Focused on Author Productivity of Arthropathy Research Publication: A Scient metric Analysis

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Abstract: The study aimed to analyze the scientific productivity of Arthropathy research from 2010 to 2020 with an international outlook. The primary purpose of the study is to understand how far the Arthropathy research literature in the state of the art while it comes as a lifestyle disease. The data retrieved from the WoS database; take a sum of 4221 records contributed by 23083 authors. The overall study period finds that PEI value is increasing trend from 2017 to 2020. The degree of collaboration over the years from 2010-2020 and varies from 0.91 to 0.97. The mean value is 0.938. "Wukich DK is the highest H index value 13 (17 Records). Lotka's law tested our study P-Value, then it is founded that the value of the observed authors was higher than that of the expected value which is 5.780324. To apply Price Square Root Law in study $\sqrt{N}$ =151(7.09%), half of the literature 299.26, but it turned that it is not applicable in the study. The year 2020 shows the topmost value in CI (5.79), CC (0.185) and MCC (0.7210). The research ensures the current state of Arthropathy research and literature. It should provide new insights into future development in the varied sub-disciplines of Arthropathy.

Abbreviations

AAPP- Average Author Per Publication, ACPP- Average Citation Per Publication, CAI- Co-Authorship Index, CI- Collaborative Index, CC- Collaborative Coefficient, DC- Degree of Collaboration, MCC- Modified Collaborative Coefficient, PEI- Publication Efficiency Index, PPA- Productivity Per Author.

1 Introduction

Arthropathy is a collective term for any disease of the joints. A myriad of arthropathic disorders can affect the joints, including sacroilitis which causes inflammation in the sacroiliac joint, Charcot's joints which lead to the degeneration of a joint due to nerve damage, and arthrogryposis which results in joint contractures. (Veritas Health, 1999-2021).

Scientometrics can be defined as the "quantitative study of science, communication in science, and science policy" (Hess, 1997). What started as Eugene Garfield's idea of an index to improve information retrieval in the 1960s and resulted in the creation of the Science Citation Index (SCI) (Garfield, 1979) was soon recognized as a novel instrument in the empirical study of the sciences (Price, 1963). The availability of output indicators (such as databases of publications and patents) complemented ongoing efforts by the Organization of Economic Cooperation and Development (OECD) in Paris to standardize input statistics of the scientific enterprise (OECD, 1963, 1976). Based on these data, the National Science Board of the U.S.A. initiated the biannual series of Science Indicators in 1972. The new journal 'Scientometrics' was launched in 1978 and in that same year leading historians, philosophers of science, and social scientists—among them Robert K. Merton—published an edited volume entitled Toward a Metric of Science: The Advent of Science Indicators, in which they reflected on the new perspectives (Elkana et al., 1978). The historian Derek J. de Solla Price published several books and articles in the 1960s and '70s which laid the foundations for the newly emerging field of quantitative science studies, culminating in a full-fledged research program (Price, 1963). Unlike the core philosophy of behavioural science and science, scientometrics measurements focus on the topic (documents) as units of analysis.

2 Literature Review

A review of previous studies identified that there is related research tools were applied in many disciplines. Alagu and Thanuskodi (2018) analyzed information literacy research of India and the data needed for the analysis is retrieved from the Web of Science database. The retrieved data for the period 1993 to 2017 is analyzed with HistCite software and different bibliographic techniques. Alvi and Vinitha (2014) analysed hepatitis research from 2004 to 2013. The analysis was based upon the PubMed database. 45991 records collected for the analysis.

Antony and Selvaraj (2019) analysed PEI and ACPP of Poultry industry research publications for ten years (2008 to 2017) and identified that most research impact of this field is in the year 2008 with the topmost value of PEI & ACPP. They also prove that that Lotka's law is matched with the poultry industry publications. Antony and Selvaraj (2020) discerned that the Price square Root law and Pareto principle are not apt with the research output of Indian Geese Publications. They tested Lotka's law by taking full count of authors and prove that this law is suited to this field of study. Arora et al. (1996) examined the research undertaken by the Indian medical colleges. The author mentioned that the high position of the 8O8 Indian medical colleges receiving research grants from ICMR. Indian medical colleges did not produce any research paper in 1991. Bansal (2017) analysed 14317 papers of celiac disease research. For this study data collected from the Scopus database. From the analysis, he identified that the AAGR of celiac research publications is 5.20% and its citation impact of 12.53. Bayoumy et al., (2016) examined the rheumatology research of Arabian countries. For this study 944 papers taken from the Web of Science database and found that most of the papers were published in the form of case reports and he also analysed ACPP. Sachithanantham and Raja (2015) conducted a study of an Indian research publication on Rabies, which is one of the most vulnerable zoonotic diseases in India. A data set was collected from the PubMed database for the period 1950–2014. There were a total of 495 records in the database during the study period. Schöffel et al., (2010) studied Rheumatoid arthritis by collecting data from the Web of Science and PubMed database from 1900 to 2007. Analysis revealed that a total of 78128 records was published in rheumatoid arthritis. This study also analysed Citation parameters and found that St. Lucia has got the highest citation. Shilpa et al., (2019) attempted to study the Leukemia research publications of Indian Scientists. The study period was from 2009 to 2018. The study analysed 3980 records from India reflected in the web of science databases. The data were analysed with Histcite and MS Excel software. India ranks 12th position in Leukemia research output.

3 Objective of the Study

The present disquisition aimed to analyze the scientific productivity of research publications of Arthropathy literature from the global perspective. In specific study aims to

- To measure Average Author Per Publication, Productivity Per Author and Publication Efficiency Index of arthropathy research publications
- To identify H-index, M-index and G-index of top 20 authors of arthropathy research publications
- To test Lotka's law by using scientific productivity of arthropathy research publications
- To test the Price Square Root Law in arthropathy research publications.
- To apply the Pareto principle (80/20) rule in arthropathy research publications.
- To identify top 20 Prolific Author & ACPP of Arthropathy Research
- To analyses the Collaborative Index, Collaborative Coefficient, and Modified Collaborative Coefficient of arthropathy research publications
- To measure the Co-Authorship Index of arthropathy research publications.

4 Methodology

The researcher downloaded 4221 records of 23083 authors from the year 2010 to 2020.The data extracted from the WOS database of Clarivate Analytics. The researcher used a couple of statistical tools like PEI, DC, Lotka's Law, Pareto Principle, Price Square Root Law, CI, CC, MCC and CAI for the analysis. HistCite, RStudio, Biblioshiny, Bib excel and Microsoft Excel 2010 software are also applied for the study.

5 Results and Discussion

5.1 AAPP, PPA and Publication Efficiency Index

The study analyzed the Research effort in the field of Arthropathy using the Publication Efficiency Index (PEI). Here PEI is calculated on the ground of citations received by the publications per year. The equation used for measuring PEI by Guan & Ma (2004) is

$$PEI = \frac{TNC_i / TNC_t}{TNP_i / TNP_t}$$

Where,

TNC$_i$ = Total number of Citations in a particular year 'i'

TNC$_t$ = Total number of Citations for all the years.

TNP$_i$ = Total number of Publications in a specific year 'i'

TNP$_t$ = Total number of Publications for all the years.

Table 1: AAPP, PPA and Publication Efficiency Index

S. NO	Year	Total No. of Publications	Total No. of Authors	AAPP	PPA	TNA$_i$ /TNA$_t$	TNP$_i$ /TNP$_t$	PEI
1	2010	338	1638	4.85	0.21	0.07	0.08	0.89
2	2011	328	1651	5.03	0.20	0.07	0.08	0.92
3	2012	356	1920	5.39	0.19	0.08	0.08	0.99
4	2013	379	1861	4.91	0.20	0.08	0.09	0.90
5	2014	392	2130	5.43	0.18	0.09	0.09	0.99
6	2015	488	2681	5.49	0.18	0.12	0.12	1.00
7	2016	491	2570	5.23	0.19	0.11	0.12	0.96
8	2017	439	2675	6.09	0.16	0.12	0.10	1.11
9	2018	526	2911	5.53	0.18	0.13	0.12	1.01
10	2019	465	2935	6.31	0.16	0.13	0.11	1.15
11	2020	19	111	5.84	0.17	0.00	0.00	1.07
Total		**4221**	**23083**	**5.47**	**0.18**	**-**	**-**	**10.99**
Average		**383.73**	**2098.45**	**0.50**	**0.02**	**-**	**-**	**1.00**

From table 1 it can be found that PEI value is higher than one from the year 2017 to 2020 which denotes that the impact of publication and research efforts is higher in those years. The value of AAPP is higher from the years 2017 to 2020 and the value of PPA is found to be higher in the year is 2010 to 2016. From the year 2010 to 2014 and in 2016, PEI is very less than one and so research impact is not satisfactory in those years. In 2015, the average research impact can be observed with the value of one. From the analysis in table 1, it can be noted that if the Average Author per Publication is higher, the value of Publication Efficiency is also will be higher. PEI and AAPP are highest in the year 2019 (1.15 and 6.31) since 5.47 authors received 465 papers. PPA is highest in the year 2010 (0.21). The average AAPP is 0.50, the average PPA is 0.02, and the average PEI is 1. Describe PPA according to the result in the table.

5.2 Degree of Collaboration

The degree of collaboration of mathematical formula was suggested by Subramanyam (1983). The degree of collaboration among authors denotes the ratio of the number of documents received in the discipline over a given period of time.

$$C = \frac{NM}{NM + NS}$$

Where,

C= degree of collaboration

Nm= number of multi-authored papers

Ns= number of single-authored papers

Table 2: Degree of Collaboration of Arthropathy Research

S. NO	Year	No. of. Single Authors	%	No. of. Multiple Authors	%	NM+NS	DC	Mean in DC
1	2010	30	11.67	308	7.77	338	0.91	
2	2011	29	11.28	299	7.54	328	0.91	
3	2012	25	9.73	331	8.35	356	0.93	
4	2013	28	10.89	351	8.85	379	0.93	
5	2014	19	7.39	373	9.41	392	0.95	
6	2015	26	10.12	462	11.65	488	0.95	0.938
7	2016	38	14.79	453	11.43	491	0.92	
8	2017	19	7.39	420	10.60	439	0.96	
9	2018	27	10.51	499	12.59	526	0.95	
10	2019	15	5.84	450	11.35	465	0.97	
11	2020	1	0.39	18	0.45	19	0.95	
Total		257	100.00	3964	100.00	4221	0.94	

The degree of collaboration is calculated in Table 2 and the same is demonstrated in Figure 1. It is calculated by the equation proposed by Subramaniam. The degree of collaboration is calculated for the years 2010-2020 and it varies from 0.91 to 0.97. The average value of DC is found to be 0.938. The highest degree of collaboration is observed in the year 2019 with a value of 0.97 because the number of single-authored paper is lowest this year as compared to multiauthored papers. The second highest DC in the year was 2017 the value of 0.96.
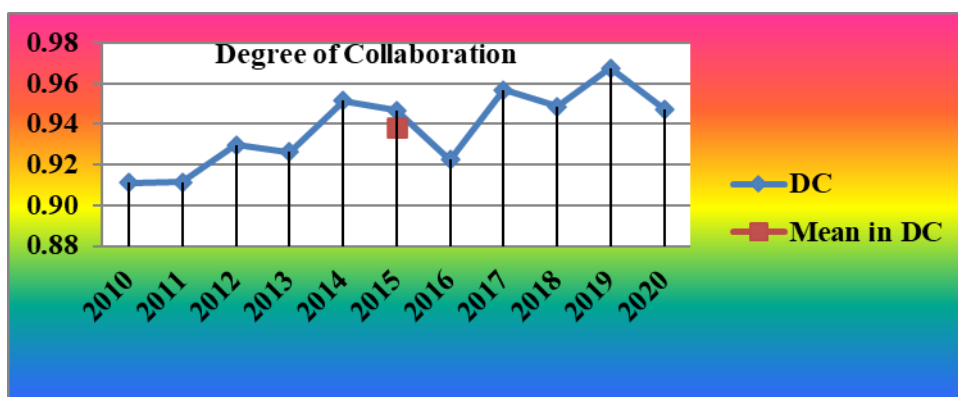
Figure 1: Degree of Collaboration

5.3 Author Impact

Table 3: Author Impact of Arthropathy Research (Top 20)

S. NO	Author	No. of. Publication	H_index	G_index	M-index
1	Wukich DK	17	13	17	1.30
2	Fischer K	36	12	21	1.09
3	Morfini M	24	12	20	1.20
4	Gallagher JA	20	12	20	1.09
5	Ranganath LR	19	11	19	1.00
6	Mcgonagle D	15	10	15	0.91
7	Valentino LA	15	10	15	0.91

8	Schutgens REG	29	9	14	1.00
9	Doria AS	22	9	17	0.82
10	Lafeber Fpjg	20	9	13	1.00
11	Srivastava A	20	9	15	0.82
12	Pasta G	18	9	14	0.82
13	Blanchette V	16	9	16	0.82
14	Di Minno MND	15	9	15	0.82
15	Santucci A	13	9	13	0.82
16	Grassi W	12	9	12	0.82
17	Hermans C	25	8	14	0.73
18	Roosendaal G	23	8	12	0.89
19	Oldenburg J	21	8	16	0.73
20	Mastbergen SC	18	8	12	0.89

Table 3 shows that the publications output of the top 20 most productive author impact of Arthropathy research from 2010 to 2020. The author Wukich DK found to be the most influential author who has attained a top H-index value of 13 for 17 publications. The author Fischer K, Morfini M, and Gallagher JA is 36, 24, and 20 publications, the second position of H-index value 12. The author Ranganath LR is 19 publications, and the third position of H-index value for 11. Other authors followed by them respectively.

Figure 2 shows that the author collaboration of co-authorship networks on Arthropathy research. This figure is a total of 11 Cluster, 90 Item, 324 Links, and 928 Total Link Strength. The author Fisher K was the first cluster in the figure, 21 links, and the total link strength was 56, and the 27 documents. The author Rodriguez-merchan, E. C is the second cluster in the figure, 5 links, and total link strength was 9, and 14 documents. The author Cuesta-Barriaso R is the third cluster, 9 links, total link strength is 48, and 23 documents.
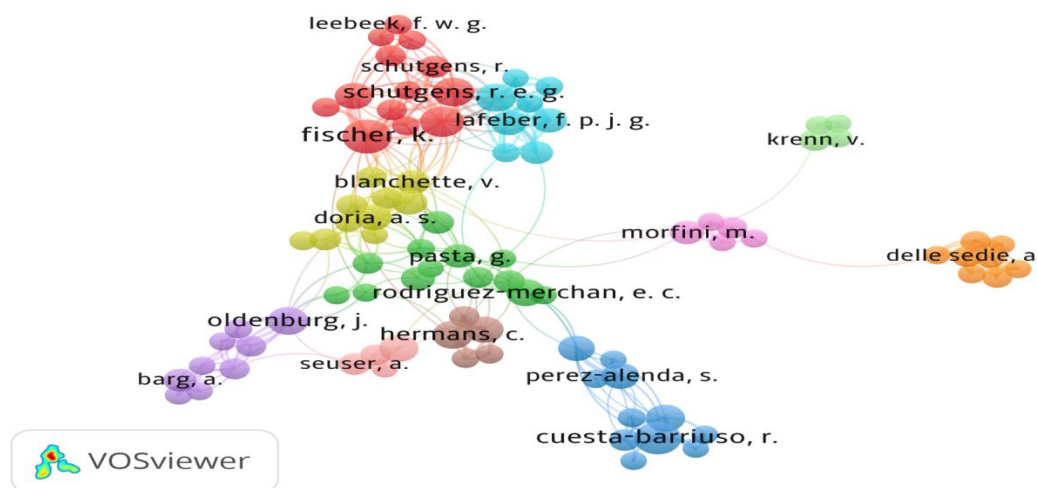

Figure 2: Co-Authorship with Author

5.4 Lotka's Law

Lokta's law is applied to test the scientific productivity of research papers to the number of contributions made by each author. To test the applicability, the value of the beta, the 'C' the 'n', and the Critical value of the data set has been determined with the help calculations made in table 2.

Table 4 and Figure 3 shows the Arthropathy research was frequency distribution of author productivity, unique authors with 16184, 13042 authors produced one article, 1848 authors produced two articles, 593 authors produced three articles, and so on.

Table 4: Application of Lotka's Law

SI. NO	No. of. Publications	No. of. Authors	X(log x)	Y(log y)	XY	X²
	X	Y				
1	1	13042	0	4.12	0	0
2	2	1848	0.30	3.27	0.98	0.09
3	3	593	0.48	2.77	1.32	0.23
4	4	283	0.60	2.45	1.48	0.36
5	5	131	0.70	2.12	1.48	0.49
6	6	75	0.78	1.88	1.46	0.61
7	7	52	0.85	1.72	1.45	0.71
8	8	41	0.90	1.61	1.46	0.82
9	9	26	0.95	1.42	1.35	0.91
10	10	21	1	1.32	1.32	1
11	11	16	1.04	1.20	1.25	1.08
12	12	6	1.08	0.78	0.84	1.16
13	13	11	1.11	1.04	1.16	1.24
14	14	4	1.15	0.60	0.69	1.31
15	15	6	1.18	0.78	0.92	1.38
16	16	3	1.20	0.48	0.57	1.45
17	17	2	1.23	0.30	0.37	1.51
18	18	5	1.26	0.70	0.88	1.58
19	19	3	1.28	0.48	0.61	1.64
20	20	4	1.30	0.60	0.78	1.69
21	21	1	1.32	0	0	1.75
22	22	1	1.34	0	0	1.80
23	23	1	1.36	0	0	1.85
24	24	1	1.38	0	0	1.91
25	25	2	1.40	0.30	0.42	1.95
26	26	1	1.42	0	0	2.00
27	28	1	1.45	0	0	2.09
28	29	1	1.46	0	0	2.14
29	34	1	1.53	0	0	2.35
30	36	1	1.56	0	0	2.42
31	55	1	1.74	0	0	3.03
Total	**533**	**16184**	**34.34**	**29.93**	**20.80**	**42.56**

The distribution of scientific productivity of authors which is denoted by exponent 'n' of Lotka's formula measured by the equation,

$$n = \frac{N\sum xy - \sum x\sum y}{N\sum x^2 - (\sum x)^2}$$

P = number of X items in the table = 533

N = Sum number of contributors = 16184

n value

$$n = \frac{533 * 20.7962 - 34.3433 * 29.9264}{533 * 42.5647 - 34.3433^2}$$

n = 10056.6 / 21507.52
n = 0.467585
Beta value = 2.735017
C value = 0.611561
R^2 value = 0.956674
Lotka's P value = 5.780324
Critical value

The critical value is one of the general formulas of Lotka's law.

$$C.V = \frac{1.63}{[\sum y + (\sum y/10)^{1/2}]^{1/2}}$$

Therefore,

$$= \frac{1.63}{[16184 + (16184/10)^{1/2}]^{1/2}}$$

Critical value = 0.00127

The 'P' value in the field of arthropathy research for all author data is 5.780324, and the critical value is 0.00127. The maximum deviation of the critical value is smaller than the, 'P' value. This explains the fact that the tabulated value showed that the value of the observed authors was higher than the expected value. Thus the present analysis does not validate Lotka's findings.
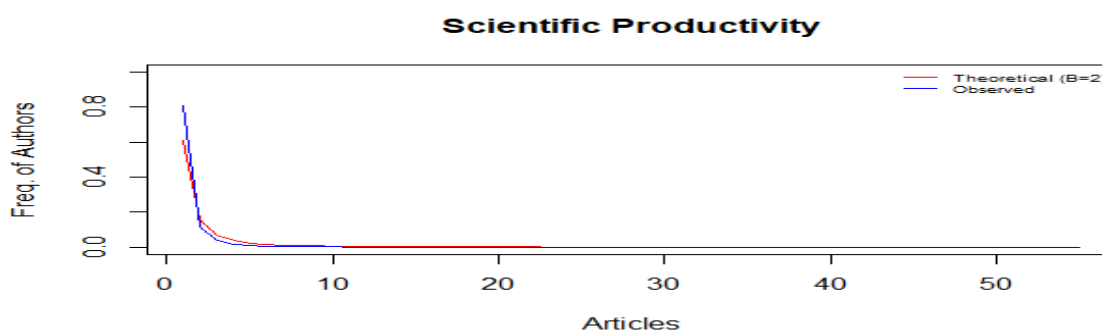
Figure 3: Lotka's Law of Scientific Productivity

5.5 Price Square Root Law

The Price Square Root Law is used to find the relationship between a subject's literature and the authors count in that particular subject field. It is said that according to the price law when published in the same area it is half of the publications coming from the square root of all the authors. A prolific group is constituted by the square root of a whole number of authors.

Table 5: Application of Price Square Root Law

SI. NO	No. of Contributions A	No. of. Contributors B	% of 16184	A*B	Cumulated A*B	Cumulated % of A*B
1	55	1	0.0062	55	55	0.24
2	36	1	0.0062	36	91	0.16
3	33	1	0.0062	33	124	0.14
4	29	1	0.0062	29	153	0.13
5	28	1	0.0062	28	181	0.12
6	26	1	0.0062	26	207	0.11
7	25	2	0.0124	50	257	0.22
8	24	1	0.0062	24	281	0.10
9	23	1	0.0062	23	304	0.10
10	22	1	0.0062	22	326	0.10
11	21	1	0.0062	21	347	0.09
12	20	4	0.0247	80	427	0.35
13	19	3	0.0185	57	484	0.25
14	18	5	0.0309	90	574	0.39
15	17	2	0.0124	34	608	0.15
16	16	3	0.0185	48	656	0.21
17	15	6	0.0371	90	746	0.39
18	14	4	0.0247	56	802	0.24
19	13	11	0.0680	143	945	0.62
20	12	6	0.0371	72	1017	0.31
21	11	16	0.0989	176	1193	0.76
22	10	21	0.1298	210	1403	0.91
23	**9**	**26(151)**	**0.1607**	**234**	**1637**	**1.01(7.09)**
24	8	41	0.2533	328	1965	1.42
25	7	52	0.3213	364	2329	1.58
26	6	75	0.4634	450	2779	1.95
27	5	131	0.8094	655	3434	2.84
28	4	283	1.7486	1132	4566	4.90
29	3	593	3.6641	1779	6345	7.71
30	2	1848	11.4187	3696	10041	16.01
31	1	13042	80.5858	13042	23083	56.50
other Authors 16151	-	**16184**	**100.00**	**23083**	-	**100.00**

As per table 5,

Total number of authors in arthropathy literature, N=23083

Total number of publications = 4221

According to this law, $\sqrt{N}$ authors contributed half of the total number of publications, Therefore, $\sqrt{23083}$ =151.93 = 151 Authors

Half of the total publications $= \frac{4221}{2} = 2110.5 = 2110$

From table 3, it can be observed that 151 authors contributed only 7.09% of total publications.

That is $4221 \times \frac{7.09}{100} = 299.2689$ publications.

The Price square root of total authors (151 authors) contributed only 299.2689 numbers of total (4221) publications. Half of the publications (2110 publications) have not come from the square root of all authors (151 authors). Therefore, the price square root law does not apply to the publication of Arthropathy literature.

5.6 Pareto Principle (80/20 Rule)

According to the Pareto Principle, 80% of total publications in a subject field are arriving from 20% of the total authors of that field.

Total number of articles in Arthropathy Research publications from 2010 to 2020 = 4221

Total number of authors in the same period of study = 23083

80% of total publications =80*4221/100 = 3376.8 = 3376 publications

20% of total authors = 20*23083/100 = 4616.6 = 4616 authors

Table 6: Application of Pareto Principle (80/20 Rule)

SI. NO	No. of Contributions A	No. of. Contributors B	% of 16184	A*B	Cumulated A*B	Cumulated % of A*B
1	55	1	0.0062	55	55	0.24
2	36	1	0.0062	36	91	0.16
3	33	1	0.0062	33	124	0.14
4	29	1	0.0062	29	153	0.13
5	28	1	0.0062	28	181	0.12
6	26	1	0.0062	26	207	0.11
7	25	2	0.0124	50	257	0.22
8	24	1	0.0062	24	281	0.10
9	23	1	0.0062	23	304	0.10
10	22	1	0.0062	22	326	0.10
11	21	1	0.0062	21	347	0.09
12	20	4	0.0247	80	427	0.35
13	19	3	0.0185	57	484	0.25
14	18	5	0.0309	90	574	0.39
15	17	2	0.0124	34	608	0.15
16	16	3	0.0185	48	656	0.21
17	15	6	0.0371	90	746	0.39
18	14	4	0.0247	56	802	0.24
19	13	11	0.0680	143	945	0.62
20	12	6	0.0371	72	1017	0.31
21	11	16	0.0989	176	1193	0.76
22	10	21	0.1298	210	1403	0.91

23	9	26	0.1607	234	1637	1.01
24	8	41	0.2533	328	1965	1.42
25	7	52	0.3213	364	2329	1.58
26	6	75	0.4634	450	2779	1.95
27	5	131	0.8094	655	3434	2.84
28	4	283	1.7486	1132	4566	4.90
29	3	593	3.6641	1779	6345	7.71
30	**2**	**1848(3142)**	**11.4187**	**3696**	**10041**	**16.01(43.49)**
31	1	13042	80.5858	13042	23083	56.50
other Authors 16151	**-**	**16184**	**100.00**	**23083**	**-**	**100.00**

43.49% of total publication = 43.49*4221/100 = 1835.7129 = 1835 publications. From table 6, it is found that 20% of total authors (4616 authors) contributed only 43.49% (1835 publications) of total publications of this subject field. So, this rule is not applicable in this subject area during the selected period of study.

5.7 Prolific Author

The publications output of top 20 most productive citation in the authors in Arthropathy research from 2010 to 2020. A total of 4221 publications and together contributed 263402 total citations, total authors 23083, and unique authors 16184.

Table 7: Top 20 Prolific Author & ACPP of Arthropathy Research

SI. NO	Author	No. of. Publication	Total Citation	ACPP
1	Wukich DK	17	629	37.00
2	Fischer K	36	472	13.11
3	Morfini M	24	405	16.88
4	Gallagher JA	20	426	21.30
5	Ranganath LR	19	371	19.53
6	Mcgonagle D	15	279	18.60
7	Valentino LA	15	394	26.27
8	Schutgens REG	29	244	8.41
9	Doria AS	22	315	14.32
10	Lafeber Fpjg	20	192	9.60
11	Srivastava A	20	253	12.65
12	Pasta G	18	205	11.39
13	Blanchette V	16	368	23.00
14	Di Minno MND	15	235	15.67
15	Santucci A	13	281	21.62
16	Grassi W	12	258	21.50
17	Hermans C	25	227	9.08
18	Roosendaal G	23	164	7.13
19	Oldenburg J	21	278	13.24

| 20 | Mastbergen SC | 18 | 158 | 8.78 |

Table 7 shows that the author Wukich DK was in the topmost position in the citation the value of 629, and the ACPP value for 37. The author Fischer K was in the second position in the citation value of 472, and the ACPP value for 13.11. The author Morfini M third place of citation value for 405 and ACPP vale is 16.88. Another author followed them respectively. Figure 4 shows that the author collaboration of co-authorship networks on Arthropathy research. This figure is a total of 9 Cluster, 732 Item, 42828 Links, and 328910 Total Link Strength. The author Dalbeth N was the first cluster in the figure, the link was 129; the total link strength was 3133 and the 166 citations. The author Fischer K is the second cluster in the figure, the link was 275, the total link strength was 9887, and the 380 citations. The author Boileau P is the third cluster, 169 links, the total link strength is 9616, and the citation was 453.
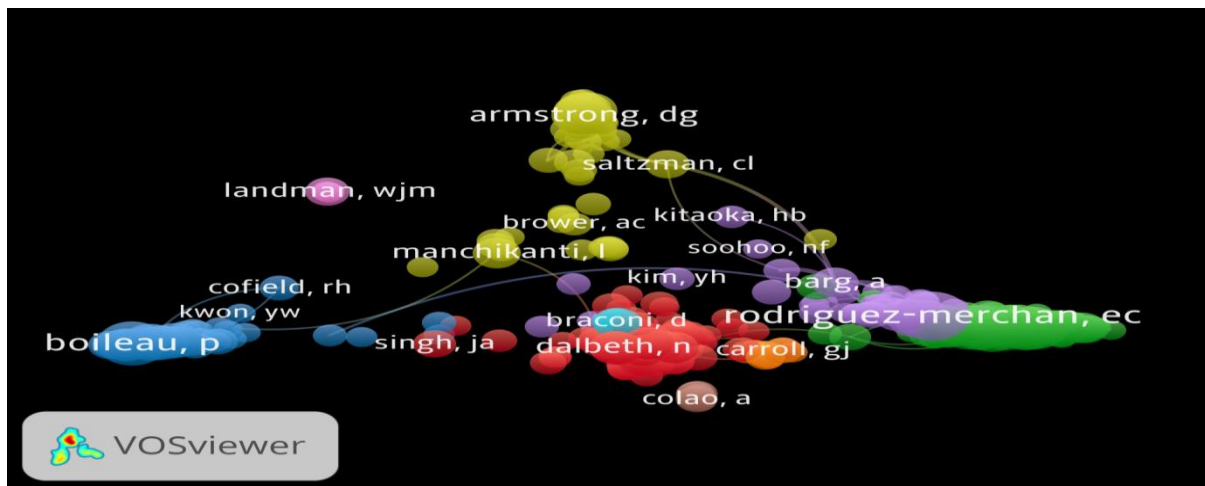

Figure 4: Co-Citation with Cited-Authors

5.8 Collaboration Index, Collaboration Coefficient and Modified Collaboration Coefficient

5.8.1 Collaboration Index

The Collaboration Index (CI) is used to interpret the mean number of authors per paper and it is fit to explore the literature using the simplest index.

$$CI = \frac{\sum_{j=1}^{k} jfj}{N}$$

Where;

   j is the number of co-authored papers appearing in a discipline;

   N is the total number of papers in the discipline over the same time interval, and

   k is the greatest number of authors per paper in a discipline.

5.8.2 Collaboration Coefficient

According to Ajiferuke, it is important to calculate the collaboration co-efficient, where the value comes in between 0 and 1. If it is bigger than 0.5 and near 0, it means that the author has a good collaboration rate and have a weak collaboration respectively. The formula is shown below.

$$CC = 1 - \left[\sum_{j=1}^{k} \left(\frac{1}{j}\right) Fj / N \right]$$

Where,

Fj	=	the number of authored papers
N	=	total number of research published
K	=	the greatest number of authors per paper

5.8.3 Modified Collaboration Coefficient

Suppose each paper carries a single credit, this credit is shared among the authors. If a paper having one author it got one credit and if a paper is shared one by two author this one credit is divided for both and each receives ½ credits. The equation of MCC as explained above is shown below.

$$MCC = \frac{A}{A-1}\left\{1 - \frac{\sum_{j-1}^{A}\left(\frac{1}{j}\right)(fj)}{N}\right\}$$

Where,

Fj	=	the number of authored papers
N	=	total number of research published; and
K	=	the greatest number of authors per paper

Table 8: Collaboration Index, Collaboration Coefficient and Modified Collaboration Coefficient on Arthropathy Research

S.NO	Year	Single Author	Two Author	Three Author	Four Author	Five Author	Six Author	Seven Author	Eight Author	Nine Author	Ten Author	Ten+ Author	Total	CI	CC	MCC
1	2010	30	46	44	53	55	31	22	16	11	13	17	338	4.81	0.140	0.6876
2	2011	29	31	50	48	45	36	31	18	10	11	19	328	5.01	0.127	0.7010
3	2012	25	42	51	42	39	47	36	20	15	7	32	356	5.27	0.149	0.7153
4	2013	28	49	62	56	40	45	38	22	13	12	14	379	4.85	0.158	0.6990
5	2014	19	42	55	51	53	53	36	30	17	12	24	392	5.32	0.173	0.7348
6	2015	26	55	65	74	50	63	59	32	19	13	32	488	5.28	0.168	0.7291
7	2016	38	56	71	69	79	62	32	25	17	6	36	491	4.97	0.146	0.7030
8	2017	19	47	63	56	53	55	35	21	32	18	40	439	5.56	0.175	0.7423
9	2018	27	66	64	75	72	71	50	35	19	6	41	526	5.23	0.174	0.7271
10	2019	15	30	55	71	74	62	51	34	14	18	41	465	5.70	0.174	0.7654
11	2020	1	1	0	3	6	4	0	0	1	1	2	19	5.79	0.185	0.8050
	Total	257	465	580	598	566	529	390	253	168	117	298	4221	5.22	0.158	0.7210
	%	6.09	11.02	13.74	14.17	13.41	12.53	9.24	5.99	3.98	2.77	7.06	100	0.12	0.004	0.0171

Table 8 shows that the author collaboration of arthropathy research measured like the Collaborative Index that is the mean number of authors per joint paper. It can be observed that the highest year was 2020 had a collaborative index value of 5.79, the second position of 2019 had a collaborative index value of 5.70. The next collaboration of CC observed that the highest year was 2020 had a collaborative coefficient value of 0.185, the second position of 2017 had a collaborative coefficient value of 0.175. And last collaboration of MCC observed that the highest year was 2020 had a modified collaborative coefficient value of 0.7210, and the second position of 2019 had a collaborative coefficient value of 0.7654.

5.9 Co-Authorship Index

In modern society, science is no longer a matter for individuals. The vast majority of large projects are completed by groups. Therefore, it is necessary to study the collaboration methods of the authors.

In the following context, we present the collaboration profiles of authors in the field of Arthropathy in 2010 and 2020 using different indicators such as the Co-authorship Index.

Co-authorship Index is used to summate the proportional contribution of multiple-authored papers in different periods and for different subfields. It is similar to the Activity Index (Price, 1981; Garg & Padhi, 2001). Co-authorship Index is given as an equation below:

$$CAI = \{(N_{ij} / N_{io}) / (N_{oj} / N_{oo})\} \times 100$$

Where:

N_{ij} = Number papers having j authors in block i;

N_{io} = Total output of block i;

N_{oj} = Number of papers having j authors for all blocks;

N_{oo} = Total number of papers for all authors and all blocks, j = 1, 2, 3…

CAI < 100 indicates that the number of publications is lower than the average.

CAI = 100 indicates that the number of publications corresponds to the average within a co-authorship pattern.

CAI > 100 indicates that the number of publications is higher than the average".

Table 9: Co-Authorship Index on Arthropathy Research

S. NO	Year	1	CAI	2	CAI	3	CAI	3+	CAI	Records
1	2010	30	145.78	46	123.54	44	94.74	218	93.27	338
2	2011	29	145.21	31	85.79	50	110.94	218	96.11	328
3	2012	25	115.34	42	107.09	51	104.26	238	96.67	356
4	2013	28	121.34	49	117.36	62	119.05	240	91.57	379
5	2014	19	79.61	42	97.26	55	102.11	276	101.81	392
6	2015	26	87.51	55	102.31	65	96.94	342	101.34	488
7	2016	38	127.11	56	103.53	71	105.24	326	96.01	491
8	2017	19	71.08	47	97.18	63	104.44	310	102.11	439
9	2018	27	84.31	66	113.9	64	88.55	369	101.44	526
10	2019	15	52.98	30	58.56	55	86.08	365	113.51	465
11	2020	1	86.44	1	47.78	0	0	17	129.38	19
Total		**257**	**-**	**465**	**-**	**580**	**-**	**2919**	**-**	**4221**

According to the number of authors contributed, the papers have been divided into four categories like single-authored, two authored, three authored and multi-authored. The table here indicated the profiles of CAI for the compared authors. This study was analyzed for single-authored CAI highest value for 145.78 in the year was 2010, and two authored CAI highest value for 123.54 in the year was 2010, and the three authored CAI highest value for 119.05 in the year was 2013, and next analyzed for more than three authored CAI highest value for 129.38 in the year was 2020.

6 Conclusions

The present study of Arthropathy Research is a Global publication on 4221 records in a scientific study from 2010 to 2020. The PEI value is higher than one from the year 2017 to 2020, and the value of AAPP is higher the year is 2017 to 2020, and the value of PPA are higher in the year is 2010 to 2016. The degree of collaboration over the years from 2010-2020 and varies from 0.91 to 0.97. The mean value is 0.938. The top 20 most productive author impact of this research was the author is Wukich DK is 17 publications but the top highest H-index value 13. The maximum deviation of the critical value is smaller than the, 'P' value. This explains the fact that the tabulated value showed that the value of the observed authors was higher than the expected value. Thus the present analysis does not validate Lotka's findings. The Price Square Root law, as well as the Pareto principle 80/20 rule, revealed that these laws are not fit to the Arthropathy Research. The Prolific author Wukich DK was in the topmost position in the citation the value of 629, and the ACPP value for 37. The CI, CC, MCC found to be highest in the year 2020. The Co-Authorship Index single-authored highest value is 2010, two authored highest year is 2010, three authored highest year is 2013 and analyzed for more than three authored CAI highest year is 2020. Arthropathy research is to allow researchers to deepen their insights; this study will help the researcher identify the most important things that have been published. To bring more balance in future research in different subdivisions of arthropathy, more attention and financial attention should be paid. Lack of funding for research is a major shortcoming for researchers.

7 Acknowledgment

8 References

1. Ajiferuke, I., Burell, Q., & Tague, J. (1988). Collaborative coefficient: A single measure of the degree of collaboration in research. *Scientometrics*, *14*(5-6), 421-433.
2. Alagu, A., & Thanuskodi, S. (2018). Information Literacy Research Publications in India: A Bibliometric Analysis. *Journal of Advances in Library and Information Science* 7(2). 201-207.
3. Alvi, K. S., & Vinitha, K. (2014). Hepatitis Research: A Scientometric Analysis of Research Output during 2004-2013. *Journal of Library Advancement,* 4(1), 39-48.
4. Antony, J., & Selvaraju, R. (2019). Growth, Indexing and Authorship Pattern of Poultry Industry Research Publications. *Journal of Scientometric Research*, *8*(3), 150-155.
5. Antony, J., & Selvaraju, R. (2020). Price square Root law, Pareto principle, and Collaborations in Indian Geese Publication output: Scientometric assessment. *Library Philosophy and Practice*, 1-15.
6. Arora, M., Banerjee, J. K., Sahni, P., Pande, G. K., &Nundy. S. (1996) Which are the best undergraduate medical colleges in India? Natl Med J India. 9, 135-40.
7. Bansal, M., Gupta, R., & Bansal, J. (2016). Celiac Disease: A Scientometric Analysis of World Publication Output, 2005-2014.
8. Bayoumy, K., MacDonald, R., Dargham, S. R., &Arayssi, T. (2016).Bibliometric analysis of rheumatology research in Arab countries. *BMC research notes*, 9(1), 393.
9. De Solla Price, D. (1981). The analysis of scientometric matrices for policy implications. *Scientometrics*, *3*(1), 47-53.
10. Elkana et al. (1978). Toward a Metric of Science: *The advent of science indicators*. New York: Wiley.
11. Garfield, E. (1979). *Citation Indexing: Its Theory and application in science, Technology and Humanities*, 8. New York: John Wiley. http://www.garfield.library.upenn.edu/cifwd.html
12. Garg, K. C., & Padhi, P. (2001). A study of collaboration in laser science and technology. *Scientometrics*, *51*(2), 415-427.
13. Guan, J., & Ma, N. (2004). A comparative study of research performance in computer science. *Scientometrics*, *61*(3), 339-359.

14. Hess, D.J. (1997). *Science Studies: An advanced introduction*. New York: New York University   Press.
15. OECD, (1963, 1976). The measurement of Scientific and Technical Activities: "*Frascati Manuel*". Paris: OECD.
16. Price, D. J. de Solla (1963). *Little Science, Big Science*. New York: Columbia University Press.
17. Sachithanantham, S., & Raja, S. (2015). Scientometric analysis of rabies research literature in India: 1950–2014. *Scientometrics*, 105(1), 567-575.
18. Schöffel, N., Mache, S., Quarcoo, D., Scutaru, C., Vitzthum, K., Groneberg, D. A., & Spallek, M. (2010). Rheumatoid arthritis: scientific development from a critical point of view. *Rheumatology international*, 30(4), 505-513.
19. Shilpa, B. S., Padmamma, S., Kumara, A. T., & Walmiki, R. H. (2019). Mapping of Scientific Articles on Leukemia: A Scientometric Study. *Library Philosophy and Practice*, 1-14. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=5910&context=libphilprac
20. Subramanyam, K. (1983). Bibliometrics studies of research collaboration: A review. Journal of Information Science, 6, 35-37.
21. Veritas Health. (1999-2021) Retrieved from https://www.spine-health.com/glossary/arthropathy