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Communication Disorders Research Literature: A Scientometric Profile

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Abstract - **This paper focuses on scientometric analysis and mapping of scientific publications on communication disorders by using VOSviewer. It aims to examine the use of various scientometric indicators on communication disorders. The study covers twenty years of publication data from 1999 to 2018 on communication disorder research. Nearly 141540 publications were retrieved and analyzed in the area of communication disorders. Harvard University published the highest number of 356 papers, with 21317 cited references and 340 total link strength in co-authorship with the organization. The USA shows 19005 articles and 621203 citations with country co-authorship. Langguth, Berthold (145) produced the highest number of papers with citation networks with other authors. K-S test Dmax value (0.1138) and critical value of D 0.05 and 0.1 levels. The chi-square test value is 2645141075. According to Price law, a single contributor, 4254 authors contributed at once, generated 4254 articles, and the square root value of each author is 1162. In the Pareto principle, 79272 authors contributed 24.02% of 141540 articles.**
Keywords: **Communication Disorders, Hearing Disorders, Scientometric Profile**

1. INTRODUCTION

For a good communication, certain imperative parameters have to be normal like speech, language and hearing. Speech refers to verbal expression of thought, feelings or ideas using the movements of articulators. The parameters of speech are voice, articulation and fluency and also prosody. The voice is the sound produced by the vibration of vocal folds. The vocal folds are a pair of structures located inside the larynx, voice box in the throat. The parameters of voice are pitch, loudness and quality. For the correct production of each and every sound, the structure inside the mouth such as tongue, soft palate and lips move in a particular pattern and is referred to as articulation. The fluency is defined as the smooth forward flow of speech without any breakdown. The parameters of fluency are rate, continuity and effort.

Hearing, one of the five senses of human being. Speech and language (communication development) are mainly acquired through hearing. Sounds in the environment vary in terms of loudness and pitch. Squirrels and Giraffe produce high and low frequency (pitch) sounds, respectively. Likewise, females and males produce high and low pitch voice, respectively. Our human ears are capable of hearing sounds varying between 15 Hz to 20,000 Hz. Above these frequencies of sounds are called ultrasounds and below the 15 Hz sounds are called infra-sounds where our human ears are not sensitive enough to perceive them.

Scientometrics is a field of study that measures and analyses scientific research and its impact. It uses quantitative methods to understand various aspects of scientific activities, such as the quantum of published papers, and their citations along with nature of collaborations among researchers.

In simple terms, scientometrics helps us keep track of how much research is being done in different fields, how often other scientists refer to that research, and how scientists work together on projects. It's like using numbers and statistics to understand how science works, grows, and influences other research. This information is valuable for policymakers, researchers, and institutions to evaluate the impact and effectiveness of scientific work and to make informed decisions about funding, collaborations, and advancements in different areas of science.

Scientometrics is a field of study that involves the quantitative analysis of scientific literature and research outputs. It uses various techniques and methods to analyze and measure different aspects of scientific research, such as identifying research trends, research networks, measuring research impact, trends in authorship and collaboration, identifying suitable research partners, cross-disciplinary work, and national and international collaboration. (Trimukhe 2020 & Kumar 2020).

Information dissemination helps in the data-driven approach to decision-making in the academic and research domains. It empowers researchers and institutions with valuable insights into research performance, trends, and collaboration opportunities at national and international levels. It also tracks corporate and academic sector collaboration, ultimately facilitating more informed and strategic decisions. (Mukherjee 2017; Mohan & Kumbar 2020). It also helps to find institutions' geographical collaboration, research strengths and most productive authors and institutions in a particular field of discipline (Ghosh 2014; Tsay & Lai 2018). It helps to identify core journals, impact factors, citation

studies, author metrics, h-index, etc. (Hu *et al.,* 2014). The most common analyses in science mapping are documents, authors, journals, cited references and descriptive words.

II. REVIEW OF LITERATURE

Yaz *et al.,* (2023) say that 8282 research publications relating to tinnitus were identified in WoS. The maximum amount of research articles is increasing. The USA and European institutions contributed significantly to the field, having high impact factor cited articles.

Moniem Ali *et al.,* (2022) found that 812 research papers published in 405 different sources. The year 2019 was identified as a particularly productive year, with 101 research papers published during that year. Among the years analyzed, 2014 received the highest (6,634). The research indicates that University of Toronto is one of the top ranking institution with 42 research papers having 5358 citations. United States of America has 433 research papers, and it is in the lead. The journal "Scientific Reports" was the most popular among researchers, with 16 publications. The research revealed that the keywords "autism" and "architecture" were used more frequently in the papers, with 257 and 165 occurrences, respectively.

Alduais *et al.,* (2022) analyzed 8,285 biolinguistics publications. The study revealed that significant portions of these publications, precisely 7,797, were published between 2000 and 2022. The analysis identified leading regions in terms of biolinguistics publications, with USA and UK are shown as significant contributors to the field. The study likely identified higher education institutions that have played a prominent role in biolinguistics research. Identifying leading journals in biolinguistics indicates where much of the research in this field is published.

Venkatesan (2022) study analyzed research topics that span clinical psychology and speech-language-hearing in indexed national journals. The study calculated an objective collaboration index (CI) measure to assess the degree of collaboration among clinical psychology and speech-language/hearing pathologists. A CI of 12-13 per cent suggests that a relatively small proportion of research articles in these fields involve collaboration between the two disciplines. The study identified several less-explored topics that could benefit from increased collaboration. These topics include cognition, brain, neuropsychology, language, speech and voice science.

Asghar, Egaji, & Griffiths (2021) give insights into **r**esearch developments in aphasia and shed light on the growth, quality, and geographical distribution of research in this area. The study reports the rate of growth of 4% in the discipline of aphasia. However, the rate of average number of citations per paper amounts to nearly seven. It indicates a moderate level of publications quality. Web of Science/Scopus are identified as the popular citation databases for research in this field. They host a significant number of studies and contribute to the quality of publications, as indicated by the P-Index values (49.26 for Scopus and 32.85 for Web of Science). The United States (USA) is the leading country in this research field, with 42% of the publications. The United Kingdom (UK) follows with 15% of the publications.

Ramkumar, Narayanasamy, Nageswara (2016) found no significant difference in collaboration with speech, language, or hearing and indicated a persistence of local collaboration, providing essential insights into research dynamics in this domain. The study analyzed a relatively small sample of only 905 papers to determine collaboration trends. Due to the limited sample size, the study's findings may be indicative rather than definitive.

Konur (2012) provides valuable insights into the research landscape in the field of deafness and hearing research during the analyzed period. The study indicates that the literature in the field of deafness and hearing research experienced exponential growth during the period under investigation. Most of the papers in this field are journal articles, reviews, and proceedings, which are common publication types in academic research. The predominance of papers in English is consistent with the international nature of academic research. The United States emerged as highly prolific publishing nations, contributing 3/4 of the research productivity. Another research institution which as significantly contributed to the research in the field is Rochester Institute of Technology was identified as the most contributing research institution.

Kelly RR is recognized as the most published author. The research in the field is prominently reported in the journal American Annals of the Deaf followed by in the journal Rehabilitation is the field's most published field. The citations (1,356) suggests that the research in this field has gained recognition and has influenced other studies. The average citations per paper is 4.5, which shows moderate impact per publications. Whereas the H-index 18 reflects the cumulative effect on the research literature.

III. SIGNIFICANCE OF THE STUDY

Scientometric techniques allow researchers and policymakers to determine the rate of growth of scientific research output in different contexts, such as nations, organizations, departments, or fields of knowledge. It helps identify patterns in publication, authorship, and author affiliation. It can reveal trends in research collaboration, interdisciplinary work, and changes in research focus within a specific field. It provides tools to identify productive authors and institutions. It allows for assessing publication productivity, which measures the relationship between research outputs (publications) and inputs (e.g., funding, human resources). Assessing the effectiveness of organizational R&D activities is crucial for evaluating the contributions of institutions and individual scientists.

IV. OBJECTIVES OF THE STUDY

The aims of the study are,

1. To assess the co-authorship network with organizations and countries.
2. To analyze the network relationship between the citation and the authors' research productivity,
3. To examine scientometric indicators relating to authors productivity.

V. HYPOTHESES

1. The distribution of scientific productivity of authors in communication disorders is in conformity with Lotka's law.
2. The contribution of scientific productivity of authors in communication disorders is in conformity with Price's law.
3. The dispersion of scientific productivity of authors in communication disorders is in conformity with Pareto Principle.

VI. METHODOLOGY

The research output on communication disorders from 1999 to 2018 would be considered the universe of the present study. The source of data collection is Web of Science. A total of 141540 research papers were downloaded during period of study. The retrieved articles have been analyzed with scientometric tools to find meaningful inferences. The data has been analyzed and classified in the VOSviewer software. The bibliographical details are converted to MS Excel using the PHP scripting language for text extraction based on delimiters. Finally, the data are re-arranged in MS Excel to eliminate the duplications. The mapping software tools such as VOS-Viewer were also used to analyze the scattering of research in different dimensions.

VII. RESULTS AND DISCUSSION

The following tables and figures indicate the results and discussion and the interpretation of scientific research output in the field communication disorders.

A. Co-authorship Network with Organizations

The data visualization for the linked institutions that participated in this study on hearing disorders utilizing full counting records is shown in figure 1 for paper publication. The top 50 organizations whose affiliates published on the subject of hearing disorders held a total of 12313 organizations, according to an analysis of the authors' affiliations. Only 1702 out of 12313 organizations satisfied the requirements.

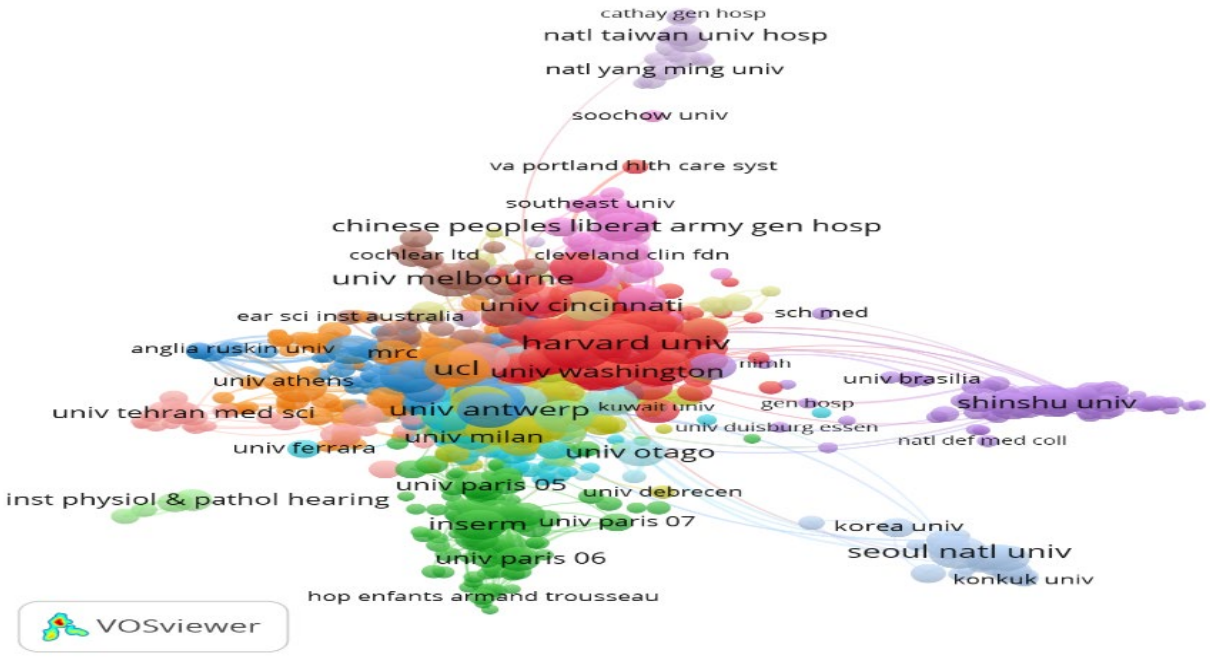

Fig. 1 Co-authorship network with Organizations

The overall strength of the citation relationships among organizations scoring 1702 was computed. The study shows that Harvard University, USA has published the greatest number of publications with a total of 356 documents, 21317 references, with total of 340 links, followed by "University Antwerp," which has produced.

B. Co-authorship Network with Countries

Using VOSviewer software, a comprehensive counting co-authorship network has been calculated based on the data. Each circles on the physical geographic map indicates how many scientific articles from that country are related to hearing impairments. The space between the circles shows

the strength and weakness of the co-authorship relationship between the associated countries, whereas closer the two circles are to each another, the greater the co-authorship link in bonding the nations together. The country co-authorship analysis necessitates determining which nations have the most effect in the research area and the level of contact among them. The nation's network of co-authors on papers relating to hearing problems. The size of the nodes represents the countries having the most influence.

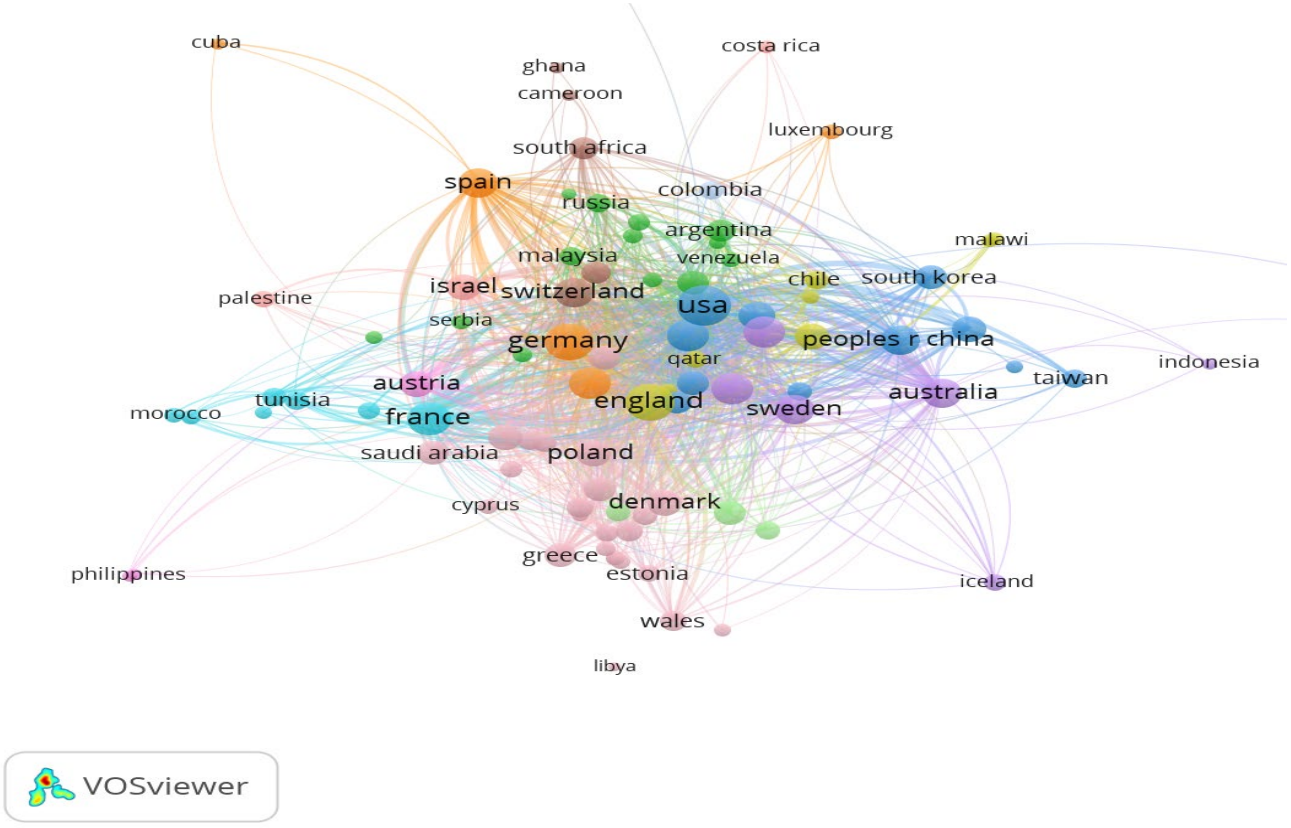

Fig. 2 Co-authorship Network with Countries

The figure 2 shows the data visualization of the nations that participated in this study on hearing diseases using complete counting records. The greatest nations per paper was 25, minimum being 5, and a total of 128 countries produced 2626 publications. 91 countries met the threshold level. There were 12 clusters/group totaling 91 items in this mapping, including cluster 1 with 24 items, cluster/group 2 with 13, cluster/group 3 with 11, cluster/group 4 with 8, etc. It is clear that Germany had 3621 overall link strength with 4524 papers and 152753 citations, coming in second place behind the United States with 6616 total link strength, 19005 articles, and 621203 citations. Additionally, the nations with the highest total are measured.

C. Citation Network with Authors

The figure 3 shows how the authors mapped the network of citations in the field of hearing problems. A total of 1350854 prolific writers created 141540 publications, with a minimum of 5 authors and a maximum of 25 authors per paper using the complete counting approach. Only 3000 writers out of 71346 satisfied the requirements.

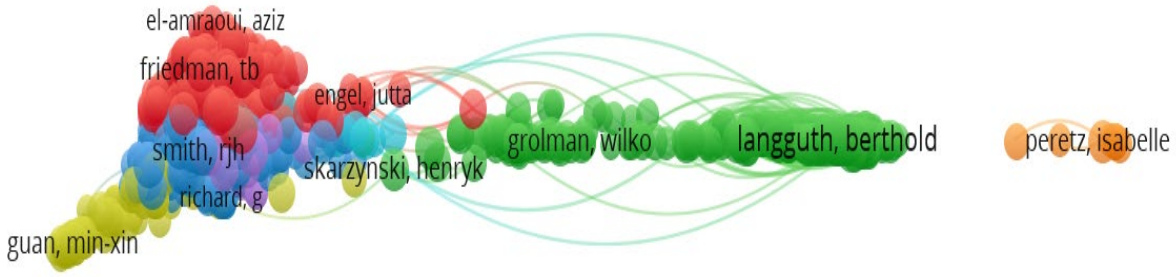

Fig. 3 Citation Network with Authors

There were 7 clusters with 1000 items each and 140176 linkages in total, with cluster/group 1 having 317 items, cluster/group 2 having 281 things, cluster/group 3 having 269 papers, cluster/group 4 having 72 items, cluster/group 5 having 36 papers, cluster/group 6 having 18 papers, and cluster/group 7 having 7 papers. It is confirmed that 145 papers by "Langguth, Berthold" and "De" have a combined link strength of 4498 and 5469.

D. Authors Productivity in Communication Disorders

To examine extent of author productivity in communication disorders Lotka's laws was applied. It is discovered that only a small number of researchers are responsible for most of the papers and that most only contribute to one publication. The logarithmic relationship between researchers and publishing numbers is therefore summarized by Lotka.

According to the statement, "the proportion of all contributors who make a single contribution is approximately 60%, and the number of authors making n contributions is about 1/n2 of those making one publication." The equation is XY = C, where X is the number of publications, Y is the proportion of authors with X publications, and n and C are constants.

TABLE I LOTKA'S LAW – CHIE-SQUARE MODEL CALCULATION OF VALUE OF 'N'

No. of Publication x	Number of Authors y	X	Y	X*Y	X*X	X^n	∑1/x^n
1	4253	0	8.3553799	0	0	1.0000	1.0000
2	20772	0.69314718	9.9413612	6.890826	0.480453	1.2000	0.8334
3	21240	1.09861229	9.96364148	10.94618	1.206949	1.3350	0.7491
4	28320	1.38629436	10.2513235	14.21135	1.921812	1.4399	0.6945
5	49575	1.60943791	10.811242	17.40002	2.59029	1.5270	0.6549
6	62322	1.79175947	11.0400698	19.78115	3.210402	1.6020	0.6242
7	62762	1.94591015	11.0471051	21.49667	3.786566	1.6682	0.5994
8	79272	2.07944154	11.2806403	23.45743	4.324077	1.7279	0.5787
9	93402	2.19722458	11.444668	25.14651	4.827796	1.7822	0.5611
10	113180	2.30258509	11.6367348	26.79457	5.301898	1.8323	0.5458
11	67408	2.39789527	11.118519	26.66104	5.749902	1.8788	0.5322
12	67896	2.48490665	11.1257324	27.64641	6.174761	1.9223	0.5202
13	24505	2.56494936	10.1066325	25.923	6.578965	1.9632	0.5094
14	85806	2.63905733	11.3598442	29.97928	6.964624	2.0019	0.4995
15	91935	2.7080502	11.4288371	30.94986	7.333536	2.0385	0.4906
16	82928	2.77258872	11.325728	31.40159	7.687248	2.0734	0.4823
17	32062	2.83321334	10.3754268	29.3958	8.027098	2.1067	0.4747
18	118800	2.89037176	11.6851967	33.77456	8.354249	2.1386	0.4676
19	125400	2.94443898	11.7392639	34.56555	8.669721	2.1693	0.4610
20	47180	2.99573227	10.7617254	32.23925	8.974412	2.1987	0.4548
21	16968	3.04452244	9.7390845	29.65086	9.269117	2.2271	0.4490
22	20812	3.09104245	9.94328502	30.73512	9.554543	2.2545	0.4436
23	10879	3.13549422	9.2945896	29.14313	9.831324	2.2810	0.4384
24	11352	3.17805383	9.33714922	29.67396	10.10003	2.3067	0.4335
25	11825	3.21887582	9.37797121	30.18652	10.36116	2.3316	0.4289
	1350854	58.0036052	264.491151	618.0506	151.2809	47.0070	13.9267

The computation of various 'n' values for the current data set is shown in table 1. The following formula yields the value of c, the hypothetical no of writers for a once article. The value of 'c' can be found by changing the values in the following equation. For this, the value of 'n' is given as 0.263, while 'p' is taken to be 26. The KS statistical test is used to assess the fitness of Lotka's law to the current data set by substituting the values of 'n' and 'c' in Lotka's law g(x)= kx-n in the current table.

E. Kolmogorov-Smirnov (K-S Test)

From Table II, the calculated maximum deviation Dmax value (0.1138) is significantly larger than the critical value of

D in the K-S test at the 0.05 and 0.1 levels (0.0113 and 0.0135, respectively). This means that the observed distribution of author productivity does not conform to Lotka's law of author productivity at either of these significant levels. In other words, there is a statistically significant deviation from what would be expected under Lotka's law (Lotka, 1926).

TABLE II KOLMOGOROV-SMIRNOV (K-S) TEST

Publication x	Authors yx	Observed Frequency (FOF) (yx/∑yx)	Observed Cumulative (CFOF)	Theoretical Frequency (FEF) (C/x^n	Theoretical Cum (CFEF)	Diff (DOECF)
1	4253	0.003148379	0.003148379	0.071	0.071	-0.0679
2	20772	0.015376939	0.018525318	0.059168	0.130168078	-0.1116
3	21240	0.015723387	0.034248705	0.053183	0.183351399	-0.1491
4	28320	0.020964516	0.055213221	0.049308	0.232659307	-0.1774
5	49575	0.036699007	0.091912228	0.046497	0.279156768	-0.1872
6	62322	0.04613526	0.138047487	0.04432	0.323477259	-0.1854
7	62762	0.046460979	0.184508467	0.04256	0.366036862	-0.1815
8	79272	0.058682878	0.243191344	0.041091	0.407127765	-0.1639
9	93402	0.069142927	0.312334272	0.039838	0.44696531	-0.1346
10	113180	0.083784036	0.396118308	0.038749	0.485714118	-0.0896
11	67408	0.049900285	0.446018593	0.03779	0.523503699	-0.0775
12	67896	0.050261538	0.496280131	0.036935	0.560438322	-0.0642
13	24505	0.018140376	0.514420508	0.036165	0.596603554	-0.0822
14	85806	0.063519818	0.577940325	0.035467	0.632070735	-0.0541
15	91935	0.068056948	0.645997273	0.034829	0.666900163	-0.0209
16	82928	0.061389314	0.707386587	0.034243	0.701143399	0.0062
17	32062	0.023734615	0.731121202	0.033702	0.734844981	-0.0037
18	118800	0.087944367	0.819065569	0.033199	0.768043727	0.0510
19	125400	0.092830165	0.911895734	0.03273	0.800773738	0.1111
20	47180	0.034926054	0.946821789	0.032291	0.833065181	0.1138
21	16968	0.012560943	0.959382731	0.03188	0.864944914	0.0944
22	20812	0.01540655	0.974789282	0.031492	0.896436982	0.0784
23	10879	0.008053424	0.982842706	0.031126	0.927563026	0.0553
24	11352	0.008403573	0.991246279	0.03078	0.958342614	0.0329
25	11825	0.008753722	1	0.030451	0.988793513	0.0112
Total	1350854	1		0.988794		-1.1967

Moreover,
CV= 2.263
Dmax = 0.1138
Dmax = 0.1138<CV = 2.263

Therefore, Lotka's law of author productivity is not applicable. Applicability of Lotka's law using Chi-square-test.

The fitness of Lotka's inverse square law is tested using the method and Chi-square statistical test which is another method of the goodness-of-fit test is studied to examine the productivity of researchers in communication disorder.

F. Applicability of Lotka's Law using Chi-Square-Test

The Chi-Square value is obtained by adding together all the differences between the squares of the observed and expected frequencies (fo-fe) and dividing them by the expected frequency, i.e. (fo-fe)2/fe.

The calculated Chi-Square value is 2645141075, which, at the 5% level of significance, is both highly significant and higher than the predicted value of 36.14, demonstrating that Lotka's rule of author productivity does not apply to the current data set of authors.

TABLE III LOTKA'S LAW USING CHI-SQUARE-TEST

No. of Papers (X)	Number of Observed Authors (fo)	Number of Expected authors (fe) $4253/1^2$= fe	fo-fe	$(fo-fe)^2$
1	4253	4253.00	0.00	0
2	20772	1063.25	19708.75	365327.8406
3	21240	472.55	20767.45	912680.0963
4	28320	265.81	28054.19	2960874.437
5	49575	170.12	49404.88	14347767.27
6	62322	118.14	62203.86	32752300.06
7	62762	86.80	62675.20	45257672.03
8	79272	66.45	79205.55	94405171.4
9	93402	52.51	93349.49	165963876.8
10	113180	42.53	113137.47	300966073.8
11	67408	35.15	67372.85	129139720.5
12	67896	29.53	67866.47	155947195.8
13	24505	25.17	24479.83	23812679.69
14	85806	21.70	85784.30	339137896.8
15	91935	18.90	91916.10	446961681.6
16	82928	16.61	82911.39	413783282.4
17	32062	14.72	32047.28	69788668.27
18	118800	13.13	118786.87	1074945710
19	125400	11.78	125388.22	1334520611
20	47180	10.63	47169.37	209259274
21	16968	9.64	16958.36	29820210.39
22	20812	8.79	20803.21	49250517.99
23	10879	8.04	10870.96	14699281.57
24	11352	7.38	11344.62	17430374.79
25	11825	6.80	11818.20	20525178.96
	1350854	6829.14	1344024.86	264514107.5

1. Hypothesis 01

Ha = Distribution of author productivity follows Lotka's law.
H0 = Distribution of author productivity does not follow Lotka's law

2. Statistical Inference

The Chi-square test is run on the data to see if the author's productivity distribution complies with Lotka's law or not. The above table presents the analyses' findings in tabular form. The crucial value at the 5% level of significance for the computed chi-square is 2645141075. When compared, it is seen that the estimated Chi-square value exceeds the chi-square critical value. Again, it is determined that the observed given all distribution of author productivity does not meet Lotka's law. The Lotka's rule in its generalized version does not suit the author productivity distribution pattern created for the earliest authors and for the contribution of all authors, according to statistical testing. Hence research hypothesis is rejected.

G. Price's Law

This law covers the link between the body of literature on a subject discipline and the number of authors to the number of publications in a specific field of study. In a given research area, approximately half of the publications are produced by a relatively small group of authors, precisely the square root of the total number of authors in that area. This law describes the concentration of productivity among a subset of prolific authors. The following calculations are used to determine if an author's distribution status complies with Price's Square Root Law:

Total Number of Authors (N) = 1350854
PSQ = √N = 1162 Authors
Total number of publications=141540
Half of the total publications = 141540/2 = 70770

The above calculation is used to verify whether the distribution status of authors complies with Price's Square root law: According to Price's square root law, 4254 articles

were generated by a single contributor, 4254 writers contributed at once, and the square root value of each author is 1162. Only 0.87 percent of publications have it. This result does not follow Price's Square Root Law since the value is a very long way from 50% (the amount of literature on a given subject that is available). The relevant result values are displayed below Table IV.

TABLE IV PRICE'S LAW

No. of Contributors A	Number of Contributions B	% of 141540	Total no. of Contributors A*B	Accumulated A*B	% of A*B	Accumulated % of A*B
1	4253	3.00	4253	4253	0.31	0.02
2	10386	7.34	20772	25025	1.54	1.56
3	7080	5.00	21240	46265	1.57	3.13
4	7080	5.00	28320	74585	2.10	5.23
5	9915	7.01	49575	124160	3.67	8.90
6	10387	7.34	62322	186482	4.61	13.51
7	8966	6.33	62762	249244	4.65	18.16
8	9909	7.00	79272	328516	5.87	24.02
9	10378	7.33	93402	421918	6.91	30.94
10	11318	8.00	113180	535098	8.38	39.32
11	6128	4.33	67408	602506	4.99	44.31
12	5658	4.00	67896	670402	5.03	49.33
13	1885	1.33	24505	694907	1.81	51.15
14	6129	4.33	85806	780713	6.35	57.50
15	6129	4.33	91935	872648	6.81	64.30
16	5183	3.66	82928	955576	6.14	70.44
17	1886	1.33	32062	987638	2.37	72.82
18	6600	4.66	118800	1106438	8.79	81.61
19	6600	4.66	125400	1231838	9.28	90.89
20	2359	1.67	47180	1279018	3.49	94.39
21	946	0.67	16968	1295986	1.26	95.64
22	946	0.67	20812	1316798	1.54	97.18
23	473	0.33	10879	1327677	0.81	97.99
24	473	0.33	11352	1339029	0.84	98.83
25	473	0.33	11825	1350854	0.88	100.00
	141540	100.00	1350854	17807574	100.00	

1. Hypothesis 2

H_a = The author productivity distribution follows the Price's Law.

H_0 = The author productivity distribution does not follow the Price's Law**.**

2. Statistical Inference

At the 0.05 level of significance, the calculated values of the dataset using the general power method and the inverse square method are 1162 and 0.87, respectively. According to Price's square root law, the 1162 total authors contributed 0.87% of the total contribution, and according to the Pareto principle, 20% of the total authors contributed 50% of the total contribution. This result does not follow Price's Square Root Law since the value is a very long way from 50% (the amount of literature on a given subject that is available). The conclusion does not conclusively support the theory. Hence research hypothesis is rejected.

H. Pareto Principle (80X 20 RULES)

It is examined to determine whether the Pareto Principle is true and to determine whether 20 percent of authors have contributed 80 percent of the articles. Since there are 1350854 authors in total, just 270170 authors represent 20% of the total authors. The statistics showed that just 79272 writers contributed 24.02% of all articles. The Pareto Principle states that 20% of all authors on a given topic produce 80% of all publications in that field.

Total number of publications from 1999 to 2018 = 141540
Total number of authors in the same period of study= 1350854
80% of total publications =80*141540/100=113232≈ 113232 publications
20% of total authors = 20*1350854/100=270170 ≈ 270170 authors
Pareto Principle (80X 20 RULES) is not applicable.

1. Hypothesis 3

H_a = The author productivity distribution follows the Pareto Principle.
H_0 = The author productivity distribution does not follow the Pareto Principle.

2. Statistical Inference

Only 79272 (24.02%) of the total (270170) articles were provided by the square root of the total authors (1350854). The square root of all authors (1162) only accounts for half of the articles (675427 publications). There are 13406 total publications, worth 113232 at 80 percent of total publications value. According to the study, 52.40 percent of the authors contributed 5.12 percent of the total "Accumulated% of A*B" value. Once the number of "Accumulated Contributors" reaches 10725, the results display over 80% of the value. The value shouldn't be very close to 80% in the 80/20 rule perspective. Therefore, the Pareto Principle does not apply to the output of communication disorder literature. Hence research hypothesis is rejected.

VIII. CONCLUSION

The present study analyzes co-authorship networks with institutions and countries using VOSviewer mapping software based on research output related to hearing disorders, which is a valuable approach. The study also focused on analyzing Lotka's law's applicability in Web of Science's research output on communication disorders. This law would also be verified if other laws related to bibliometric studies, such as the Price's Law and the Pareto Principle, were used. It is observed that Harvard University, USA, has published the most significant number of publications, with 356 documents and 21317 citations. It is clear from the study that Germany had 3621 overall link strength with 4524 papers and 152753 citations, coming in second place behind the United States with 6616 total link strength, 19005 articles, and 621203 citations. Germany was a prolific country that made huge publications compared to other countries. "Langguth, Berthold, was a prolific author; he published 145 articles with 4498 total link strength and 5469 citations. The chi-square test proved that Lotka's law does not fit into author productivity of communication disorders. According to Price's law, the 1162 authors contributed 0.87% of the total contribution. This result does not follow Price's Law since the value is a very long way from 50% (the amount of literature on a given subject). Since the total number of authors is 1350854, 20 per cent of the total authors are in 270170. It was observed from the study that 79272 authors contributed only 24.02% of total publications. The total number of publications is 13406, and its 80 per cent value is 113232. The results show nearly 80 per cent of value' once the "accumulated contributors" are 10725. In the 80/20 rule's view, the value should not be nearly 80 per cent. Therefore, the price square root law does not apply to the communication disorders literature output.

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