

Scientometric Analysis of Communication Disorders

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Abstract - This paper presents the scientometric study of the growth of literature on communication disorders from 1999-2018. The study analyzed and discussed the yearly growth of publications, authorship pattern, citation pattern, co-authorship, most productive authors, and ranking of authors by using various indices. The researcher collected the required data from the Web of Science database. After standardization, the retrieved research literature has been analyzed with scientometric tools and meaningful inferences. The year 2018 has contributed the highest number of research papers, scoring 20948. The keyword 'Autism' occurrences in 50744 (35.85%) papers. The Collaboration Index (CI=9.55), Degree of Collaboration (DC=0.97), and Collaboration Coefficient (CC=0.52) of research output in communication disorders. Langguth, Berthold is a most prolific and influential author of hearing disorders research. He published 132 articles with 5682 citations. There is a decrease in compound year growth rate (CAGR=-6.36) in research publications on communication disorders.

Keywords: Communication Disorders, Scientometric Analysis, Web of Science, Authorship pattern, Citations and Degree of Collaboration

I. INTRODUCTION

Hearing disorders is one such handicap that cannot be recognized until the individual is spoken to or otherwise engaged in communication is impaired. Hearing impairment, hearing loss, or hard of hearing are all terms used to describe hearing loss, whether it is complete or partial.

A speech and language disability is said to occur when the ability to communicate is compromised. This can occur in any age group of children, adults as well as in elderly. For example, a child may exhibit difficulty in not being able to understand the words spoken or narrate experiences in sentences. Others may have difficulty in speaking clearly as a result of pronunciation error or stammering or a voice problem. Further, damage to brain or head and neck region can result in a sudden speech and language impairment.

The global scientific community faces continuous pressure to produce research publications of high scientific quality. The aim is to attract citation indexes, where scientometrics evaluates the international impact of publications (Bartol & Stopar, 2004). Scientometrics is the discipline that focuses on quantitatively analyzing and evaluating scientific output.

It employs various metrics and methodologies to examine the impact, research productivity, and quality of research articles, authorship pattern, journals, institutions in a discipline. Scientometrics aims to establish benchmarks and standards for evaluating the quality and impact of scientific information output. Scientometric studies are used to characterize different scientific disciplines by analyzing their growth patterns, citation networks, and other attributes.

Scientometrics helps gain insights into the organization and development of a specific scientific field or discipline. It allows researchers to track and analyze trends in research topics and discover networks of collaborating researchers. The study patterns of authorship, collaboration, and the evolution of research teams over time. It aids in identifying opportunities for interdisciplinary research and encourages national and international collaboration across different scientific disciplines. (Trimukhe, 2019).

Information dissemination and scientometric tools have several valuable applications in decision-making for researchers and institutions. Institutions can use scientometric tools to allocate research funds more effectively. By identifying research areas with significant impact and potential, they can prioritize funding allocation to support high-impact projects.

Institutions can compare their research impact and productivity with peer institutions or competitors. Scientometrics facilitates the identification of potential research collaborators and partners, whether at a national or international level. Scientometrics also plays a role in tracking collaboration between academic institutions and corporate entities (Mukherjee, 2017). It also helps to examine author affiliations and collaboration patterns; scientometrics can reveal how institutions collaborate geographically, domestically and internationally.

It helps identify the most productive authors and institutions, top core journals, impact factors, citation studies and other metrics, scholarly publication output, h-index, etc., in a specific discipline or field. The most common analyses in science mapping are publications, journals, authors, cited references and descriptive words.

II. REVIEW OF LITERATURE

Scientometric studies involve the quantitative analysis of scientific publications, such as articles in academic journals, conference papers, patents, and other forms of scholarly communication.

Mohan and Kumbar (2020) study indicates that the scientific research literature on Indian solar physics has experienced significant growth, with an annual rate of growth rate of approximately 9 percent. The study reports that Astrophysical Journal and Solar Physics are most productive in Indian solar physics. Together, they account for approximately 34.92 percent of the total publications in this area. The study highlights that a substantial majority of the published papers (about 91 percent) in the area of solar physics in India are multi-authored, and a small percentage (9 percent) of the publications are solo-authored. The rate of growth rate for India's publication output in solar physics is 0.19, whereas doubling time for Indian solar physics research output is 4.9.

Sumathi *et al.*, (2020) analysed the Research Journal of Chemistry and Environment publication patterns over 15 years (2005–2019); 1,471 publications were published in the 'Research Journal of Chemistry and Environment'. Single authors contributed to 148 publications, double authors contributed to 445 publications, and triple authors were involved in 399 publications. The multi-authored publications are 482. The year 2019 contributed nearly 214 publications, which accounted for 14.56 percent of the total research output; the year 2005 has lowest number of research papers scoring 48 (3.27%). A mean value of 0.9 suggests a high degree of collaboration, with most publications involving multiple authors.

Kumar (2020) has used data WoS for data collection for the study. About 6963 research papers were downloaded. Of the total publications, 5,202 were published in referred research journals. The remaining publications were distributed among conferences, symposiums, bulletins, and reviews. The study employed various analysis and visualization software tools to process and make sense of the collected data.

Jahina *et al.*, (2020) focused on trends and characteristics in brain concussion research publications. The study shows that the research productivity relating to brain concussions has been increasing at an average growth rate of 0.851. The mean collaborative index entire was reported as 0.19. Lotka's Law is applied to brain concussion research and is considered "good" for its application.

Tsay and Lai (2018) revealed a significant growth annual rate of approximately 9.72 percent in the literature related to heat transfer. This study identified the emergence of new subjects within the field of heat transfer through an analysis of authors' keywords. The USA contributed 17.5 percent of the publications, while China contributed 14.4 percent. About 92 percent of the papers on heat transfer are published by co-

authors. The majority of papers (74 percent) are two-four authors. The productivity of authors seems fit for applying Lotka's law, with 61.3 percent of one paper and 15.9 percent of authors publishing two papers (Hu, Chen & Liu 2014).

III. OBJECTIVES OF THE STUDY

The aims of the study are:

1. To find out year-wise productivity of research output.
2. To find out annual ratio of growth and annual growth rate of research output in communication disorders.
3. To identify the degree of collaboration, collaboration index, and collaboration coefficient of research output in communication disorders.
4. To analyze hearing disorders, the co-authorship network with authors.

IV. HYPOTHESES

1. There is an increase in the trend in Degree of Collaboration, Collaboration Index, and Collaboration Coefficient in research output on communication disorders.
2. There is an increase in the annual growth of research output on communication disorders.

V. METHODOLOGY

In this study, Web of Science database is used for data harvesting in the area of communication disorders research literature. The study uses twenty years of publication data from 1999 to 2018 on communication disorder research. A total of 141540 records were identified in the field of communication disorders, which have been published in the Web of Science. The downloaded data have been analyzed with scientometric tools to find meaningful inferences. The researcher has intended to analyze the source- and journal-wise distribution of Web of Science research outputs, relative growth of literature, doubling time, local and global citations and annual growth rate in a certain period indexed by the WoS database. The researcher applied the search string "Scientometrics", which was used for the data extraction and analysis using MS Excel and Bibexcel software applications for this study.

VI. RESULTS AND DISCUSSION

The following tables indicate the result and discussion/interpretation of scientific research productivity in communication disorders.

A. Year-Wise Breakup of Research Productivity

The year-wise growth of publications is shown in Table I. It was observed that from 1999 to 2018, twenty years were chosen to assess the research output in communication disorders.

TABLE I YEAR-WISE BREAKUP OF THE RESEARCH PRODUCTIVITY

Sl. No.	Years	No. of Articles Published	%
1	1999	3709	2.6
2	2000	2872	2.0
3	2001	3466	2.4
4	2002	3738	2.6
5	2003	4041	2.9
6	2004	4235	3.0
7	2005	3365	2.4
8	2006	4378	3.1
9	2007	3373	2.4
10	2008	3507	2.5
11	2009	4241	3.0
12	2010	3622	2.6
13	2011	4657	3.3
14	2012	2642	1.9
15	2013	2407	1.7
16	2014	14300	10.1
17	2015	14296	10.1
18	2016	18471	13.1
19	2017	19272	13.6
20	2018	20948	14.8
	Total	141540	100

Average number of papers per year = 141540/20 =7077

After validating and standardizing the retrieved data, 141540 research papers were found fit for the study. Table I shows that in the year 2018, 20949 (14.8%) articles were published, followed by 19272 articles in 2017 and 18471 (13.1%) in

2016. The year 2018 has contributed highest number of research papers scoring 20948. It means that the number of research outputs increased yearly from 2013 to 2018.

TABLE II DISTRIBUTION OF THE RESEARCH OUTPUT BASED ON KEYWORDS

Sl. No.	Keywords	No. of Publications	Percentage
1	Aphasia	12017	8.49
2	Articulation Disorder	74	0.05
3	Auditory Neuropathy Spectrum Disorder	149	0.11
4	Autism	50744	35.85
5	Central Auditory Processing Disorder	119	0.08
6	Communication Disorder	245	0.17
7	Deafness	14349	10.14
8	Dysarthria	3679	2.60
9	Fluency Disorder	43	0.03
10	Hearing Disorder	43323	30.61
11	Language Disorder	1063	0.75
12	Language Impairment	4962	3.51
13	Specific Language Disorder	31	0.02
14	Speech Disorder	556	0.39
15	Speech Impairment	535	0.38
16	Speech Sound Disorder	182	0.13
17	Stuttering	2361	1.67
18	Tinnitus	6666	4.71
19	Voice Disorder	442	0.31
	Total	141540	100

B. Distribution of Research Output Based on Keywords

The distribution of keywords for harvesting research output in communication disorders using Web of Science is shown in Table II.

The research was observed to be more prominent in the area of Autism, with the contribution of 50744 (35.85 percent) papers. The next large number of papers are in the branch of hearing disorders, 43323 (30.61 percent) papers, this is followed by deafness (10.14 percent) papers and aphasia (12017 articles, 8.49 percent) papers. It is concluded that more research papers have been produced on Autism,” whereas it has produced the fewest research papers on Articulation Disorder.

C. Collaboration Index (CI), Degree of Collaboration (DC), Collaboration Coefficient (CC) of Research Output

The distribution of Collaboration Index, Degree of Collaboration, Collaboration Coefficient is shown in Table III. The mean collaboration index during the research period is 9.55 and has been calculated during the twenty years. The year 2005 scores highest CI of 9.72, and the lowest CI is 9.41 in the year 2000. As far as the trend in authorship patterns and collaborative measures, the Collaborative Index for the universal level was 9.55, which showed more popularity for collaborative research patterns than single-author research in the chosen field of communication disorders.

TABLE III CI, DC, CC OF RESEARCH OUTPUT

Year	Total Articles	Total number of Authors	CI	DC	CC
1999	3709	35289	9.51	0.97	0.37
2000	2872	27034	9.41	0.97	-0.67
2001	3466	33507	9.67	0.97	-0.46
2002	3738	36031	9.64	0.97	-0.66
2003	4041	38561	9.54	0.97	-0.62
2004	4235	40415	9.54	0.97	-0.66
2005	3365	32703	9.72	0.97	-9.54
2006	4378	41860	9.56	0.97	0.52
2007	3373	32123	9.52	0.97	0.52
2008	3507	33326	9.50	0.97	0.52
2009	4241	40284	9.50	0.97	0.52
2010	3622	34824	9.61	0.97	0.52
2011	4657	44443	9.54	0.97	0.52
2012	2642	25433	9.63	0.97	0.52
2013	2407	23105	9.60	0.97	0.52
2014	14300	134908	9.43	0.97	0.52
2015	14296	137038	9.59	0.97	0.52
2016	18471	176150	9.54	0.97	0.52
2017	19272	183752	9.53	0.97	0.52
2018	20948	200068	9.55	0.97	0.52
Total	141540	1350854	9.55	0.97	0.52

The Collaborative Index (CI) is calculated by dividing the total no of authors and the total no of published articles. The result of the degree of collaboration is $C = 0.97$, which means that 97 percent of the authors in the study have collaborated on the published articles.

A collaborative index of 0.97 indicates a strong tendency for multiple authors to work together on articles. The mean collaboration coefficient of 0.52 was counted from 1999 to 2018. The strongest collaboration coefficient is 0.52, during 2006 to 2018, followed by the lowest collaboration coefficient of -9.54 in 2005.

1. Hypothesis 01

$H_a =$ There is an increasing in the trend of Collaboration Index, Degree of Collaboration and Collaboration Coefficient of research productivity on communication disorders during 1999-2018.

$H_0 =$ There is a decreasing in the trend of Collaboration Index, Degree of Collaboration and Collaboration Coefficient of research productivity on communication disorders during 1999-2018.

2. Statistical Inference

Table III shows research output on communication disorders with regard to Collaboration Index, Degree of Collaboration and Collaboration Coefficient; that study indicates that there is a decreasing trend in case of Collaboration Index, Degree of Collaboration, Collaboration Coefficient of research output on communication disorders. This analysis did not prove the hypothesis that there is an increase in the Collaboration Index (CI=9.55), Degree of Collaboration (DC=0.97), and Collaboration Coefficient (CC=0.52) of research output in communication disorders. Hence research hypothesis is rejected.

D. Distribution of Year-wise Growth Rate of Research Output

The breakup of annual growth rate of research output of in communication disorders for the period of twenty years in Table IV.

TABLE IV DISTRIBUTION OF YEAR-WISE GROWTH RATE OF RESEARCH OUTPUT

Year	Total Articles	Annual Ratio Rate	Annual Growth Rate	Compounded Annual Growth Rate
1999	3709			
2000	2872	0.77	-0.23	-6.36
2001	3466	1.21	0.21	
2002	3738	1.08	0.08	
2003	4041	1.08	0.08	
2004	4235	1.05	0.05	
2005	3365	0.79	-0.21	
2006	4378	1.30	0.30	
2007	3373	0.77	-0.23	
2008	3507	1.04	0.04	
2009	4241	1.21	0.21	
2010	3622	0.85	-0.15	
2011	4657	1.29	0.29	
2012	2642	0.57	-0.43	
2013	2407	0.91	-0.09	
2014	14300	5.94	4.94	
2015	14296	1.00	0.00	
2016	18471	1.29	0.29	
2017	19272	1.04	0.04	
2018	20948	1.09	0.09	
Total	141540			

The year 2014 indicates highest rate of growth of research output scoring 4.94, which shows that the particular year’s publication has slightly increased. The year 2000 growth rate was -0.23, the year 2001 growth rate was 0.04, the 2002 growth rate was 0.08, and the 2003 growth rate was negative.

0.08, the 2004 growth rate decreased up to 0.05, the 2005 growth rate again negatively declines to -0.21, the 2006 growth rate increased to 0.30, and the 2007 growth rate negatively decreased to -0.23. Compared to other years’ productivity, there is variation in their exponential growth rate; it is decline. The compound year-wise rate of growth rate is 4.365. The annual growth of research output for communication disorders is declining. It was also found that the rapid rate of growth rate was more or less equal during the study period, and it was the lowest at -0.43 with 2642 articles during 2012. It is inferred that the publications and its exponential growth rate are approximately equal, with a slight variation in the research productivity of communication disorders, and its growth rate was negative -6.36.

1. Hypothesis 02

H_a = There is an increasing in the yearly growth rate of research productivity on communication disorder during 1999-2018.

H_0 = There is a decreasing in the yearly growth rate of research output on communication disorder during 1999-2018.

2. Statistical Inference

Table IV shows the research output growth rate, and there is a decrease in the yearly growth rate of research publications on communication disorders (CAGR = -6.36). This analysis did not prove the hypothesis that there is an increase in the annual growth rate of research output on communication disorders. Hence research hypothesis is rejected.

E. Co-Authorship Network

The co-authorship network in hearing disorders research is shown in Table V. It may be seen from the table that nearly 1350854 prolific authors produced 141540 articles, however the strongest number of authors per paper is 25 and the minimum number of authors papers is 5.

A total of 71346 authors, only 3006 authors contributed specified threshold. There were 20548 total link strengths and 27 clusters/group with 758 items. In cluster/group, 1 (61 items), cluster/group 2 (47 items), cluster 3 (47 items), cluster/group 4 (46 items), cluster/group 5 (45 items), cluster/group 6 (43 items), cluster/group 7 (43 items), cluster/group 8 (45 items), cluster/group 9 (44 items), cluster/group 10 (34 items) etc., It is witnessed that a number of 132 publications of “Langguth, Berthold” and with 162 total link strength with 132 articles with 5682 citations and “De Ridder, Dirk” have 142 total link strength has 106 articles and 3839 citations seen through scientometric analysis. It may be seen that the authors are intensely engaged in in this research collaboration in hearing disorders. Langguth, Berthold is a most prolific and influential author of hearing disorders research and published 132 articles with 5682 citations, with a total link strength of 162.

TABLE V CO-AUTHORSHIP NETWORK

Sl. No.	Author	Articles	Citations	Total Link Strength
1	Langguth, Berthold	132	5682	162
2	De Ridder, Dirk	106	3839	142
3	Lenarz, Thomas	145	5511	131
4	Van De Heyning, Paul	42	1496	105
5	Vanneste, Sven	55	2029	103
6	Smith, Richard J. H.	112	3277	99
7	Smith, Rjh	39	1430	96
8	Cremers, Cwrj	65	3069	95
9	Usami, Shin-Ichi	47	2382	92
10	Lin, Frank R.	32	1363	92
11	Grolman, Wilko	47	2248	92
12	Van Camp, G	99	1633	85
13	Cremers, Cor W. R. J.	84	3633	85
14	Ogawa, Kaoru	55	1801	84
15	Carlson, Matthew L.	100	4328	84
16	Nakashima, Tsutomu	49	1497	79
17	Skarzynski, Henryk	64	1044	72
18	Van Camp, Guy	53	1548	67
19	Salvi, Richard	104	5062	60
20	Dai, PU	72	1317	60
21	Petit, C	45	907	59
22	Cruickshanks, Karen J.	35	900	56
23	Nishio, Shin-Ya	81	1863	54
24	Choi, Byung Yoon	55	1126	51
25	Friedman, TB	84	2008	49
26	Petit, Christine	78	2716	48
27	Kim, Un-Kyung	105	4397	48
28	Tekin, Mustafa	58	678	43
29	Mylanus, Emmanuel A. M.	60	720	41
30	Lee, Kyu-Yup	52	2055	40
31	Yamasoba, Tatsuya	58	1381	39
32	Friedman, Thomas B.	43	1264	28
33	Landgrebe, Michael	53	1101	20
34	Sone, Michihiko	83	1070	17
35	Huygen, Plm	48	1239	17
36	Guan, Min-Xin	61	927	17
37	Yan, Denise	88	1455	16
38	Sterkers, Olivier	57	1660	14
39	Schecklmann, Martin	53	1853	14
40	Griffith, Andrew J.	59	1696	14
41	Knipper, Marlies	113	2189	8
42	Frijns, Johan H. M.	50	1294	8

43	Klein, Barbara E. K.	80	1532	6
44	Klein, Ronald	70	6670	5
45	Han, Dongyi	72	1829	4
46	Kremer, Hannie	60	4181	3
47	Yuan, Huijun	48	1708	2
48	Riazuddin, Saima	85	5644	2
49	Ahmed, Zubair M.	59	2644	2
50	Riazuddin, Sheikh	84	1578	0

VII. CONCLUSION

The Web of Science database contributed 141540 valid and standardized research papers for a period of twenty years ranging between 1999-2018. The study revealed that the year 2018 is the strongest year contributing 20948 papers, whereas the year 2013 has contributed least number of papers scoring 2407. The study shows that a majority of authors prefer to use journals as their primary source of information. Journals are considered to be a reliable and credible source for scholarly communication in various scientific fields. Journals are also noted as the most cited form of communication for autism among scientists and research scholars. It is observed from the journal-wise publications that the *Otology & Neurotology* journal has made a high level of publication during the study period (published 2084 papers with citations of 43798). It dominates in the first place of research output in the field of hearing disorders. It is found from the analysis that 20948 papers received a high level of total citations, which is 19256, followed by 19272 papers that received local citations, which is 18470. The overall study witnessed a mean relative growth rate is 4.365 in 2014. The annual growth of research output for communication disorders is decline in nature. The highest relative rate of growth observed during the specified research period is 0.57, which occurred in 2000. Moreover, the lowest relative growth rates were observed in 2012 and 2013, with a rate of 0.05. The Doubling time for different years gradually increases, starting at 0.96 (1999) and reaching 9.64 (2018). The mean Doubling time for the first ten years (from 1999 to 2009) was reported as 3.5, while for the last ten years (from 2009 to 2018), it increases to 7.18. The publication growth rate decreased, and the corresponding Double time increased. This study also suggests that the authors engaged in communication disorders research had a strong collaboration trend in producing research papers especially on hearing disorders. Langguth, Berthold is a most prolific influential author in the area of hearing disorders during 1999-2018. He has

contributed 132 research papers scoring 5682 citations; his total link strength is 162. The present study has broader implications on scholars and policymakers in the area of communication disorders. It may be inferred that there is a need to enhance research strategies and specific research directions to explore recent trends effectively in increasing international research collaboration in the area of communication disorders.

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