the *Scopus* database created and developed by Elsevier in the Netherlands [13, 14]. *Scopus* contains a large database with more than 24,000 titles of which about 20,000 are peer-reviewed journals from about 5,000 international publishers [14, 15]. It is known to harbor reliable data and can provide a larger information for analysis when compared to PubMed and Web of Science [14, 16]. This study contains only English peer-reviewed research articles retrieved from 2012 till December 31, 2019 with specified search terms: “severe acute respiratory syndrome” or “middle east respiratory syndrome” or “MERS” or “SARS” or “coronavirus” or “SARS-CoV” as part of its title, abstract or keywords. Data involving the latest SARS-CoV outbreak (COVID-19) discovered in December 2019 were excluded from this bibliometric analysis. All of these terms are used in one query and retrieved in one day to avoid possible bias that comes from update on the Scopus database due to the constant change in metrics [8, 17,18]. Data retrieved were analyzed quantitatively and qualitatively by RStudio (1.2.5001), Tableau (2020.1) and Microsoft Excel (2019); involving the calculation of average, percentages, sum and relative frequencies [22]. Parameters analyzed include year of publications, patterns of international collaboration, country, journals author, keywords research institutions, *h*-index, impact factors (IF) and times cited [21, 22].

The measurement of the impact or productivity of the published researches in SARS-CoV, MERS-CoV, *h*-index and IF were used as indicators for this bibliometric evaluation. In 2005, Jorge E. Hirsch introduced the *h*-index as a metric that attempts to evaluate the citation and productivity impact of the publications of a region, scientist or scholar. The IF of the journals reported in the SCImago Journal & Country Rank was used [19, 20]. Ranking of the top journals was considered for this study and shown in descending order starting with the 1st (standard competition ranking) as obtained from the day of retrieval.

Results

In this study, 1707 associated articles were retrieved, with 7444 authors and 39,094 citations at an average of 22.80 citations per documents (Table 1). The SARS-CoV and MERS-CoV associated articles originated from 106 countries/territories, indicating the global widespread of SARS-CoV and MERS-CoV research. A total number of 87 (5.10%) articles were published in year 2012, 143 (8.38%) in 2013, 243 (14.24%) in 2014, 260 (15.23%) in 2015, 288 (16.87%) in 2016, 238 (13.94%) in 2017, 223 (13.06%) in 2018 and 225 (13.18%) in 2019 (Figure 1), the annual growth of publications between the year 2012 and 2019 was recorded at 14.54%.

Table 2 shows the top countries/territories with the highest number of h-index publications including the number and percentage of their publications with international collaborations. Out of 1707 publications, United States had the highest number of contributors with 249 publications (14.57% of total publications); this was followed by South Korea with 186 publications (10.89% of total publications), Saudi Arabia at 111 (6.50%) publications and China (5.33%). From the top ten countries with the most published articles, Netherlands had the highest publication percentage with international collaboration at 79.17% (19 out of its 24 articles); followed by Hong Kong at 56.09% (23 of its 41 articles) and Saudi Arabia at 54.05 % (60 out of 111 articles) (Table 2). A network map was created using RStudio to visualize the network distribution and collaboration of countries/territories contributing to the field of MERS-CoV and SARS-CoV research between 2012 and 2019, which is presented in Figure 2, matching the general ranking marks in Table 2.

This shows USA (86) with the highest number of articles with global collaboration, followed by Saudi Arabia (60), China (35), South Korea (27) and Germany (25).

The SARS-CoV and MERS-CoV related articles were retrieved from 509 journals, but mostly in these journals: *Journal of Virology* (133), *Emerging Infectious Disease* (85), *PLOS One* (60) and *Eurosurveillance* (36); (Table 3). The impact factor (IF) for the top ten publication ranged from 2.48 (*Journal of Infection and Public Health*) to 9.58 (*Proceedings of the National Academy of Science of the United States of America*). Zaki et al. (1400) and Assiri et al. (587) produced the top 2 frequently cited publication; published in the *New England Journal of Medicine* with an impact factor of 70.67 (Table 4), this is followed by Agarwala et al. with 487 total citations in the *Nucleic Acid Research* journal (IF of 11.147) and Assiri et al. (391) in *The Lancet Infectious Diseases* (IF of 27.516).

The number of citations in this study was totaled at 39,094 (Table 5); with USA having the highest citations (7824), followed by Saudi Arabia (4701), Netherlands (3411), China (2294) and Germany (1951). Figure 3 shows the network map of the top 20 most productive institutions in SARS-CoV and MERS-CoV research created using RStudio between 2012 and 2019; with Ministry of Health, Saudi Arabia taking the lead as the most productive institute (84 publications), followed by Alfaisal University, Saudi Arabia (76), King Saud University, Saudi Arabia (63), The University of Hong Kong (62) and Centers for Disease Control and Prevention, USA (55).

From this study, 7444 authors were involved in the MERS-CoV and SARS-CoV research; Figure 4 shows the global map distribution (created using Tableau) of the top ten countries with the highest number of authors. USA recorded the highest number with 1763 authors, followed by Saudi Arabia (964), Hong Kong (767), China (715) and United Kingdom (322 authors).

Discussion

This bibliometric analysis of MERS-CoV and SARS-CoV examined global research trends between 2012 and 2019 based on data retrieved from Scopus database. Comparing previous studies on the SARS-CoV outbreak in 2003, a rise in research followed by a decline may be due to the containment and near-

eradication of the disease [8, 10, 11, 21, 23]. This trend may be seen in the novel coronavirus pandemic (COVID-19) after a decline in the disease spread due to vaccination or other safety precautions. In 2016, WHO listed MERS-CoV and SARS-CoV as one of several viruses likely to cause epidemic in the future, which gives a possibility for another rise in this research field in the future since there are no current treatment or prophylactic vaccine to prevent or ameliorate the disease outbreak [6, 24].

United States produced the highest number of publications, this is not a surprise because United States have always played a prolific role in general scientific research from previous bibliometric researches [21, 23, 25, 26]. This may also be due to the focus of the Center for Disease Control and Prevention (CDC) on potential coronavirus threats to humans than any other country [27, 28, 29]. Another reason is also the size, economic strength and stance of the country as the center of innovation; this can also be said about South Korea and China involvement in MERS-CoV and SARS-CoV research [27, 29, 30]. These two countries over the years are climbing ranks among the top research countries in the world [31, 32, 33]. Saudi Arabia, a middle-eastern country, comes out third among the top productive countries; may be due to the origination and outbreak of MERS-CoV from the middle east. These reasons can also be used to justify the high number of citations among these countries; with USA recording the highest followed by Saudi Arabia; with China, South Korea and Hong Kong also featuring among the top ten [21, 27, 29, 31, 32, 34, 35].

The *Journal of Virology* had the most published article in the field of MERS-CoV and SARS-CoV research, and this is not surprising since the journal specializes on viruses with a high IF of 4.324 [19].

Emerging Infectious Disease, PLOS One, Eurosurveillance and *Mbio* follow suit; from previous bibliometric studies, these journals are the top-ranking journals in microbial research and may be due to their high IF and the international presence they have in the scientific research field [19]. Zaki et al. was the first (2012) to report the outbreak of MERS-CoV in an article, making it the most cited publication in this research field. This is also due to the high impact factor (70.67) of the journal it was published in (*New England Journal of Medicine*) [21,23]. The second most cited publication also featured in the *New England Journal of Medicine*, reported by Assiri et al. in 2013 [12, 21]. This publication reported cases of MERS-CoV in the middle eastern country. Other articles in the top ten cited publications also featured in high impact factor journals with global recognition; which may be the reason for its numerous citations [19]. Previous study showed that a higher IF of a journal result in a higher number of citations and that the most cited publications usually have high IF, which in turn make the IF go higher or stay high [36,37].

The high number of authors, publications, international collaborations and citations showed the global impact of MERS-CoV and SARS-CoV in science and around the world. Research involves actions taken to produce and develop knowledge which are used to solve problems, develop new and better products and invent solution to global, continental, national, state and local crisis [38]. This bibliometric analysis in combination with previous bibliometric study proves that it is important to continue scientific researches to fight the current global problems; like the novel coronavirus (COVID-19 or SARS-CoV-2).

Conclusion

This bibliometric study showed the trends of severe coronaviruses research from the outbreak of MERS-CoV in 2012 till 2019, prior to the COVID-19 pandemic. It provides useful information on the trends of coronaviruses to tackle the novel COVID-19 outbreak. The analysis showed a rise in research followed by a decline after the containment of the outbreak in 2012. It also shows USA and Saudi Arabia as the top research countries on MERS-CoV and SARS-CoV; with majority of publications in this field are published by high-income countries. This study provides a useful reference for researchers and workers in the field of medicine, virology, epidemiology, microbiology, policy making and public health.

Declarations

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Availability of data and materials

Not applicable

Ethics approval and consent to participate

As a bibliometric analysis, there were no patients involved and only the use of secondary database, there was no institutional review board (IRB) approval and it was exempted.

Competing interest

The authors declare that there are no competing interests.

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Tables

Table 1: Overview of published scientific documents on MERS-CoV and SARS-CoV

Description	Findings
Document type	Articles
No of documents	1707
Keywords plus (ID)	8703
Author's keywords	2437
Period	2012-2019
Number of Citations	39,094
Average citations per documents	22.80
Authors	7444
Authors appearance	14897
Authors of single-authored documents	87
Authors of multi-authored documents	7357
Single-authored documents	98
Documents per author	0.23
Authors per document	4.36
Co-authors per documents	8.73
Annual percentage growth rate	14.54
Number of countries	106
Collaboration index	4.57

Table 2: The top ten countries/territories with scientific research on MERS-CoV and SARS-CoV research at *Scopus* (up to December 31, 2019)

SCR	Countries/territories	Total number of publications (%)	Number (%) of publications with international collaboration
1 st	United States	249 (14.57)	86 (34.54)
2 nd	South Korea	186 (10.89)	27 (14.52)
3 rd	Saudi Arabia	111 (6.50)	60 (54.05)
4 th	China	91 (5.33)	35 (38.46)
5 th	Germany	49 (2.87)	25 (51.02)
6 th	Hong Kong	41 (2.40)	23 (56.09)
7 th	United Kingdom	36 (2.11)	15 (41.67)
8 th	Japan	34 (1.99)	17 (50.00)
9 th	Taiwan	26 (1.52)	6 (23.08)
10 th	Netherlands	24 (1.41)	19 (79.17)

SCR standard competition rankings

Table 3: The 10 most published journals

SCR ^a	Journal	Frequency (%)	IF ^b
1 st	<i>Journal of Virology</i>	133 (7.79)	4.324
2 nd	<i>Emerging Infectious Diseases</i>	85 (4.69)	7.422
3 rd	<i>PLOS One</i>	60 (3.51)	2.776
4 th	<i>Eurosurveillance</i>	36 (2.11)	7.150
5 th	<i>MBio</i>	34 (1.99)	6.747
6 th	<i>Scientific Reports</i>	32 (1.88)	4.011
7 th	<i>Viruses</i>	29 (1.69)	3.811
8 th	<i>Proceedings of the National Academy of Sciences of the United States of America</i>	26 (1.52)	9.580
9 th	<i>International Journal of Infectious Diseases</i>	25 (1.47)	3.538
10 th	<i>Journal of Infection and Public Health</i>	25 (1.47)	2.487

SCR standard competition ranking, IF impact factor. ^a Equal journals have the same number of ranking. ^b The impact factor was reported according to the SCImago Journal & Country Rank (2020)

Table 4: The top ten cited publications

SCR ^a	Authors	Source title	Year of publication	IF ^b	TC	TC/Year
1 st	Zaki et al	<i>New England Journal of Medicine</i>	2012	70.670	1400	155.60
2 nd	Assiri et al	<i>New England Journal of Medicine</i>	2013	70.670	587	73.40
3 rd	Agarwala et al	<i>Nucleic Acid Research</i>	2016	11.147	487	97.40
4 th	Assiri et al	<i>The Lancet Infectious Diseases</i>	2013	27.516	391	48.90
5 th	Reusken et al	<i>The Lancet Infectious Diseases</i>	2013	27.516	374	46.80
6 th	De Groot et al	<i>Journal of Virology</i>	2013	4.324	361	45.10
7 th	Ge et al	<i>Nature</i>	2013	43.070	322	40.20
8 th	Memish et al	<i>Emerging Infectious Diseases</i>	2013	7.422	307	38.40
9 th	Haagmans et al	<i>The Lancet Infectious Diseases</i>	2014	27.516	304	43.40
10 th	Azhar et al	<i>New England Journal of Medicine</i>	2014	70.670	299	42.70

SCR standard competition ranking, IF impact factor, TC total citations. ^a Same journals have the same number of ranking ^b The impact factor was provided according to the SCImago Journal & Country Rank (2020).

Table 5: Total citations per country

SCR	Country	Total Citations	Average Article Citations
1 st	USA	7824	31.42
2 nd	Saudi Arabia	4701	42.35
3 rd	Netherlands	3411	142.12
4 th	China	2294	25.21
5 th	Germany	1951	39.82
6 th	South Korea	1706	9.17
7 th	Hong Kong	1687	41.15
8 th	United Kingdom	896	24.89
9 th	France	796	36.18
10 th	Japan	550	16.18

SCR standard competition ranking, *IF* impact factor. ^a Equal journals have the same number of ranking. ^b The impact factor was reported according to the SCImago Journal & Country Rank (2020).

Figures

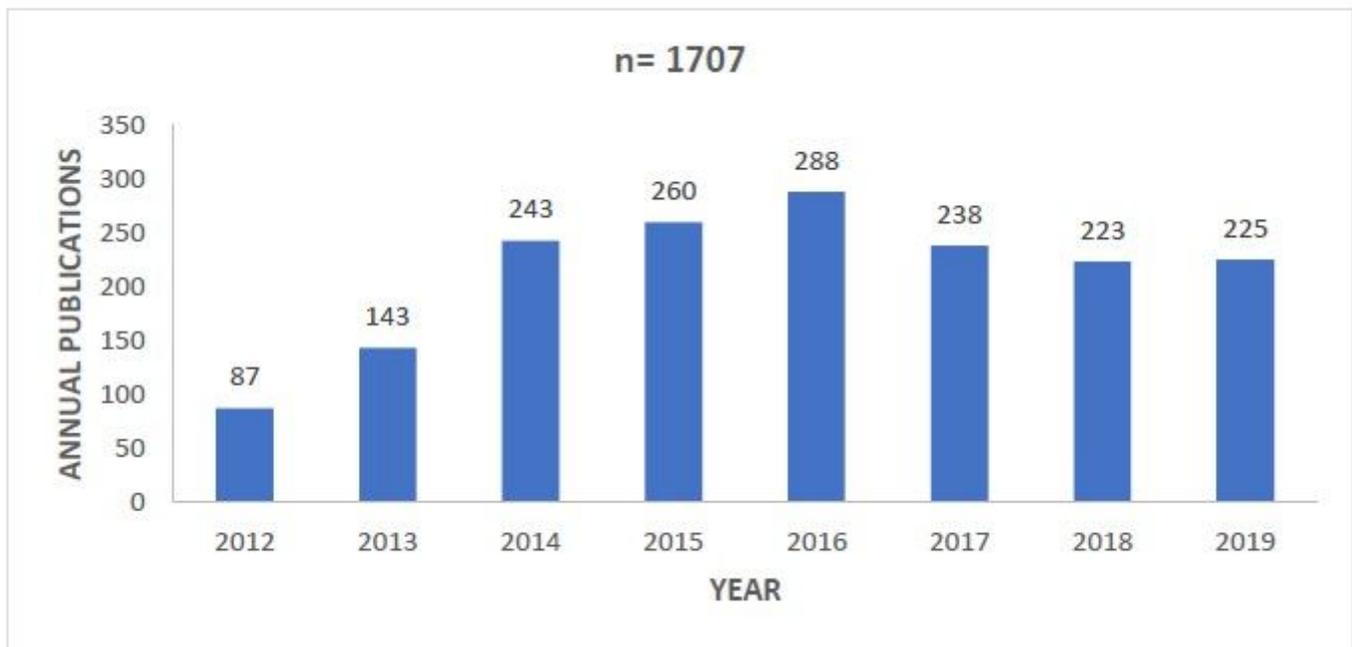


Figure 1

Distribution of yearly publications on SARS-CoV and MERS-CoV from 2012 to 2019

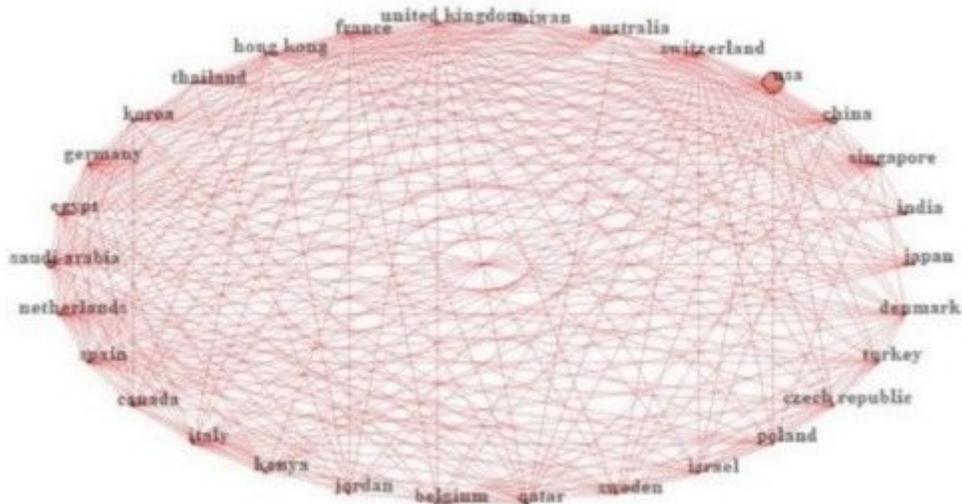


Figure 2

Countries/territories collaborations focusing on MERS-CoV and SARS-CoV research

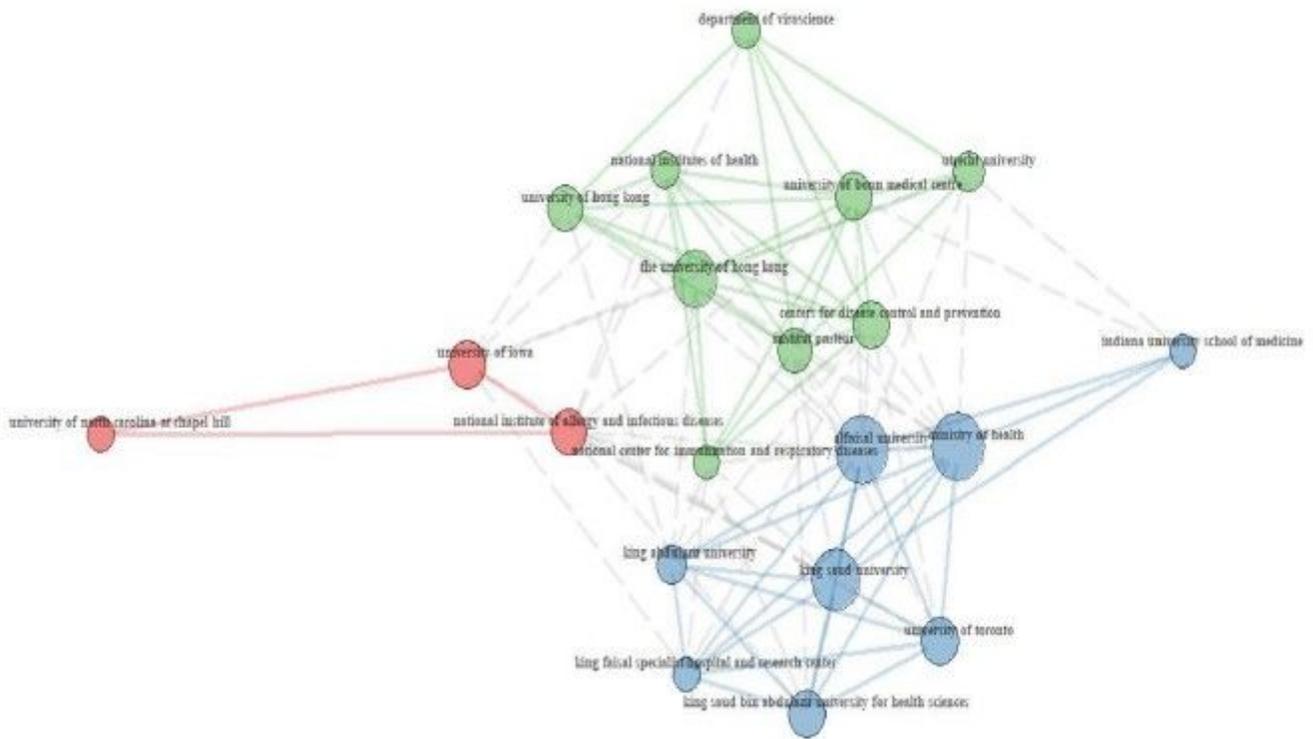


Figure 3

The top 20 highly productive and influential institutions in SARS-CoV and MERS-CoV research field.



Figure 4

The top ten countries with the highest number of authors. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.