Research output on Hantavirus: A Scientometric Study

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Abstract

This paper describes results of a scientometric study on Hantavirus. The purpose of the study is to evaluate the research performance on Hantavirus during the period of 1984-March 2020. The findings indicate that in the study period, Scientists produced 3678 publications shared by 10152 authors from 122 countries and recorded 86204 Global Citations Scores. EMERGING INFECTIOUS DISEASES is the first journal with the highest number of publication with 161 (g-index-77 and h-index-43, Citations-6906) and Impact Factor value is 7.42 and 13 journals published 50 and above publications. The highest impact factor journal is LANCET (59.10) among the top 20 titles. As expected, the United States (1310) is at the top of the list of countries and recorded 44522 Global Citation Scores, followed by Germany (395) with 7720 Citations, Finland (329) and received 10439 Citations, China (309) and 4528 Citations, Sweden (246) and 7081 Citations as the countries contributing the largest numbers of articles and Citations. There were 142 papers, which have recorded 100-855 Citations, besides this the citations count has been taken as the number of citations received by each paper since these were published till March 2020. The most cited paper "GENETIC IDENTIFICATION OF A HANTAVIRUS ASSOCIATED WITH AN OUTBREAK OF ACUTE RESPIRATORY ILLNESS" by NICHOL ST, SPIROPOULOU CF, MORZUNOV S, ROLLIN PE, KSIAZEK TG, et al., 1993, SCIENCE, recorded 855 citations. Virology, Infectious Diseases and Immunology have been identified as the three high priority research areas of Hantavirus with each contributing publication share 920(25.56%), 798 (22.17%) and 486(13.50%). 13 Subjects covered more than 100 publications and 115 subject areas focused on Hantavirus research.

Keywords: Scientometrics, Hantavirus, Scientometric Mapping

INTRODUCTION

Publications are representations of scholarly contributions to research of subjects or any of their sub-fields. Such research publications appear in journals are indexed in databases provide integrated information services by Web of Science, Scopus, PubMed and Google Scholars (Citation, Abstracting and Indexing Databases). It is very difficult to evaluate the research trends manually, from total publication of all research work performed in a particular field from databases. Bibliometrics/Scientometrics is an effective tool for evaluating research trends in any subject field of Publications, Journals, Authors, Country etc,. The Modern bibliometric/Scientometric method analyzed research trends, Collaboration Network of authors,

Country and Institution. Moreover the keywords co-occurrence analysis was increasingly applied to understand the evolving trends of research topics in particular fields and evaluate research fields, often with the help from visualization techniques.

Hantaviruses are a family of viruses spread mainly by rodents and can cause varied disease syndromes in people worldwide. Infection with any hantavirus can produce hantavirus disease in people. Hantaviruses in the Americas are known as "New World" hantaviruses and may cause hantavirus pulmonary syndrome **(HPS)**. Other hantaviruses, known as "Old World" hantaviruses, are found mostly in Europe and Asia and may cause hemorrhagic fever with renal syndrome **(HFRS)**. Each hantavirus serotype has a specific rodent host species and is spread to people via aerosolized virus that is shed in urine, feces, and saliva, and less frequently by a bite from an infected host. The most important hantavirus in the United States that can cause HPS is the **Sin Nombre virus**, spread by the deer mouse. (CDC-USA 2020).

Laksham S. et al. (2020) have presented the global level perspective of Coronavirus research output during the period of 1989 to March 2020 and these analyses included year wise research growth, global publication share and patterns of research communication channels and the most productive journals. Data was extracted from the Web of Science citation database using the search string of "Coronavirus" OR "Covid 19" and limited to Open Access Publications during 1989 to 2020, a total of 7381 publications were retrieved. The highest numbers of publications (561) were published in 2019, which have received 848 citations. Thus this article can be concluded by collaborative author's productivity dominates compared to the single author's contribution. On the basis of literature analysis around the world, it is found that the 7381 publications came from 127 countries. United States (USA) is the most productive country with 2801 publications (37.9% and received 107738 Citations. India (80) has to improve in the field of Coronavirus research in future. The research articles published in peer-reviewed journals of Open Access will create a global impact on the Country, Institutions with subdivision and scientists. These contributions will help the research community to get required information for the research and encourage the researcher in the field of Coronavirus.

Laksham S. et al. (2020) have examines the publications on Coronavirus from India indexed in web of science online database. The search term "Coronavirus" or "COVID 19" with topic field has been used as keyword and limited to India. A total of 281 unique records over the year 1975–2020 have been downloaded and analyzed under various categories considered for

this study. The highest number of articles are published in the year 2016, 2017, 2018 and 2019. Year 2015 has highest number of Citations with 531 for 17 (6.2 %) Publications. The study found that 1369 authors concentrated the research in this field and 281 papers published in indexed journals. International Centre for Genet Engineering & Biotechnology stood in the first with the highest number of publications with 20 (7.3 %) and received 549 Citations followed by All India Institute of Medical Science with 12 (4.4 %) Publications and received 67 Citations, Guru Ghasidas Vishwavidyalaya with 10 (3.7%) Publications and received 482 Citations, Indian Institute of Technology with 10 (3.7 %) Publications and received 86 Citations, University of Delhi with 8(2.9 %) Publications and received 128 Citations, Indian Institute of Science with 6 (2.2%) and received 61Citations. India has collaborated with 38 countries. CSIR, DBT India, UGC, USDHHS, DST India and ICMR are most funded agencies in the field of Coronavirus. Furthermore, this study also identified that document wise distribution, Journal wise, institution with subdivision wise, and geographical collaboration of the literature and citation analysis is also distinguished.

Thulasi, K., & Arunachalam, S. (2010) Cholera research in India over the past six decades has been mapped using HistCite. The analysis based on data from *Science Citation Index Expanded* reveals not only the significant papers, key players, important institutions and core journals, but also provides a visual representation of evolution of knowledge in the field showing the cognitive links between key papers both from within India and elsewhere.

OBJECTIVES OF THE STUDY

The major objectives are framed with the exclusive notion of the present study as mentioned below:

- To identify the country-wise distribution of publications, Citation and research Collaboration.
- To examine the effectiveness of various sources of research publications with years.
- To examine the growth of research productivity on Hantavirus during 1984 – March 2020.
- To identify the authorship pattern of Hantavirus research output.
- To assess the Institution wise research concentration.
- To identify the highly Cited papers.

- To identify the Language wise distribution of Publications.
- To identify the Channels of Communication.
- To identify the High Productive subject areas of Hantavirus research.
- To identify the Co-occurrence of Network (word Frequency).
- To visualize (Mapping) the Country, Source, Institutions and Authors of three Fields Plot.

MATERIAL AND METHODS

The data was retrieved from "Web of Science (WoS) Core Collection" for time span=1984 to 2020 (March). The search string "Hantavirus" with topic field was used to retrieve the publication data. Name of the Countries, Institutions, Source title, Highly Cited papers, and research areas were isolated separately and rank ordered based on their number of publications and Citations and data were analyzed and presented graphically. The query: [Topic: Hantavirus] was used to retrieve details of research publications and application tools (Histcite, VosViewer and Biblioshiny) are used for tabulate the data and visualize the Concepts.

DATA ANALYSIS AND INTERPRETATIONS

Channels of Communication

Table 1 lists the channels used for communicating of Hantavirus research includes Journal articles, Reviews, Meeting Abstract, Letter, Editorial materials, Proceedings paper, Notes, Reprints, Corrections, News items and book chapters. It has been observed from the table there are many communicating channels are used by scientists to publish their research articles. The majority of publications are published in Journals i.e. 2772 (75.4%), followed by Reviews 303 (8.2%) publications, 170 (4.6%) of papers published in Meeting Abstracts, 164 are as published as Letters. It found 11 channels are recorded more than 10 publications and 8 channels are single digit of publications in Hantavirus.

Table 1 shows that Channels used for communicating Hantavirus research

#	Document Type	Records	%	TLCS	TGCS
1	Article	2772	75.4	39734	66952
2	Review	303	8.2	5412	13798
3	Meeting Abstract	170	4.6	16	22
4	Letter	164	4.5	1494	1753
5	Editorial Material	78	2.1	309	460

6	Article; Proceedings Paper	66	1.8	929	1598
7	Note	38	1.0	938	1084
8	Reprint	24	0.7	16	25
9	Correction	23	0.6	8	17
10	News Item	18	0.5	20	32
11	Review; Book Chapter	10	0.3	28	328
12	Article; Early Access	3	0.1	0	0
13	Article; Book Chapter	2	0.1	47	97
14	Discussion	2	0.1	31	37
15	Article; Retracted Publication	1	0.0	1	1
16	Biographical-Item	1	0.0	0	0
17	Correction, Addition	1	0.0	0	0
18	Editorial Material; Early Access	1	0.0	0	0
19	Review; Early Access	1	0.0	0	0

Year wise distribution of Source

Below the table 2 indicates that the source title wise distribution of total research output on Hantavirus research literature. EMERGING INFECTIOUS DISEASES in the first journal with the highest number of publication with 161 (g-index-77 and h-index-43, Citations-6906) and Impact Factor value is 7.42. After 2009 published more than 100 publications and the highest number of publication (161) published in very short period (January to March 2020), 2019 with 159, 2018 with 153. JOURNAL OF VIROLOGY with 156 (g-index-77 and h-index-54, Citations-7616) and Impact Factor value is 4.32. After 2010 published more than 100 publications and the highest number of publication (156) published in very short period (January to March 2020), 2019 with 155, 2018 with 153. It is very nearest to the EMERGING INFECTIOUS DISEASES. AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE with 121 and recorded 3453 Citations. 2019 and 2020 (January to March) covered 121 publications respectively. The highest number of publications published in very short period (2020) with 121.

Table 2 shows year wise distribution of Publications in top 10 Journals

Year	EMERGING INFECTIOUS DISEASES	JOURNAL OF VIROLOGY	VIRUSES-BASEL	VIRUS RESEARCH	JOURNAL OF MEDICAL VIROLOGY	JOURNAL OF GENERAL VIROLOGY	VECTOR-BORNE AND ZOONOTIC DISEASES	VIROLOGY	AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE	ARCHIVES OF VIROLOGY
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	1
1987	0	0	0	0	0	0	0	0	0	1
1988	0	0	0	0	0	1	0	0	0	2

1989	0	0	0	0	1	1	0	0	0	3
1990	0	0	0	0	1	1	0	1	0	4
1991	0	0	0	4	3	2	0	1	2	4
1992	0	0	0	6	5	5	0	1	4	6
1993	0	0	0	9	7	8	0	1	5	7
1994	0	4	0	12	10	10	0	5	8	9
1995	1	8	0	16	15	12	0	13	14	13
1996	2	10	0	17	17	15	0	17	18	15
1997	8	13	0	21	20	16	0	20	24	15
1998	14	15	0	23	21	19	0	23	30	18
1999	26	22	0	25	23	20	0	26	33	19
2000	32	26	0	27	28	23	0	28	37	20
2001	37	31	0	32	30	26	2	31	41	21
2002	45	39	0	36	33	30	5	32	44	24
2003	51	52	0	38	37	33	5	36	45	27
2004	58	58	0	42	40	37	6	42	50	32
2005	59	65	0	44	43	38	12	45	59	36
2006	65	73	0	44	45	39	12	47	67	36
2007	80	82	0	49	49	42	16	48	73	36
2008	87	86	0	53	54	47	21	52	84	40
2009	101	93	2	54	55	51	23	55	91	42
2010	108	105	3	57	57	56	32	58	97	45
2011	113	115	5	60	61	62	42	59	99	48
2012	121	129	5	64	66	68	48	63	100	52
2013	128	135	10	66	66	69	51	66	102	54
2014	135	143	37	83	67	71	59	67	108	55
2015	139	147	41	84	70	76	64	67	111	56
2016	139	149	46	84	72	79	68	69	115	58
2017	145	152	46	87	78	79	76	69	117	59
2018	153	153	46	89	81	80	77	69	119	62
2019	159	155	86	92	84	82	80	70	121	63
2020	161	156	87	92	84	82	80	70	121	63

Authorship Pattern

The table 3 shows the details about the authorship pattern of publications are published during the period of study in Hantavirus publications. The highest number of articles contributed by Multiple Authors were greater than the number of Single authored articles. There was a significant increase in multi-authored papers. The highest number of multi-authored articles included more than Ten authors with 662 publications, five authors (11.85%), Four authors

(11.56), six authors (11.50%), Three authors (10.52) and single author contributed very less 220 (5.98%). These results make clear that team research is a significant aspect in scientific development.

Table 3 shows Authorship Pattern of research in Hantavirus

Authorship Pattern	Publications	%
Single Author	220	5.98
Double Authors	308	8.37
Three Authors	387	10.52
Four Authors	429	11.66
Five Authors	436	11.85
Six Authors	423	11.50
Seven Authors	328	8.92
Eight Authors	269	7.31
Nine Authors	216	5.87
Ten and above Authors	662	18.00
Total	3678	100

Language wise distribution of Publications

Table 4 provides the language-wise distribution of publications on Hantavirus is published in different languages; English, Spanish, German, French Russian, Portuguese, Turkish, Czech and so on. It is observed that the majority (93.8%) of articles published in English language followed by Spanish 76 (2.1%), German 70(1.9%, French 38 (1.0), Russian 13 (0.4) Language. and very less number of articles are published in remaining languages. It found that China published only 2 articles in own mother tongue. Spanish (483), German (316) and French (214) Language also recorded good number of Citations.

Table 4 shows that Language wise distribution of Publications

#	Language	Records	%	TGCS		Language	Records	%	TGCS
1	English	3450	93.8	85045		Dutch	3	0.1	3
2	Spanish	76	2.1	483		Indonesian	3	0.1	0
3	German	70	1.9	316		Chinese	2	0.1	8
4	French	38	1.0	214		Serbian	2	0.1	2
5	Russian	13	0.4	23		Croatian	1	0.0	3
6	Portuguese	9	0.2	67		Italian	1	0.0	2
7	Turkish	5	0.1	30		Polish	1	0.0	0
8	Czech	3	0.1	5		Slovene	1	0.0	3

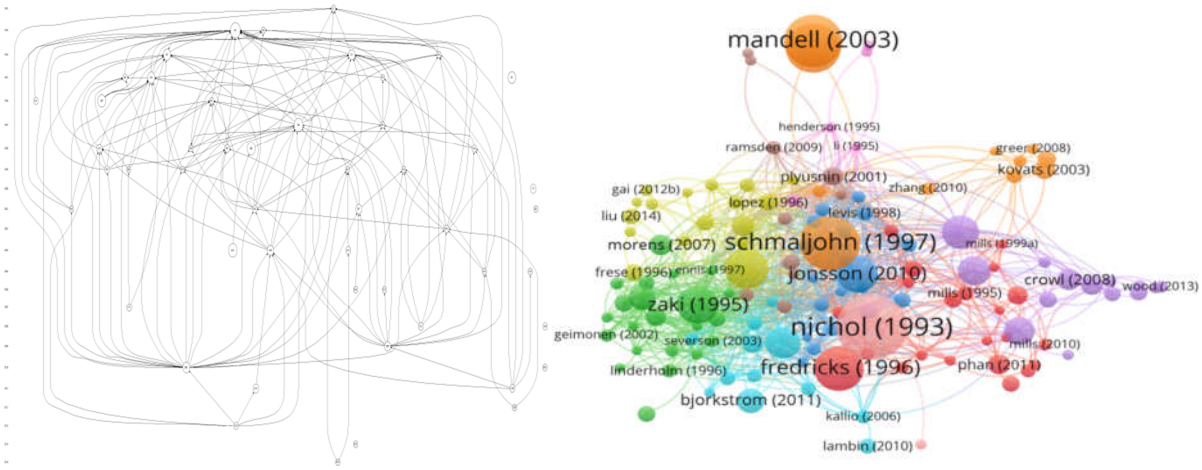
Highly Cited Papers (Most Global Cited Document)

Table 5 presents the pattern of frequently and highly cited papers. The study found there were 142 papers, which have recorded 100-855 Citations, besides this the citations count has been taken as the number of citations received by each paper since these were published till March 2020. The most cited paper "GENETIC IDENTIFICATION OF A HANTAVIRUS ASSOCIATED WITH AN OUTBREAK OF ACUTE RESPIRATORY ILLNESS" by NICHOL ST, SPIROPOULOU CF, MORZUNOV S, ROLLIN PE, KSIAZEK TG, et al., 1993, SCIENCE, recorded 855 citations followed by Hantaviruses: A global disease problem by Schmaljohn C, and Hjelle B with 700 Citations (SCHMALJOHN C, 1997, EMERG INFECT DIS). The remaining papers are listed in the below table with citations and Total Citation Per Year.

Table 5 shows that the most Global Cited Document in Hantavirus

Paper	Total Citations	TC per Year
NICHOL ST, 1993, SCIENCE	855	30.54
SCHMALJOHN C, 1997, EMERG INFECT DIS	700	29.17
MANDELL LA, 2003, CLIN INFECT DIS	687	38.17
BARTLETT JG, 1998, CLIN INFECT DIS	630	27.39
FREDRICKS DN, 1996, CLIN MICROBIOL REV	569	22.76
MORSE SS, 1995, EMERG INFECT DIS	547	21.04
DUCHIN JS, 1994, NEW ENGL J MED-a	498	18.44
ZAKI SR, 1995, AM J PATHOL	463	17.81
JONSSON CB, 2010, CLIN MICROBIOL REV	453	41.18
CHILDS JE, 1994, J INFECT DIS	407	15.07
VAPALAHTI O, 2003, LANCET INFECT DIS-a	385	21.39
GUBLER DJ, 2001, ENVIRON HEALTH PERSP	352	17.60
MEERBURG BG, 2009, CRIT REV MICROBIOL	338	28.17
BJORKSTROM NK, 2011, J EXP MED	292	29.20
ALMIRALL J, 2000, EUR RESPIR J	291	13.86
GAVRILOVSKAYA IN, 1998, P NATL ACAD SCI USA	281	12.22
CROWL TA, 2008, FRONT ECOL ENVIRON	254	19.54
MORENS DM, 2007, J INFECT DIS	242	17.29
PADULA PJ, 1998, VIROLOGY	238	10.35
PHAN TG, 2011, PLOS PATHOG	229	22.90
YATES TL, 2002, BIOSCIENCE	229	12.05
KOVATS RS, 2003, LANCET	224	12.44
MILLS JN, 1998, EMERG INFECT DIS	214	9.30
GAVRILOVSKAYA IN, 1999, J VIROL	210	9.55
PLYUSNIN A, 2001, CURR TOP MICROBIOL	209	10.45

VAHERI A, 2013, NAT REV MICROBIOL	208	26.00
DJIKENG A, 2008, BMC GENOMICS	200	15.38
FRESE M, 1996, J VIROL	193	7.72
NOLTE KB, 1995, HUM PATHOL	192	7.38
WU XX, 2016, ENVIRON INT	187	37.40
LOPEZ N, 1996, VIROLOGY	185	7.40
LAMEIRE N, 2006, NAT CLIN PRACT NEPHR	183	12.20
PUMPENS P, 2001, INTERVIROLOGY	183	9.15
MILLS JN, 1999, EMERG INFECT DIS-a	179	8.14
LIU Q, 2014, LANCET INFECT DIS	178	25.43
OSTFELD RS, 2012, ANNU REV ECOL EVOL S	178	19.78
KLEMPA B, 2006, EMERG INFECT DIS	177	11.80
FELDMANN H, 1993, VIRUS RES	177	6.32
BENGIS RH, 2004, REV SCI TECH OIE	176	10.35
HOOPER JW, 2001, VIROLOGY	175	8.75
MILLS JN, 1997, AM J TROP MED HYG	175	7.29
AVSICZUPANC T, 1992, J MED VIROL	174	6.00
LEVIS S, 1998, J INFECT DIS	172	7.48
PLYUSNIN A, 1994, J VIROL	169	6.26
LAMBIN EF, 2010, INT J HEALTH GEOGR	168	15.27
OSTFELD RS, 2004, FRONT ECOL ENVIRON	167	9.82
PETERS CJ, 1999, ANNU REV MED	167	7.59
MORI M, 1999, J INFECT DIS	160	7.27
MILLS JN, 1995, J MAMMAL	158	6.08
ENGELTHALER DM, 1999, EMERG INFECT DIS	156	7.09



High Productive Subject Areas in Hantavirus

Table 6 provides the observation from the table Virology, Infectious Diseases and Immunology have been identified as the three high priority research areas of Hantavirus with each contributing publication share 920(25.56%), 798 (22.17%) and 486(13.50%). 13 Subjects covered more than 100 publications and 115 subject areas focused on Hantavirus research.

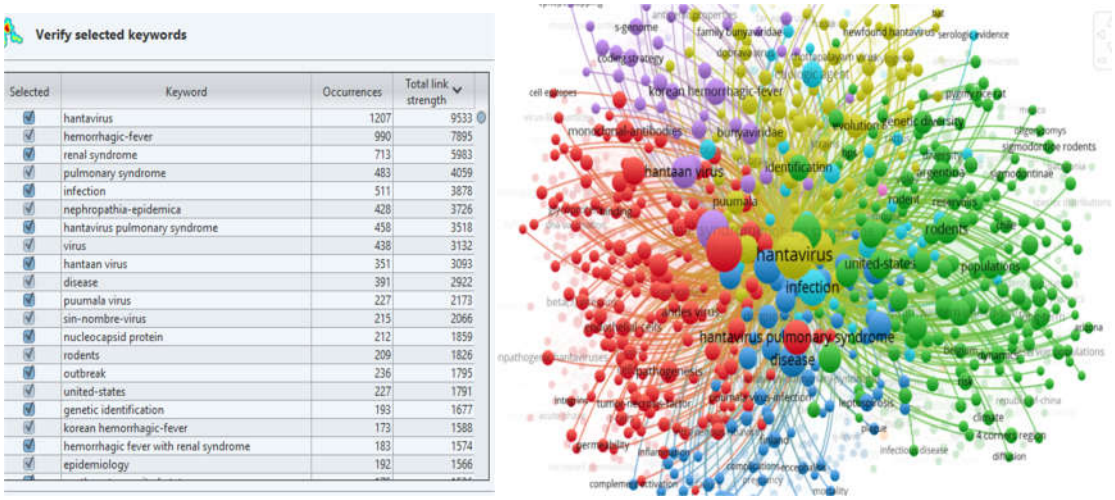
Table 6 shows High Productive Subject Areas in Hantavirus

Web of science categories	records	%
Virology	920	25.563
Infectious diseases	798	22.173
Immunology	486	13.504
Public environmental occupational health	386	10.725
Microbiology	353	9.808
Medicine general internal	309	8.586
Tropical medicine	233	6.474
Biotechnology applied microbiology	164	4.557
Veterinary sciences	160	4.446
Urology nephrology	130	3.612
Multidisciplinary sciences	122	3.390
Parasitology	120	3.334
Ecology	117	3.251
Zoology	87	2.417
Biochemistry molecular biology	85	2.362
Medicine research experimental	84	2.334
Environmental sciences	64	1.778
Pharmacology pharmacy	64	1.778
Genetics heredity	56	1.556
Biochemical research methods	54	1.500
Biodiversity conservation	48	1.334
Cell biology	48	1.334
Biology	47	1.306
Critical care medicine	42	1.167
Respiratory system	42	1.167
Evolutionary biology	40	1.111
Pathology	33	0.917
Pediatrics	33	0.917
Transplantation	28	0.778
Radiology nuclear medicine medical imaging	22	0.611
Mathematical computational biology	21	0.583
Entomology	20	0.556
Chemistry analytical	19	0.528
Medical laboratory technology	17	0.472

Hematology	15	0.417
Peripheral vascular disease	13	0.361
Emergency medicine	12	0.333
Mathematics applied	12	0.333
Biophysics	11	0.306
Physics mathematical	11	0.306
Neurosciences	10	0.278
Physics fluids plasmas	10	0.278
Physiology	10	0.278

Co-Occurrence of Network

It is a well-known fact that keyword can reflect the full meaning or core content of a research publication or literature. In order to identify the dynamic changes of the most important research topics in Hantavirus research, the co-occurrence relationships among top keywords were extracted through visualized with VOSviewer software.



Geographical wise distribution of Publications and Citations

It shows the countries with the largest shares of all articles between 1984 and March 2020. As expected, the United States (1310) is at the top of the list of countries and recorded 44522 Global Citation Scores, followed by Germany (395) with 7720 Citations, Finland (329) and received 10439 Citations, China (309) and 4528 Citations, Sweden (246) and 7081 Citations as the countries contributing the largest numbers of articles and Citations. India appears 23 in the total number of articles with 33 and recorded 319 Citations. 13 Countries contributing more than 100 publications and 19 Countries recorded more than 1000 Citations. Top of the list of countries in terms of research collaboration Sweden to Finland with 88 articles followed by Korea to USA

(60), Germany to Slovakia (57), China to USA (49), USA to Chile (49), USA to Argentina (46), USA to Canada (41), USA to France (38), Russia to USA 36), USA to Germany (35), USA to Japan (35), Germany to Switzerland (34), Sweden to Germany (31) and USA to Brazil (30). The study found that United States 866 (SCP 585 and MCP 283) is at the top of the list of countries and the MCP ratio is 0.326 followed by Germany, China, Finland, Mexico, Brazil, Sweden, Belgium and Japan. India is not listed in top 50 of the countries in terms of research collaboration.

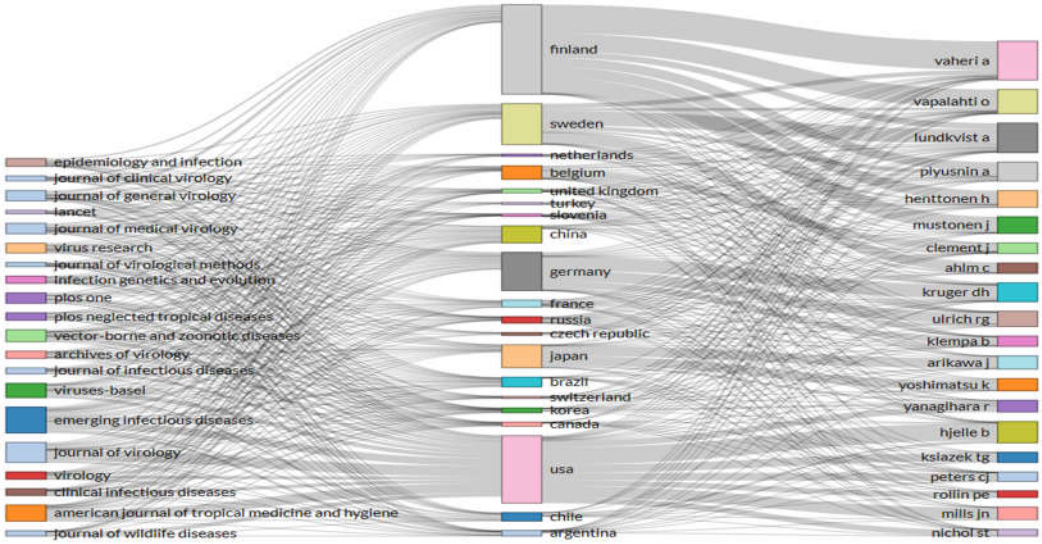


Figure shows that three Fields Plot (Country, Source and Authors)

Institution wise distribution of Publications and Citations

The Publications along with the Global Citations Scores of top 30 Institutions working in the field of Hantavirus during the period 1984-March 2020. University of Helsinki from Finland computed highest 283 (9186 Citations) followed by University of New Mexico from USA 267 (10279 Citations), Centers Disease Control & Prevent (USA) with 214 (11551 Citations), Karolinska Inst (Sweden) with 150, Hokkaido University (Japan) with 111 and Swedish Inst Infect Dis Control (Sweden) with 102 Publications. 6 Institutions contributed more than 100 publications and 18 Institutions with 50 and above. The study found that Finland, USA, Sweden and Japan occupied top 10 Positions. It indicates Centers Disease Control & Prevent (USA) has highest Citation value (11551) closely followed by University of New Mexico (USA) (10279), University of Helsinki from Finland (9186), Karolinska Institute from Sweden (5267), and

Swedish Inst Infect Dis Control (Sweden) (4800). 34 Institutions recorded 1000 and above Citations and 422 Institutions 100 and above Citations.

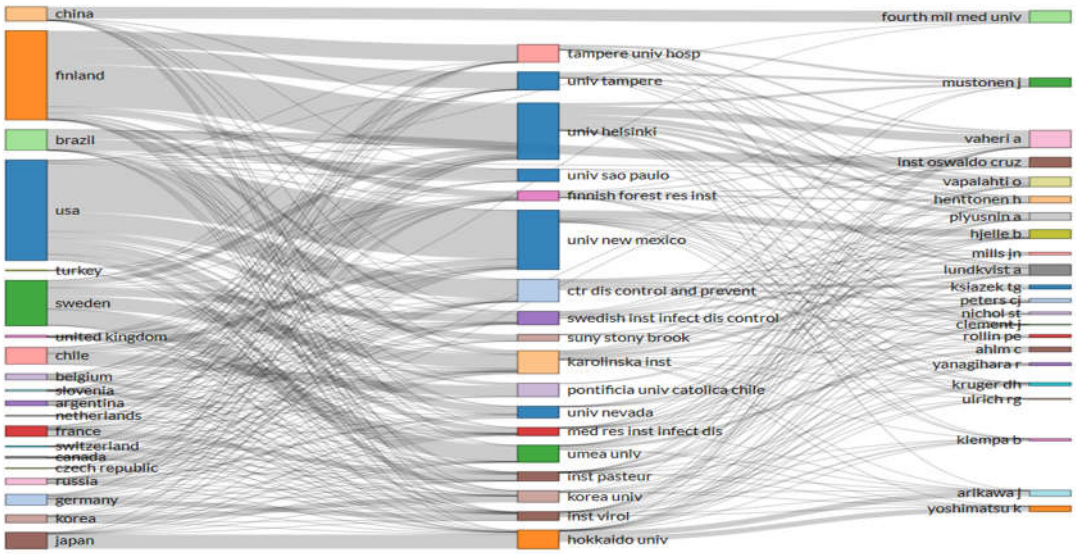


Figure shows that three Fields Plot (Country, Institution and Authors)

FINDINGS AND CONCLUSION

Based on the analysis undertaken the present study reveals the following findings:

- The study found that 3678 publications are published and recorded 86204 Citations.
- As expected, the United States (1310) is at the top of the list of countries and recorded 44522 Global Citation Scores, followed by Germany (395) with 7720 Citations, Finland (329) and received 10439 Citations, China (309) and 4528 Citations, Sweden (246) and 7081 Citations as the countries contributing the largest numbers of articles and Citations.
- There were 142 papers, which have recorded 100-855 Citations, besides this the citations count has been taken as the number of citations received by each paper since these were published till March 2020.
- The most cited paper "GENETIC IDENTIFICATION OF A HANTAVIRUS ASSOCIATED WITH AN OUTBREAK OF ACUTE RESPIRATORY ILLNESS" by NICHOL ST, SPIROPOULOU CF, MORZUNOV S, ROLLIN PE, KSIAZEK TG, et al., 1993, SCIENCE, recorded 855 citations.

- Virology, Infectious Diseases and Immunology have been identified as the three high priority research areas of Hantavirus with each contributing publication share 920(25.56%), 798 (22.17%) and 486(13.50%). 13 Subjects covered more than 100 publications and 115 subject areas focused on Hantavirus research.
- The study found that It indicates Centers Disease Control & Prevent (USA) has highest Citation value (11551) closely followed by University of New Mexico (USA) (10279).
- The highest impact factor journal is LANCET (59.10) among the top 20 titles.

The reputation of any Scientist can be measured on the basis of its publication output. The quality of publications should be measured by means of quantitative (papers) as well as qualitative (citations, h-index, g-index, m-index and Impact Factor) analysis. Identifications of newly emerged research areas at successive periods will be helpful in predicting the future prospects of the research fronts and will be useful to design the further research plan in this field. It will promote the newer form of research front analysis; thus, it will be useful to analyze other research fields.

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