

A Scientometric Study of Cardiomyopathy Disease Research in BRICS Countries During 2011-2020

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Abstract

The study tries to determine the research trends of BRICS countries on cardiomyopathy disease research during 2011–2020. The study analyses 8,013 cardiomyopathy research documents retrieved from the Web of Science database for ten years. Findings of the study revealed that the maximum documents 1,189 were published in 2020, 23.07% maximum annual growth rate was recorded in 2013, and the highest 93.11% CAGR was recorded in the year 2012. The highest RGR 1.84 and doubling time 1.17 recorded in the year 2020 and 2013, respectively. The most prolific journal was the International Journal of Cardiology, with 209 articles. Zhang Y contributed the most number of documents (236, 2.94%). The University of Sao Paulo had the top most relevant affiliation with 787 documents. China led the list of most cited countries with 53,306 total citations, but the USA had the highest average article citations, i.e., 29.24. The majority of documents were in the form of articles. China contributed the most number of documents among all the BRICS countries.

Keywords: Cardiomyopathy, Scientometrics, Annual Growth Rate, Compound Annual Growth Rate, Relative Growth Rate, Doubling Time

Introduction

Cardiomyopathies are disorders characterised by structural and functional malformation of the myocardium (Jarvis, 2019). The main types of cardiomyopathies are Dilated cardiomyopathy (DCM), Hypertrophic cardiomyopathy (HCM), Restrictive cardiomyopathy (RCM), Arrhythmogenic cardiomyopathy (ACM) and Unclassified cardiomyopathies (Elliott et al., 2008). According to the World Health Organization, India

is responsible for one-fifth of cardiovascular deaths worldwide, particularly among the younger population. According to the findings of the Global Burden of Disease study, India has an age-standardised CVD death rate of 272 per 100,000 people, which is much higher than the global average of 235 (Kumar & Sinha, 2020). Vassily V. Nalimov and Z. M. Mulchenko invented the Russian word ‘scientometrics’ (‘naukometriya’) in 1969. As the name implies, this word is mainly used to explore all areas of science and technology literature (Hood & Wilson, 2001). M. T. Beck defined scientometric as the study of the calculation of scientific and technological advancement (Beck, 1978). Scientometrics as a technique has a wide range of applications in identifying research, trends in a subject, trends in authorship and collaboration in research, core periodicals, studying the author’s productivity and impact of research and scientific publication distribution. Additionally, scientometrics could be used to identify new research areas (Brindha & Murugesapandian, 2016). BRICS is a group of states comprising the Federative Republic of Brazil, the Russian Federation, the Republic of India, the People’s Republic of China, and South Africa. The Russian side first proposed the formation of BRICS. On the initiative of Russian President Vladimir Putin, the inaugural BRICS Ministerial Meeting was held on September 20, 2006 (BRICS Information Portal, n.d.). BRICS is a significant grouping that brings together the world’s biggest emerging economies. According to World Bank data (2019), BRICS countries account for 41% of the world’s population or 3.14 billion people. The total aggregate area of the world’s land surface is 29.3%. It accounts for 24% of world GDP and 16% of all global trade. (BRICS INDIA 2021 | Ministry of External Affairs, n.d.). As the CVD deaths are increasing day by day, according to WHO, 17.9 million people die each year from CVDs, an estimated 32% of all deaths worldwide (Cardiovascular diseases, 2021). For that

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reason the present study named “A Scientometric Study of Cardiomyopathy Disease Research in BRICS Countries During 2011-2020” has been carried out to know the growth and development of cardiomyopathy disease research in BRICS countries.

Study Objectives

- To identify the year-wise publications and annual growth rate (AGR).
- To determine the compound AGR.
- To find out the relative growth rate and doubling time of publications.
- To identify the most prolific journals and most local cited sources.
- To discover the most relevant authors and affiliations in cardiomyopathy research.
- To know the most used author keywords.
- To find out the most corresponding authors countries.
- To analysis the document-wise publication.
- To identify the geographical distribution of the publication.

Scope and Limitations

This study is confined to BRICS countries (Brazil, Russia, India, China and South Africa) on cardiomyopathy disease which was indexed in web of science database. This study is further limited to ten years from 2011 to 2020.

Methodology

Web of Science is a citation database maintained by Clarivate analysis and from which we can access over 171 million records. The study retrieved publication data of the BRICS countries on cardiomyopathy from the Web of Science database covering 2011–2020. The search was carried out in the month of August 2021. The data was extracted in CSV format for the study. For further analysis, 8,013 publications were retrieved and loaded in open source software, Bibliometrix R package. The keyword “cardiomyopathy” was used in the search string, and the time frame was set between 2011 and 2020. BRICS country’s publication data further refined the search string. To extract Web of Science data, the

following advanced query was formulated: TOPIC: (Cardiomyopathy) Refined by: PUBLICATION YEARS: (2020 OR 2019 OR 2018 OR 2017 OR 2016 OR 2015 OR 2014 OR 2013 OR 2012 OR 2011) AND COUNTRIES/ REGIONS: (PEOPLES R CHINA OR SOUTH AFRICA OR BRAZIL OR INDIA OR RUSSIA) Results: 8,013.

Related Literature

González-Alcaide et al. (2018) conducted a scientometric analysis of research activity and collaboration patterns in Chagas cardiomyopathy. The researchers collected 1,932 documents on Chagas cardiomyopathy from the MEDLINE database. The study reveals that the most common document type was article. Brazil and the United States led the study, with 53.1% and 25.7% participation, respectively. Heart failure and dysfunction (physical symptoms, imaging techniques and medication), as well as myocarditis and parasitemia in animal models, were recognised as four major research clusters. Lastly, the study found a high rate of domestic collaboration (83.1% of documents published between 2010 and 2016) and a lower but substantial rate of international collaboration (32.5%) in the same time period.

Kapoor et al. (2015) depicted a picture of global research trends in cardiology during 1993–2013. All the data of the study were collected from PubMed. The study reveals that the United States was the top country, and Boston was the top city in cardiology research. Christodoulos Stefanadis contributed the most number of articles. The study also disclosed that the most popular journal during the study period was the American Journal of Cardiology, and Circulation had the highest impact factor among all the journals.

Batcha (2018) conducted Scientometric research on cardiovascular disease research in SAARC countries. The study was limited only to five SAARC countries (India, Pakistan, Bangladesh, Sri Lanka and Nepal). According to the findings of the study, India contributed the highest number of research outputs among the SAARC countries in cardiovascular disease research. The United States, England and Australia were the top collaborative countries for SAARC nations. Lastly, India’s Activity Index showed an increase of more than one percent. In 2017, India’s Activity Index reached its greatest level (163.81).

Gupta and Bala (2011) conducted a study on asthma research in India. This study was based on the Indian publication data in asthma, retrieved from the SCOPUS. In that span of the study (1999–2008), the USA contributed the largest publications share of 51.72%, and the highest research output is from the medicine field. During the same time period, the sub-field immunology and microbiology had the highest citation effect, with 6.70 citations per paper. The study also reflects the fact that during the period 1999–2008, India ranked 15th among the top 23 nations in asthma research, with a global publication share of 1.27% (862 publications), an average citation per paper of 3.43 and an h-index of 33.

Phull et al. (2021) retrieved a total of 85,500 items from the SCOPUS database for the study. The researchers conducted a Scientometric analysis of dyslipidemia which includes an Ayurvedic perspective also. The study found that majority of the items were research articles and maximum publications were from the last decade. The study also reveals that the most consulted Journal was Atherosclerosis and the year 2020 was the most productive, with 7,614 publications regarding dyslipidemia.

Gupta and Bala (2011) analysed India's medical research activities from 1999 to 2008. The researchers retrieved data from the SCOPUS database. Different types of Scientometric parameters were used in this study. After a detailed analysis, the study found that during the period 1999–2008, India placed 12th among the most productive countries in medical research (65,745 articles), with a global publication share of 1.59%. It was also noticed that the growth rate of publication increased from 76.68 % from 1999 to 2003 to 2004–2008.

Chinnaraj and Narzary (2020) studied 2,053 publications of SAARC countries on colorectal cancer indexed in the Web of Science database. The researchers applied different Scientometric tools and techniques in the study. Findings revealed that among the five SAARC countries, India contributed the maximum number of publications on colorectal cancer. Other developed countries such as the United States, Australia and the United Kingdom were the top collaborating countries with SAARC regions.

Verma and Shukla (2019) conducted a Scientometric study of information literacy research trends during 2008–2017. The study is limited to the top ten contributed countries on information literacy, which was indexed in

the SCOPUS database. The study reveals that a maximum of documents, 1,234 (12.99%), was published in the year 2016. Wolf, M.S was the most prolific author, and The United States was the highest contributing country. It also reflects the AGR, compound AGR, relative growth rate and doubling time of information literacy during 2008–2017. The highest AGR (25.679%), compound AGR (10.212), relative growth rate (0795), doubling time (5.824) was recorded in the year of 2010, 2009, 2009 and 2017, respectively.

Data Analysis and Interpretations

Year-Wise Distribution and Annual Growth Rate of Publications

Table 1 and Fig. 1 show the year-wise distribution and annual growth of publication on 'Cardiomyopathy' during 2011–2020. The number of publications in the field of 'Cardiomyopathy' increased from 460 in 2011 to 1,189 in 2020. Out of a total of 8,013, 1189 (14.83%) were the maximum recorded in the year 2020, followed by 1,081 (13.49%) publications in the year 2019. The least number of publications (460) was recorded in the year 2011. From this table, we can observe a steady growth of publications in the field of 'Cardiomyopathy' from 2011 to 2020. Table 1 also indicates the AGR of publications during the period 2011–2020. The highest AGR, 23.07, was recorded in the year 2013, followed by 16.64 AGR in the year 2017 and the minimum AGR 0.46 recorded in the year 2019. The AGR is computed using the following formula (Santhakumar & Kaliyaperumal, 2015).

$$AGR = \frac{EndValue - FirstValue}{FirstValue} \times 100$$

Table 1: Year-Wise Distribution and Annual Growth Rate of Publications

Year	Publications	Percentage	AGR
2011	460	5.74	0
2012	494	6.16	7.39
2013	608	7.58	23.07
2014	651	8.12	7.07
2015	710	8.86	9.06
2016	805	10.04	13.38

Year	Publications	Percentage	AGR
2017	939	11.71	16.64
2018	1076	13.42	14.58
2019	1081	13.49	0.46
2020	1189	14.83	9.99

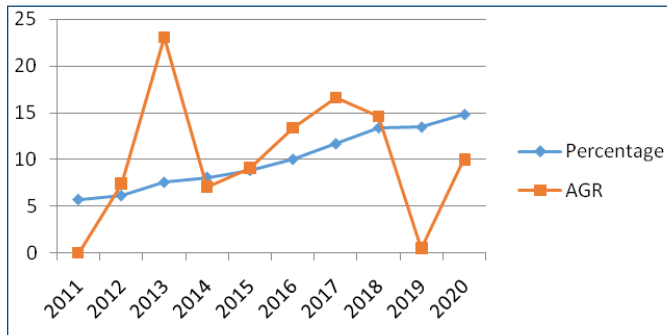


Fig. 1: Year-Wise Distribution and Annual Growth Rate of Publications

The AGR has an increasing trend from 7.39 (2012) to 23.07 (2013). However, it decreased 7.07 in the year 2014, and again it increased 9.06 in the year 2015. Since then, there has been a variation which we can observe in figure. Though the overall AGR increased from 7.39 (2012) to 9.99 (2020).

Compound Annual Growth Rate of Publications

Table 2 illustrates the relative growth rate and doubling time of publications on cardiomyopathy during the study period. The highest RGR 1.84 recorded in the year 2020, followed by 1.77 in the year 2019 and the lowest RGR 0.59 recorded in 2013.

$$CAGR = \left(\frac{\text{ending value}}{\text{begining value}} \right)^{\frac{1}{n}} - 1$$

Table 2: Compound Annual Growth Rate of Publications

Year	Publications	Cumulative	CAGR
2011	460	460	—
2012	494	954	93.11
2013	608	1102	34.62
2014	651	1753	39.12

Year	Publications	Cumulative	CAGR
2015	710	2463	36.47
2016	805	3268	32.34
2017	939	4207	28.39
2018	1076	5283	25.52
2019	1081	6364	24.8
2020	1189	7553	22.8

Relative Growth Rate, Doubling Time and Three Field Plot

The RGR and D_t model is used to calculate the growth rate of all publications. D_t is closely connected to RGR, which is used to analyse the rise in the number of publications on time. The following formula yields a mathematical representation of the mean relative growth rate of articles during a specific period (Mahapatra, 1985):

$$RGR = \frac{W2 - W1}{T2 - T1}$$

Where,

RGR= Growth Rate over the specific period of the interval
 $W1 = \text{Log}_e$ (natural log of the initial number of contributions)

$W2 = \text{Log}_e$ (natural log of the final number of contributions)

$T1$ =the unit of initial time

$T2$ = the unit of final time

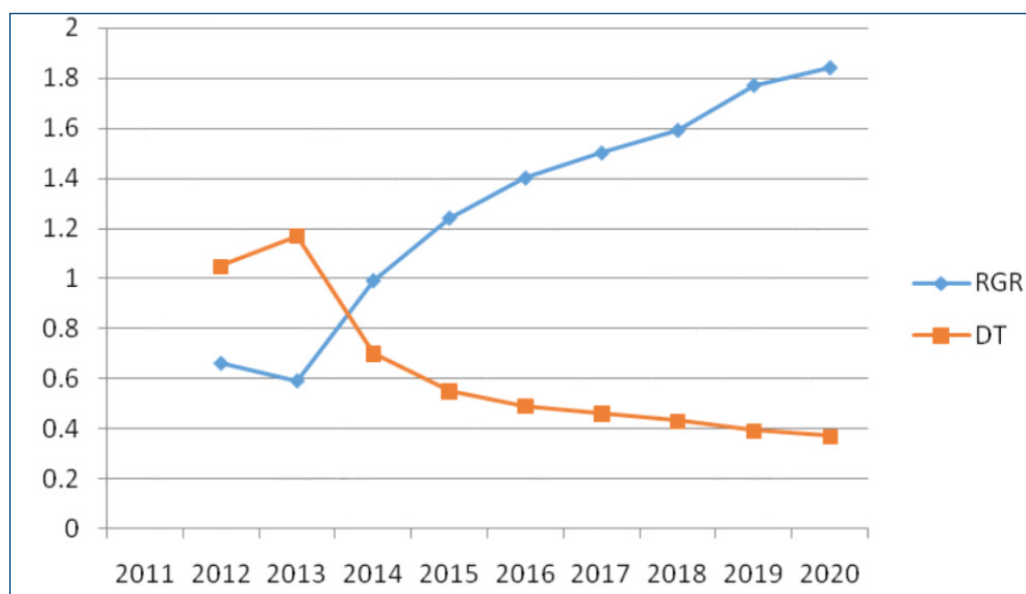
Doubling Time

The doubling time is the amount of time it takes for a population's size/value to double. It is determined that the RGR and D_t have a direct equivalence based on the calculations. Suppose the number of contributions made by a subject doubles throughout the research. In that case, the difference between the logarithms of numbers at the beginning and end must be number 2. This discrepancy has a value of 0.693 when calculated using the natural logarithm, the equivalent D_t formula for calculating contributions and pages (Verma & Shukla, 2019).

$$D_t = \frac{0.693}{R}$$

Table 3: Relative Growth Rate and Doubling Time

Year	Publications	Cumulative	logeW1	logeW2	RGR	Dt
2011	460	460	-	6.13	-	-
2012	494	954	6.2	6.86	0.66	1.05
2013	608	1102	6.41	7	0.59	1.17
2014	651	1753	6.47	7.46	0.99	0.7
2015	710	2463	6.56	7.8	1.24	0.55
2016	805	3268	6.69	8.09	1.4	0.49
2017	939	4207	6.84	8.34	1.5	0.46
2018	1076	5283	6.98	8.57	1.59	0.43
2019	1081	6364	6.98	8.75	1.77	0.39
2020	1189	7553	7.08	8.92	1.84	0.37

**Fig. 2: Relative Growth Rate and Doubling Time**

It has been observed from Table 3 and Fig. 2 that the relative growth rate has decreased from the year 2012 (0.66) to 2013 (0.59). From 2014 (0.99) to 2020 (1.84) it has been observed a steady growth of RGR on cardiomyopathy disease literature.

The doubling time has increased from the year 2012 (1.05) to 2013 (1.17). In 2014, it decreased into 0.70. From 2014 onwards to 2020 (0.37), it has been observed a declining trend of DT.

Three-Field Plot

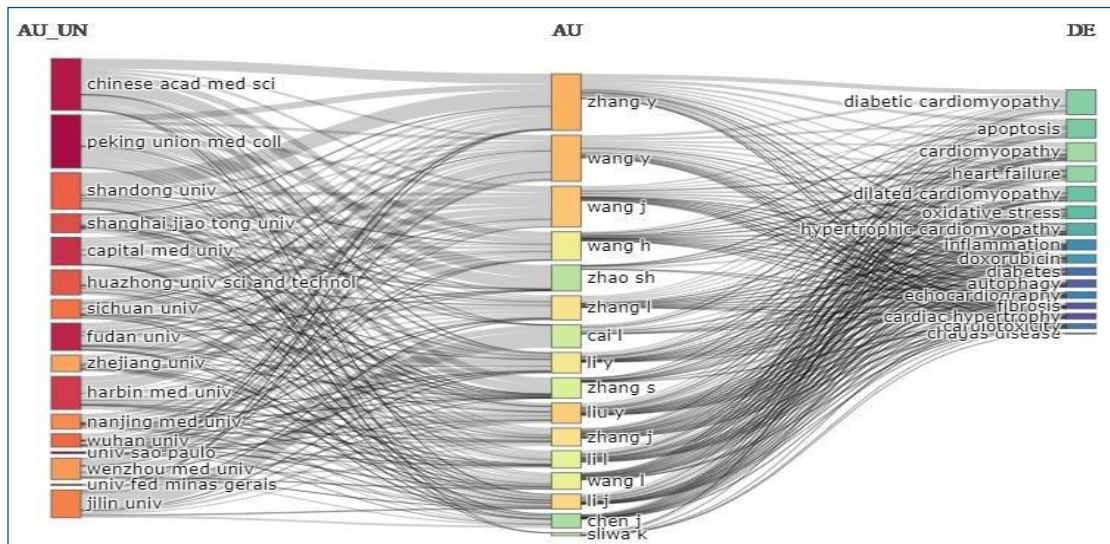


Fig. 3: Affiliation-Author-Keyword Flows of Cardiomyopathy-Related Publications Contributed by BRICS Countries in the Web of Science Database

In Fig. 3 a Sankey diagram (a figure used to depict the flow of input and output of specified qualities or objects) was used to describe relationships among the top ten affiliations, top ten authors and top 20 keywords (Kim & Jeong, 2021).

Most Prolific Journals

Table 4 gives us the information of the most prolific Journal on Cardiomyopathy during the study period. Findings revealed that the most number of publications, 209 (2.60%), was published in the International Journal of Cardiology, followed by 182 (2.27%) publications in the Journal of the American College of Cardiology. The least number of publications, 92 (1.14%), was published in Kardiologiya in this list.

Table 4: Top Ten Most Prolific Journals

Sr. No.	Sources	Publications	Percentage
1	International Journal of Cardiology	209	2.6
2	Journal of the American College of Cardiology	182	2.27
3	European Heart Journal	172	2.14

Sr. No.	Sources	Publications	Percentage
4	PLOS One	171	2.13
5	Arquivos Brasileiros De Cardiologia	169	2.1
6	European Journal of Heart Failure	161	2.0
7	Scientific Reports	123	1.53
8	Circulation	102	1.27
9	Molecular Medicine Reports	100	1.24
10	Kardiologiya	92	1.14

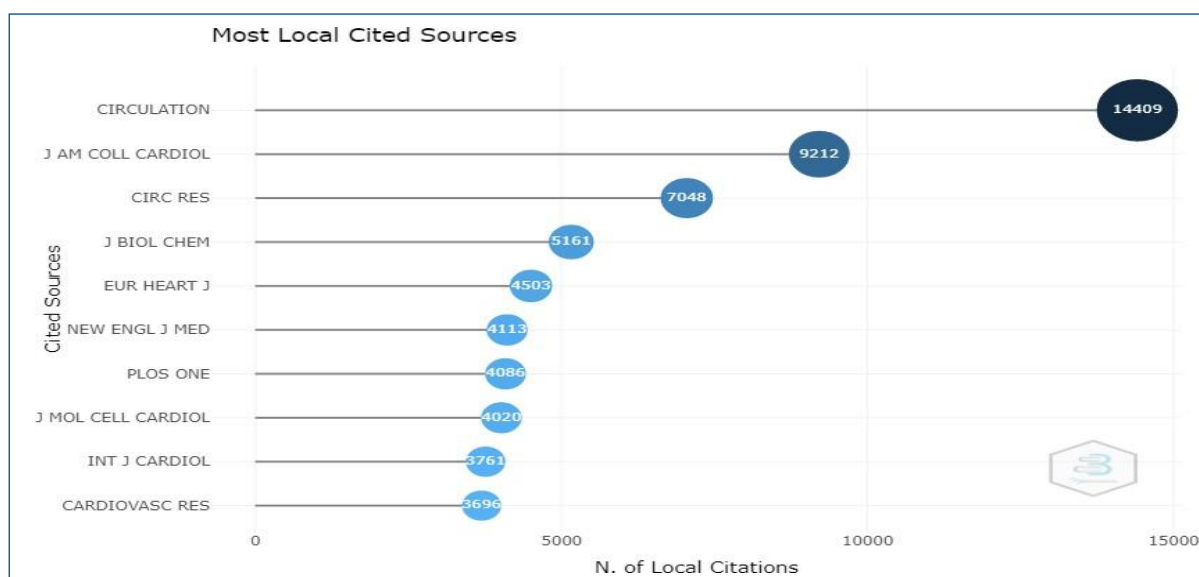
Local Cited Sources

A cited source is a journal/ book/ conference proceedings series etc., included in at least one of the reference lists (bibliography) of the documents set (<https://www.bibliometrix.org/biblioshiny/assets/player/KeynoteDHTMLPlayer.html#50>).

Table 4 illustrates the top ten most local cited sources. Circulation with 14,409 publications tops the list, followed by the Journal of the American College of Cardiology with 9,212 publications.

Table 5: Top Ten Most Local Cited Sources

Rank	Sources	Publications
1	Circulation	14409
2	Journal of the American College of Cardiology	9212
3	Circulation Research	7048
4	Journal of Biological Chemistry	5161
5	European Heart Journal	4503
6	The New England Journal of Medicine	4113
7	PLOS One	4086
8	Journal of Molecular and Cellular Cardiology	4020
9	International Journal of Cardiology	3761
10	Cardiovascular Research	3696

**Fig. 4: Top Ten Most Local Cited Sources**

Most Relevant Authors

Table 6 depicts the top ten most relevant authors in the field of Cardiomyopathy during the period of study.

A total number of publications were recorded 8,013 during 2011–2020. Zhang Y produced the most number of publications, 236 (2.94%), followed by Wang Y. with 222 (2.77%) publications. At the same time, Wang H and Wang L both contributed 101 (1.26%) publications.

Table 6: Top Ten Most Relevant Authors

Rank	Authors	Publications	Percentage	Articles Fractionalized
1	Zhang Y	236	2.94	30.09
2	Wang Y	222	2.77	28.53
3	Wang J	178	2.22	24
4	Liu Y	116	1.44	15.28
5	Li J	113	1.41	15.32
6	Zhang J	112	1.39	15.32

Rank	Authors	Publications	Percentage	Articles Fractionalized
7	Zhang L	109	1.36	13.86
8	Li Y	108	1.34	14.97
9	Wang H	101	1.26	11.57
10	Wang L	101	1.26	15.6

Most Relevant Affiliations

Table 7 and Fig. 5 analyses the top ten ranking institutions in terms of output. Findings show that the University of São Paulo, Brazil, with 787 (9.82%) publications, was the most productive institution in the field of cardiomyopathy followed by Peking Union Medical College, China with

489 (6.10%) publications and Chinese Academy of Medical Sciences, China with 480 (5.99%) publications. Most of the institutions were from China in the top ten lists. Hence, it can be interpreted that the cardiomyopathy research has been dominated by Chinese researchers during 2011–2020.

Table 7: Top Ten Most Relevant Affiliations

Rank	Affiliations	Publications	Percentage
1	University of São Paulo	787	9.82
2	Peking Union Medical College	489	6.1
3	Chinese Academy of Medical Sciences	480	5.99
4	Fudan University	393	4.9
5	Capital Medical University	370	4.61
6	Harbin Medical University	364	4.54
7	Universidade Federal de Minas Gerais	360	4.49
8	Shanghai Jiao Tong University	352	4.39
9	Huazhong University Science and Technology	344	4.29
10	Shandong University	334	4.16

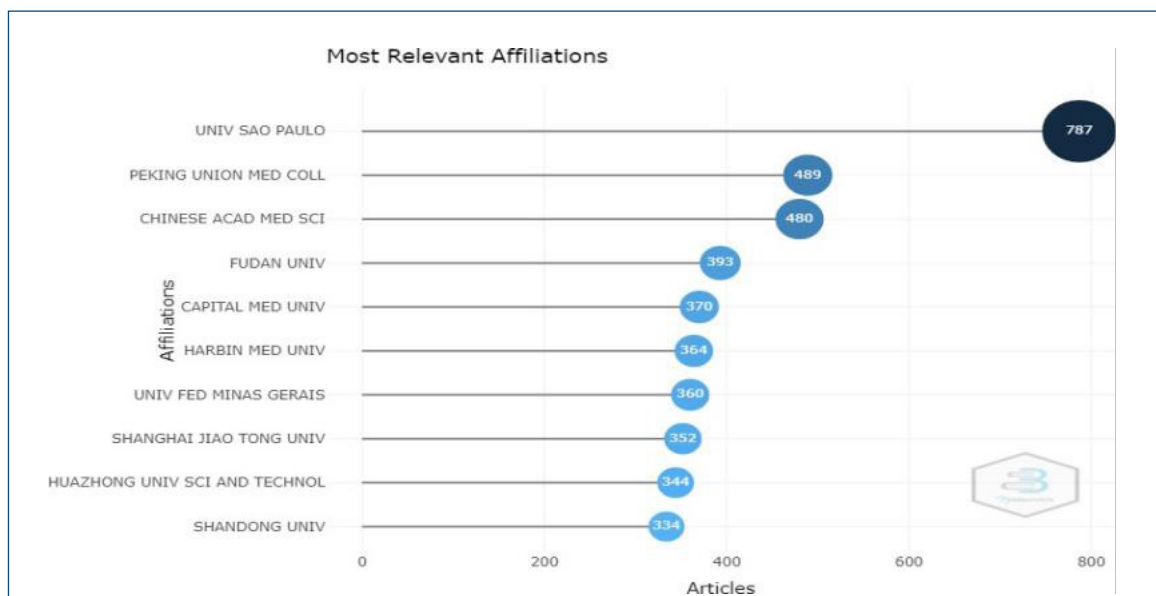


Fig. 5: Top Ten Most Relevant Affiliations

Author's Keywords

Authors Keyword is a keyword that consists of terms that authors believe best represent the content of their paper. They are often selected prudently and need to be cleaned (<https://www.bibliometrix.org/biblioshiny/assets/player/KeynoteDHTMLPlayer.html#50>).

Table 8 and Fig. 6 show the list of the Author's Keywords which were mostly used during the study period. Cardiomyopathy was the most used author's keywords used 598 times, followed by heart failure 573 times, diabetic cardiomyopathy 501 times. Apart from these keywords, apoptosis, DCM, oxidative stress, HCM, Chagas disease, doxorubicin and inflammation were used most frequently.

Table 8: List of Author's Keywords

Rank	Terms	Frequency
1	Cardiomyopathy	598
2	Heart Failure	573
3	Diabetic Cardiomyopathy	501
4	Apoptosis	372
5	Dilated Cardiomyopathy	344
6	Oxidative Stress	317
7	Hypertrophic Cardiomyopathy	308
8	Chagas Disease	224
9	Doxorubicin	224
10	Inflammation	211

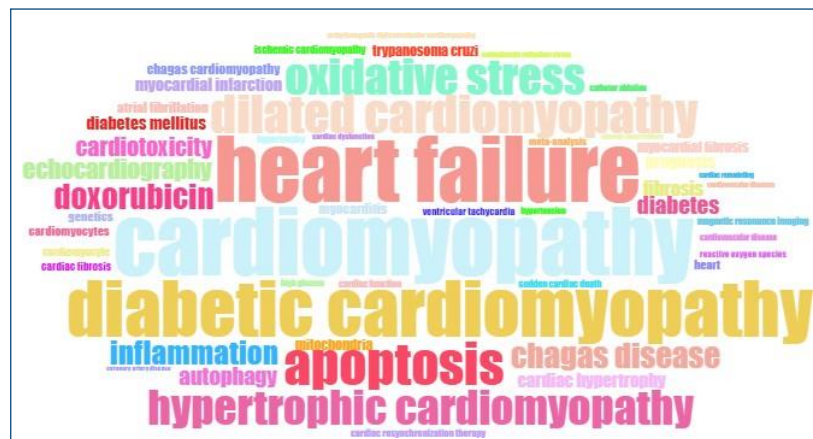


Fig. 6: Word Cloud Based on the Most Used Words of the Cardiomyopathy Related Publications Contributed by BRICS Countries in the Web of Science Database

Most Cited Countries

Table 9 shows the top ten most-cited countries on 'cardiomyopathy' during 2011–2020. Findings reveal that the maximum 53,306 citations with 11.78 average article citations were received by China, followed by 18,714 citations (29.24 AAC) and 11,054 citations (10.53 AAC) were received by the USA and Brazil, respectively.

Table 9: Top Ten Most Cited Countries

Rank	Country	Total Citations	(AAC)
1	China	53306	11.78
2	USA	18714	29.24
3	Brazil	11054	10.53

Rank	Country	Total Citations	(AAC)
4	India	6446	12.49
5	Canada	2505	39.76
6	SouthAfrica	2352	18.09
7	United Kingdom	2039	37.76
8	Germany	1446	30.12
9	Russia	1113	3.93
10	Japan	766	45.06

AAC- Average Article Citations.

Corresponding Authors' Country

The corresponding author is the person, who is responsible for communicating with the journal during the article

submission, peer review, and publishing process. (What is a Corresponding Author? | Elsevier Author Services Blog, n.d.). Table 9 reveals the top ten most corresponding authors' countries. The table shows that most of the corresponding authors were from China with 4,525 documents (SCP 3728 and MCP 797), followed by

Brazil with 1050 documents (SCP 854 and MCP 196) and the USA with 640 documents (SCP 1 and MCP 639). MCP- Multiple Countries Publications, It is the number of documents in which there is at least there is one co-author from a different country. SCP- Single Country Publication has a co-author from the same country.

Table 10: Top Ten Most Corresponding Authors' Country

Rank	Country	Documents	Freq	SCP	MCP	MCP_Ratio
1	China	4525	0.59469	3728	797	0.176
2	Brazil	1050	0.137994	854	196	0.187
3	USA	640	0.084111	1	639	0.998
4	India	516	0.067814	438	78	0.151
5	Russia	283	0.037193	248	35	0.124
6	South Africa	130	0.017085	80	50	0.385
7	Canada	63	0.00828	0	63	1
8	United Kingdom	54	0.007097	0	54	1
9	Germany	48	0.006308	0	48	1
10	Australia	27	0.003548	1	26	0.963

SCP- Single Country Publication

MCP- Multiple Countries Publications

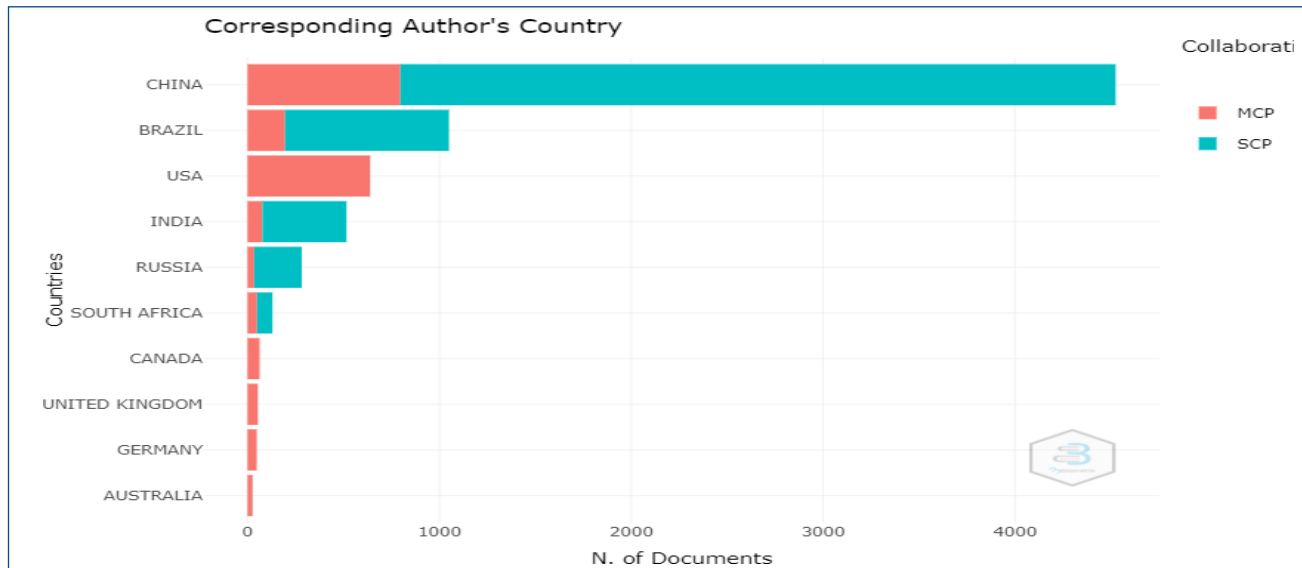


Fig. 7: Top Ten Most Corresponding Authors' Country

Document Types

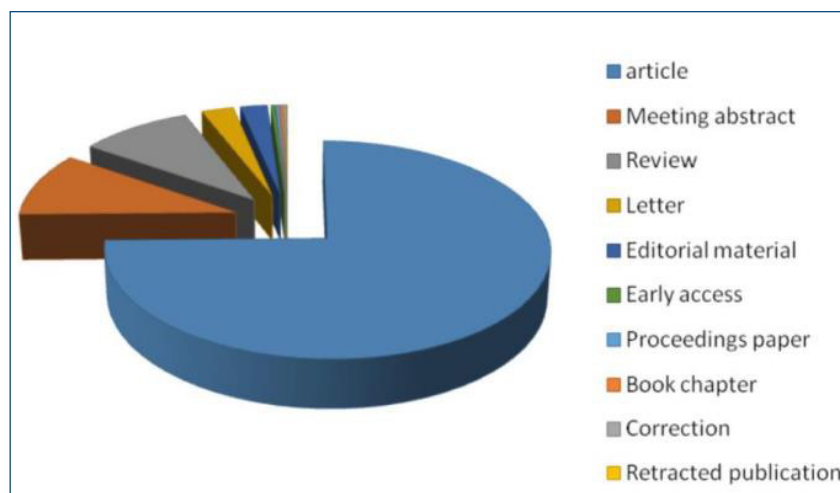
Table 11 and Fig. 8 analyses the document-wise distribution of publications on 'Cardiomyopathy' during the study period. The maximum 6,041 (75.38 %) of

publications were 'Article' type documents, followed by 'Meeting abstract' type document with 800 (9.98 %) of publications and 758 (9.45 %) of publications was 'Review' type documents.

Table 11: Document Types

Document Types	Record Count	Percentage
Article	6041	75.38
Meeting abstract	800	9.98
Review	758	9.45
Letter	215	2.68
Editorial material	180	2.24
Early access	26	0.32

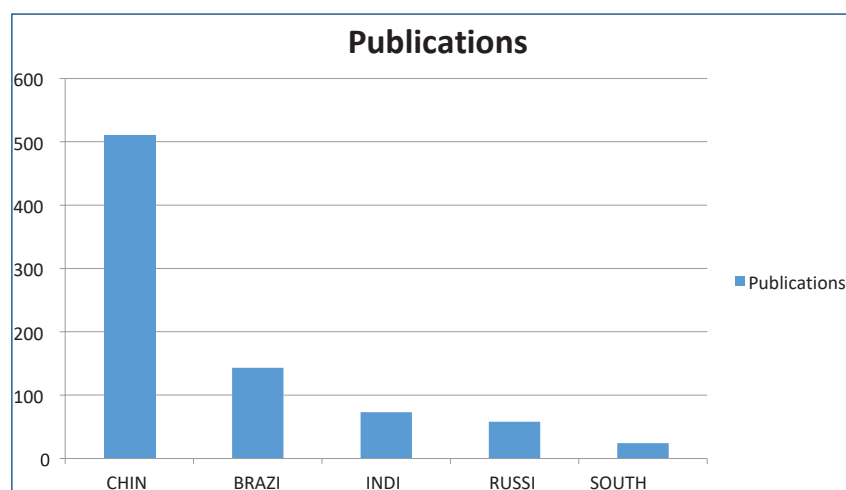
Document Types	Record Count	Percentage
Proceedings paper	22	0.27
Book chapter	18	0.22
Correction	17	0.21
Retracted publication	5	0.06
Data paper	1	0.01
News item	1	0.01
Retraction	1	0.01

**Fig. 8: Document Types**

Country-Wise Distribution of Publications

Fig. 9 depicts the country-wise distribution of publications. A maximum of 5,113 documents was contributed by

China, followed by Brazil with 1,430 documents and 730 documents contributed by India. Russia and South Africa contributed 580 and 241 documents, respectively.

**Fig. 9: Country-Wise Distribution of Publications**

Discussions and Conclusions

We can conclude with the fact that the aim of the study is to find the research trends of the literature on cardiomyopathy by BRICS Nations published on the Web of Science database during 2011–2020. The study analysed a total of 8,013 documents on cardiomyopathy disease. The study has observed a consistent growth in the number of publications in this field during the study period. China (5,113) contributed the highest number of documents, followed by Brazil (1,430) and India (730) among the BRICS nations during the mark study period. The most productive authors were Zhang Y, with 236 documents, followed by Wang (222). The University of Sao Paulo from Brazil (787) contributed the most number of publications, followed by Peking Union Medical College (489) China. A maximum number of 209 publications were contributed by the international Journal of Cardiology. China received 53,306, the maximum citations followed by USA 1871 for citations. The study revealed that most of the scientists consulted circulation journal followed by the Journal of the American College of Cardiology. Most of the documents are in the form of articles. The highest number of AGR (2,307) was recorded in the year 2013. The maximum CAGR, RGR and DT were recorded in the years 2012, 2020 and 2013, respectively. As for the India concern, India ranked third among BRICS nations in terms of publications. Most corresponding authors were from China, followed by Brazil.

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