Collaboration Pattern of Nephrology Literature Published from the USA during 2014-2023: A Scientometric Analysis

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Abstract: -

This study presents a comprehensive analysis of authorship patterns and collaboration trends in nephrology literature published from the United States over the period 2014–2023. A total of 16,449 research papers were examined, revealing a dominant trend of multi-authored publications, which accounted for 91.77% of the total output. The Degree of Collaboration (DC) remained high throughout the decade, ranging from 0.89 to 0.94, indicating strong collaborative tendencies. The Rate of Single Authorship (RSA) showed a consistent decline, stabilizing at 0.06 in recent years. The Collaborative Index (CI) — representing the average number of authors per jointly authored paper — increased from 7.07 in 2014 to 8.64 in 2023, with a decade average of 8.09, suggesting increasingly larger research teams. The Co-authorship Index (CAI) analysis indicated a decline in single and two-authored papers, while publications with more than two authors showed increasing CAI values in the later years, confirming the rise in large-group authorship. Similarly, the Collaborative Coefficient (CC) rose modestly from 0.69 to 0.75, while the Modified Collaborative Coefficient (MCC) declined from 1.42 to 1.29, reflecting a shift toward broader yet more distributed authorship structures.

Keywords: - Authorship Pattern, Collaboration Trend, Degree of Collaboration (DC), Collaborative Index (CI), Collaboration Coefficient (CC), Co-authorship Index (CAI), Scientometric Analysis.

Introduction: -

The nature of scientific research has undergone a significant transformation over the past few decades, with collaboration emerging as a central feature of scholarly productivity. In biomedical sciences in particular, increasing complexity of research problems, the need for interdisciplinary approaches, and the advancement of large-scale clinical trials and data analytics have contributed to a marked rise in multi-authored publications. The field of nephrology, which encompasses a wide spectrum of clinical and translational research, is no exception to this trend. Authorship patterns serve as a valuable proxy for understanding the dynamics of scholarly collaboration. Analyzing such patterns provides insights into the structure of research teams, the prevalence of joint authorship, and the shifting roles of contributors in scientific output. Key metrics such as Degree of Collaboration (DC), Collaborative Index (CI), Collaborative Coefficient (CC), Modified Collaborative Coefficient (MCC), and Co-authorship Index (CAI) offer quantifiable measures to assess the extent and evolution of collaborative practices in academic publishing. This study investigates the authorship and collaboration trends in nephrology literature published from the United States between 2014 and 2023. By examining over 16,000 research articles indexed during this period, the study aims to identify significant shifts in collaborative behavior, the growing prevalence of large multi-author teams, and the corresponding decline in single-authored works. The findings are expected to illuminate broader changes in the research ecosystem and underscore the increasing reliance on collective scientific inquiry in nephrology research.

Review of Literature: -

Collaboration in scientific research has garnered significant attention in bibliometric and scientometric studies due to its implications for research quality, productivity, and innovation. As early as Subramanyam (1983), the concept of Degree of Collaboration (DC) was introduced

to assess the ratio of multi-authored to total publications, establishing a foundational metric for analyzing scientific teamwork. Since then, various models and indices, including the Collaborative Index (CI) (Lawani, 1980), Collaborative Coefficient (CC) (Ajiferuke et al., 1988), and Co-authorship Index (CAI) (Garg & Padhi, 2001), have been employed to explore collaboration patterns across disciplines and regions.

Multiple studies have confirmed a general trend toward increased collaboration in the sciences, particularly in medicine and allied health fields. For instance, Wuchty, Jones, and Uzzi (2007) demonstrated that research teams increasingly dominate knowledge production, with team-authored papers receiving more citations than those by individual authors. Katz and Martin (1997) further emphasized the importance of collaborative research in improving methodological diversity and enhancing innovation, especially in interdisciplinary fields like nephrology.

In the domain of medical literature, Gazni and Thelwall (2014) noted a steady rise in international and multi-institutional collaborations, driven by complex healthcare challenges and advancements in communication technology. Specifically in nephrology, Prathap (2011) observed a growth in author teams over time, attributing it to the nature of clinical trials, data sharing, and the need for diverse expertise.

However, increasing collaboration also raises questions about the distribution of credit and individual contribution. The Modified Collaborative Coefficient (MCC), an enhancement over traditional CC, accounts for both single and multi-authored contributions and adjusts for potential dilution of individual authorship in large teams (Kumar & Garg, 2005). Thus, it provides a more nuanced view of collaborative structures.

While global trends have been extensively studied, country-specific analyses—especially for highly productive nations like the United States—are necessary to understand regional patterns

and institutional strategies that drive research collaboration. This study fills that gap by examining the authorship and collaborative metrics of nephrology literature from the USA over ten years, utilizing established bibliometric indicators to map evolving patterns in team science.

Methodology: -

This study employs a bibliometric approach to analyze authorship trends and collaboration patterns in nephrology literature published from the United States during the ten years from 2014 to 2023. The data for the analysis were extracted from a comprehensive bibliographic database, i.e., Web of Science, with a focus on peer-reviewed journal articles affiliated with USA-based authors in the field of nephrology. Collaboration pattern-related indicators have been applied to test Collaboration trends, especially in the field of Nephrology. Ms-Excel spreadsheets have been used to document the scattered data in a tabulation form, and suitable graphs have also been used to represent the data systematically.

Scope and Limitation: -

The present study focuses on the Nephrology literature published in the ten-year tenure, i.e., 2014-2023, hence the has its limitations where the authors have applied Collaboration pattern related Scientometric indicators such as DC, CI, CAI, MCC, and alike. However, the study is limited to the above-mentioned dataset and the specific indicators.

Major Objectives: -

- To analyze the authorship pattern of nephrology literature published from the USA between 2014 and 2023, with a focus on single and multi-authored contributions.
- To assess the degree of collaboration (DC) and trends in joint authorship over the study period.
- To compute the Collaborative Index (CI), Collaborative Coefficient (CC), and Modified Collaborative Coefficient (MCC) to evaluate the intensity and growth of research collaboration among nephrology researchers.

- To determine the Rate of Single Authorship (RSA) and its fluctuation over the decade.
- To examine the Co-authorship Index (CAI) about different authorship groups (single, two, and more than two authors) and its variation over time.
- To study the annual productivity patterns in terms of total papers, multi-authored papers, and contributing authors.
- To identify trends in the average number of authors per paper, highlighting changes in team-based research in nephrology.
- To provide a quantitative overview of how collaborative practices in nephrology research have evolved in the USA over the ten-year span**.**

Data analysis and Interpretation: -

Table 1: Authorship Pattern of Nephrology Literature Published from the USA during 2014-2023

Authorship Pattern of Nephrology Literature Published from the USA during 2014-2023															
Sl. No.	**Year**	**Authorship Pattern**											**MP**	**Total**	**%**
		Single	**2***	**3***	**4***	**5***	**6***	**7***	**8***	**9***	**10***	**>10***			
1	2014	161	248	155	124	151	146	124	102	83	72	214	**1419**	**1580**	**9.61**
2	2015	114	265	147	121	150	140	111	105	86	70	237	**1432**	**1546**	**9.40**
3	2016	155	244	140	123	145	136	129	144	104	81	245	**1491**	**1646**	**10.01**
4	2017	156	261	154	116	102	109	126	107	87	96	303	**1461**	**1617**	**9.83**
5	2018	176	280	133	119	127	111	101	103	101	71	342	**1488**	**1664**	**10.12**
6	2019	149	264	105	113	116	97	102	110	87	71	364	**1429**	**1578**	**9.59**
7	2020	147	273	161	144	123	136	138	117	88	89	380	**1649**	**1796**	**10.92**
8	2021	104	279	159	151	133	149	108	98	91	75	446	**1689**	**1793**	**10.90**
9	2022	97	188	181	131	149	95	110	79	78	69	407	**1487**	**1584**	**9.63**
10	2023	94	184	147	149	146	131	116	113	86	90	389	**1551**	**1645**	**10.00**
	Total	**1353**	**2486**	**1482**	**1291**	**1342**	**1250**	**1165**	**1078**	**891**	**784**	**3327**	**15096**	**16449**	**100**
	%	**8.23**	**15.1**	**9.01**	**7.85**	**8.16**	**7.6**	**7.08**	**6.55**	**5.42**	**4.77**	**20.2**	**91.77**	**100**	

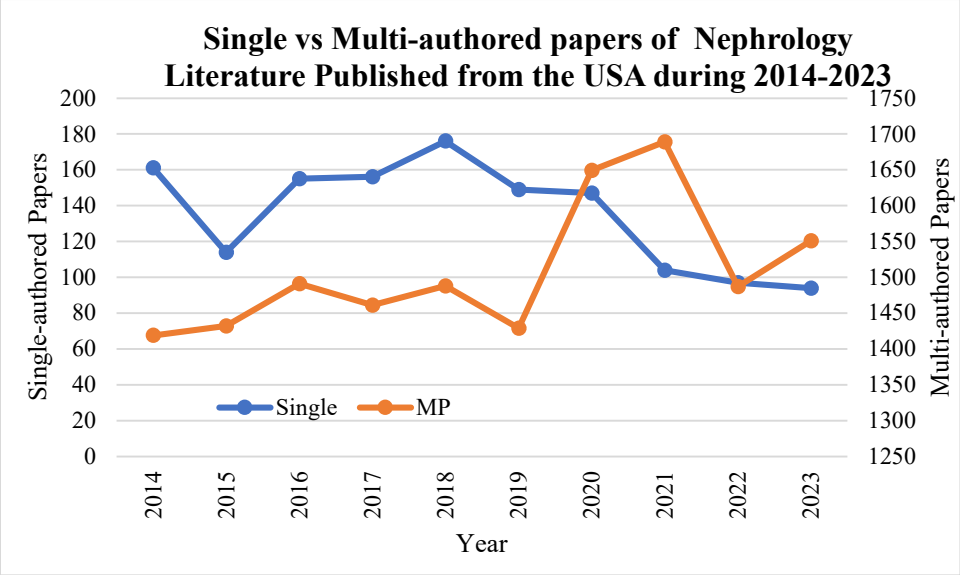

Figure 1: Single vs multi-authored papers of Nephrology Literature Published from the USA during 2014-2023

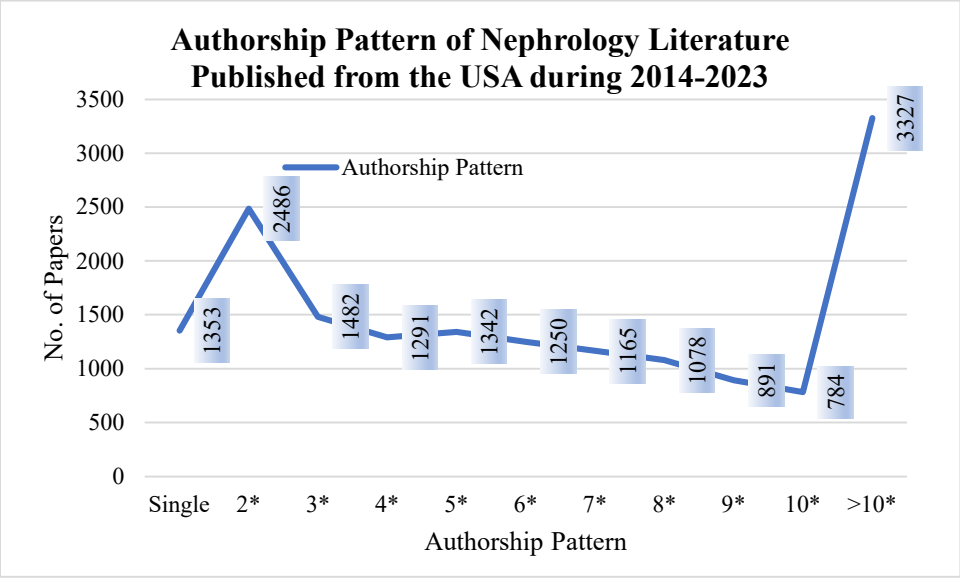

Figure 2: Authorship Pattern of Nephrology Literature Published from the USA during 2014-2023

Table No. 1 represents the nephrology literature from the USA, which exhibits a strong inclination toward collaborative authorship, with multi-authored papers accounting for 91.77% of the total 16,449 publications. The most prominent category is papers with more than 10 authors, constituting 20.23%, indicating large-scale collaborations and possibly multi-institutional research. This is followed by two-author (15.11%) and three-author (9.01%)

papers. The percentage of single-authored papers is relatively low (8.23%), reflecting a minor share of individual research contributions in this field. A notable increase is observed in the number of mega-authored papers (>10 authors) over the years, peaking in 2021 (446 papers), suggesting a trend towards extensive collaborative efforts, possibly due to interdisciplinary or multicentric studies. 2020 also saw a high percentage (10.92%) of total publications, likely reflecting intensified research activities during the COVID-19 pandemic. Overall, the data indicate a consistently high mean proportion of multi-authored papers (MP), ranging from 1400+ to over 1600 annually, reinforcing the collaborative nature of nephrology research in the USA, which is also represented in Graphs 1 & 2.

Table 2: Degree of Collaboration & Rate of Single Authorship of Nephrology Literature Published from the USA during 2014-2023

Degree of Collaboration & Rate of Single Authorship of Nephrology Literature Published from the USA during 2014-2023					
Year	**Total papers**	**Single**	**Multiple**	**DC**	**RSA**
2014	1580	161	1419	0.90	0.10
2015	1546	114	1432	0.93	0.07
2016	1646	155	1491	0.91	0.09
2017	1617	156	1461	0.90	0.10
2018	1664	176	1488	0.89	0.11
2019	1578	149	1429	0.91	0.09
2020	1796	147	1649	0.92	0.08
2021	1793	104	1689	0.94	0.06
2022	1584	97	1487	0.94	0.06
2023	1645	94	1551	0.94	0.06
Total	**16449**	**1353**	**15096**	**0.92**	**0.08**

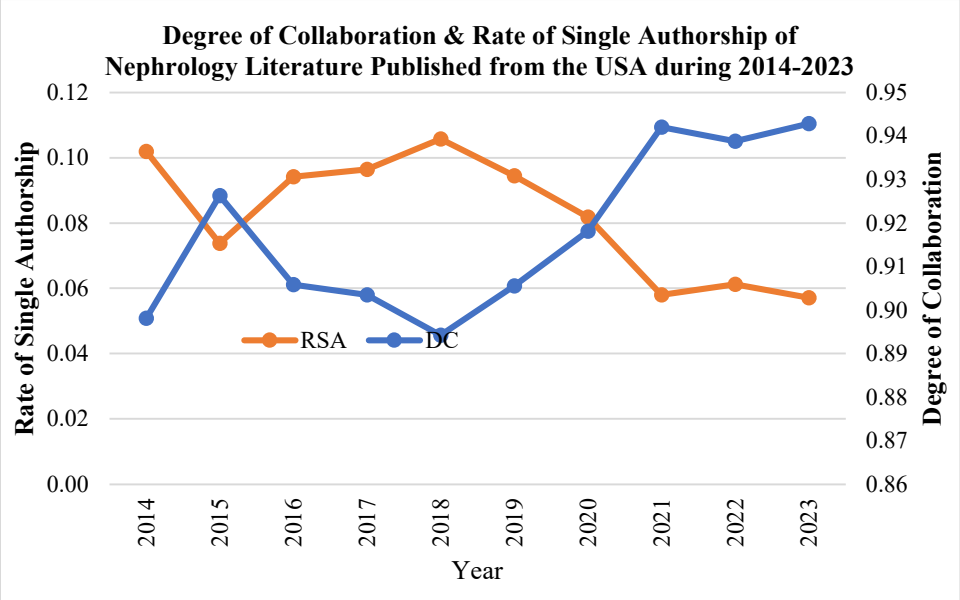

Figure 3: Degree of Collaboration & Rate of Single Authorship of Nephrology Literature Published from the USA during 2014-2023

Table No. 2 shows the nephrology literature published from the USA over the decade 2014–2023 demonstrates a consistently high Degree of Collaboration (DC), averaging 0.92, with annual values ranging from 0.89 to 0.94. This indicates that the overwhelming majority of research output was produced through collaborative efforts. Notably, the DC reached its peak value of 0.94 in the last three years (2021–2023), signifying a growing trend in multi-authored publications and possibly reflecting increased emphasis on interdisciplinary and team-based research. Conversely, the Rate of Single Authorship (RSA) remained low throughout the period, averaging just 0.08, with a steady decline over time, from 0.10 in 2014 to 0.06 by 2023. This decline underscores a shift away from solo research endeavours toward more collaborative models. Overall, these trends emphasize the collaborative nature of nephrology research in the USA, aligning with global movements toward team science in biomedical fields.

Table 3: Co-authorship Index of Nephrology Literature Published from the USA during 2014-2023

Co-authorship Index of Nephrology Literature Published from the USA during 2014-2023							
Year	**Single Author**	**CAI**	**Two Authors**	**CAI**	**> Two Authors**	**CAI**	**Total**

2014	161	123.88	248	103.86	1171	96.68	1580
2015	114	89.65	265	113.42	1167	98.47	1546
2016	155	114.48	244	98.08	1247	98.82	1646
2017	156	117.29	261	106.80	1200	96.80	1617
2018	176	128.59	280	111.34	1208	94.70	1664
2019	149	114.79	264	110.70	1165	96.30	1578
2020	147	99.51	273	100.58	1376	99.94	1796
2021	104	70.52	279	102.96	1410	102.58	1793
2022	97	74.45	188	78.53	1299	106.97	1584
2023	94	69.47	184	74.01	1367	108.40	1645
Total	**1353**	**100.00**	**2486**	**100.00**	**12610**	**100.00**	**16449**

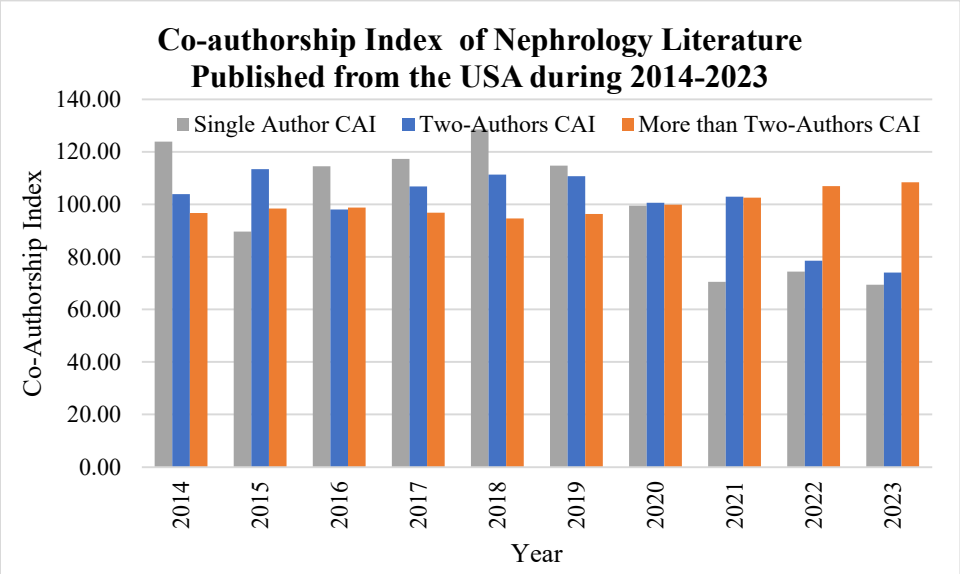

Figure 4: Co-authorship Index of Nephrology Literature Published from the USA during 2014-2023

Table No. 3 accounts for the Co-authorship Index (CAI), data reveals significant variations in authorship patterns across the three categories — single authors, two authors, and more than two authors — over the decade. Single-author publications, though few (1,353 out of 16,449), show fluctuating CAI values, peaking in 2018 (CAI: 128.59) and declining sharply in later years, reaching a low of 69.47 in 2023, indicating a diminishing trend in individual authorship. In contrast, two-author publications maintain relatively stable CAI values around the average (CAI: 100), with the highest CAI of 113.42 in 2015 and a drop to 74.01 in 2023, suggesting a modest but noticeable decline in dual authorship. Meanwhile, the CAI for publications with

more than two authors, which form the majority (12,610 papers or 76.67% of total output), shows an increasing trend in recent years. After staying below 100 for much of the period, the CAI for this group rose above average starting in 2021 (CAI: 102.58) and reached 108.40 in 2023, indicating a growing preference for larger collaborative teams. Overall, the shifting CAI values reflect a clear and ongoing transition in US nephrology research towards broader co-authorship networks, reducing reliance on smaller author teams or individual contributors and emphasizing the collective, interdisciplinary nature of contemporary medical research.

Table 4: Collaborative Coefficient of Nephrology Literature Published from the USA during 2014-2023

Collaborative Coefficient of Nephrology Literature Published from the USA during 2014-2023																
Sl. No.	**Year**	**Authorship Pattern**											**MP**	**Total**	**%**	**CC**
		Single *	**2***	**3***	**4***	**5***	**6***	**7***	**8***	**9***	**10***	**>10***				
1	2014	161	248	155	124	151	146	124	102	83	72	214	**1419**	**1580**	**9.61**	0.69
2	2015	114	265	147	121	150	140	111	105	86	70	237	**1432**	**1546**	**9.40**	0.71
3	2016	155	244	140	123	145	136	129	144	104	81	245	**1491**	**1646**	**10.01**	0.71
4	2017	156	261	154	116	102	109	126	107	87	96	303	**1461**	**1617**	**9.83**	0.70
5	2018	176	280	133	119	127	111	101	103	101	71	342	**1488**	**1664**	**10.12**	0.69
6	2019	149	264	105	113	116	97	102	110	87	71	364	**1429**	**1578**	**9.59**	0.71
7	2020	147	273	161	144	123	136	138	117	88	89	380	**1649**	**1796**	**10.92**	0.72
8	2021	104	279	159	151	133	149	108	98	91	75	446	**1689**	**1793**	**10.90**	0.74
9	2022	97	188	181	131	149	95	110	79	78	69	407	**1487**	**1584**	**9.63**	0.74
10	2023	94	184	147	149	146	131	116	113	86	90	389	**1551**	**1645**	**10.00**	0.75
Total		**1353**	**2486**	**1482**	**1291**	**1342**	**1250**	**1165**	**1078**	**891**	**784**	**3327**	**15096**	**16449**	**100.00**	0.72
%		**8.23**	**15.1**	**9.01**	**7.85**	**8.16**	**7.6**	**7.08**	**6.55**	**5.4**	**4.8**	**20.2**	**91.77**	**100**		

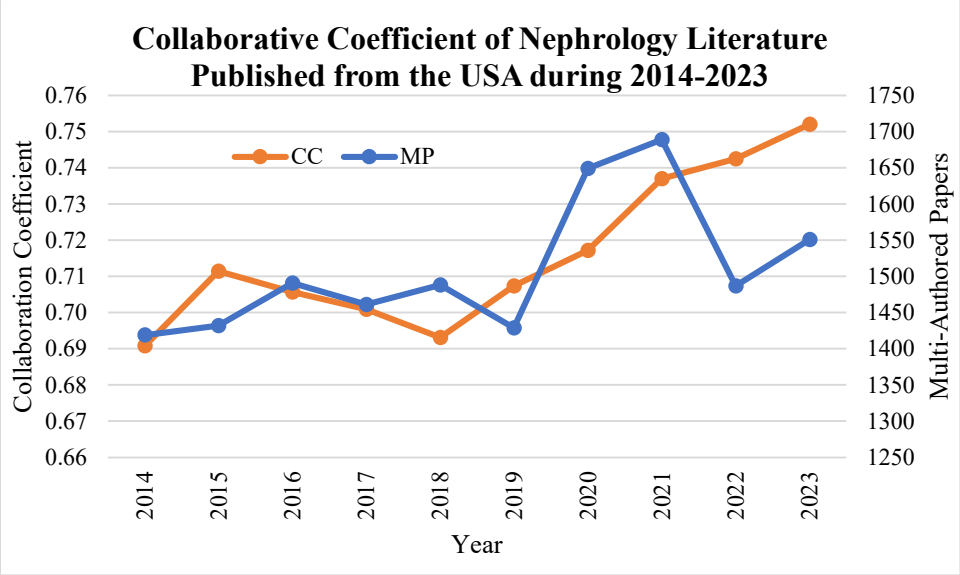

Figure 5: Collaborative Coefficient of Nephrology Literature Published from the USA during 2014-2023

The Collaborative Coefficient (CC) values for nephrology literature from the USA during 2014–2023 indicate a strong and increasing trend toward multi-authored research. Throughout the decade, CC values remained consistently high, starting at 0.69 in 2014, and showing a gradual upward trend, reaching a peak of 0.75 in 2023. This steady increase reflects a growing reliance on collaborative research efforts within the field. The overall average CC for the decade stands at 0.72, underscoring the dominant role of joint authorship in nephrology publications. This rise in CC aligns with the decreasing proportion of single-authored works (only 8.23% of the total), and a marked surge in publications with large author teams, particularly those with more than 10 authors (20.2%). Notably, the years 2021–2023 show the highest CC values (0.74 to 0.75), coinciding with a peak in mega-authored papers, likely influenced by large-scale studies and consortium-based projects post-COVID-19. These findings affirm that nephrology research in the USA has become increasingly collaborative, characterized by interdisciplinary partnerships, multi-institutional cooperation, and shared authorship.

Table 5: Collaborative Index of Nephrology Literature Published from the USA during 2014-2023

Collaborative Index of Nephrology Literature Published from the USA during 2014-2023							
S. No.	**Year**	**Total Papers**	**Total Joint authored publications**	**Total authors of total joint-authored publications**	**Single Authors**	**Total Authors**	**CI**
1	2014	1580	1419	9868	161	10029	7.07
2	2015	1546	1432	9555	114	9669	6.75
3	2016	1646	1491	10542	155	10697	7.17
4	2017	1617	1461	11342	156	11498	7.87
5	2018	1664	1488	11538	176	11714	7.87
6	2019	1578	1429	14635	149	14784	10.35
7	2020	1796	1649	13339	147	13486	8.18
8	2021	1793	1689	13957	104	14061	8.33
9	2022	1584	1487	12737	97	12834	8.63
10	2023	1645	1551	13310	94	13404	8.64
	Total	**16449**	**15096**	**120823**	**1353**	**122176**	**8.09**

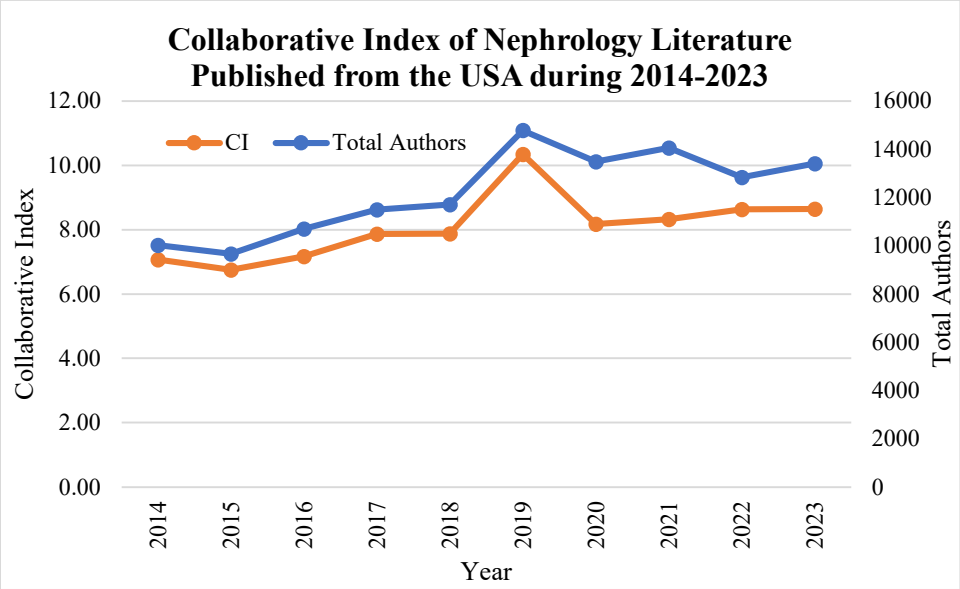

Figure 6: Collaborative Index of Nephrology Literature Published from the USA during 2014-2023

The Collaborative Index (CI) of nephrology literature from the USA during 2014–2023 reveals a robust and progressively strengthening collaborative research culture. The CI, which

measures the average number of authors per joint-authored paper, shows a rising trend over the decade. Starting at 7.07 in 2014, it dips slightly to 6.75 in 2015, but climbs steadily thereafter, peaking at 10.35 in 2019 — a significant surge reflecting larger author groups and perhaps the inclusion of national or global consortia. Subsequent years maintain high CI values, consistently above 8.0 from 2020 to 2023, with 2023 recording a CI of 8.64. This trend indicates a clear evolution toward larger, more complex author teams over time. The overall CI for the decade stands at 8.09, reflecting that, on average, each jointly authored nephrology paper had over eight contributors. This aligns with other indicators such as the rising number of mega-authored publications (>10 authors) and high Degree of Collaboration (DC), supporting the notion that nephrology research in the USA has become increasingly team-based, interdisciplinary, and collaborative in nature, likely driven by the complexity of modern biomedical research and the growing emphasis on collective scientific efforts.

Table 6: Modified Collaborative Coefficient of Nephrology Literature Published from the USA during 2014-2023

Modified Collaborative Coefficient of Nephrology Literature Published from the USA during 2014-2023																	
Sl. No.	**Year**	**Authorship Pattern**											**MP**	**Total**	**%**	**CC**	**MCC**
		1	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10**					
1	2014	161	248	155	124	151	146	124	102	83	72	214	**1419**	**1580**	**9.61**	0.69	1.42
2	2015	114	265	147	121	150	140	111	105	86	70	237	**1432**	**1546**	**9.40**	0.71	1.38
3	2016	155	244	140	123	145	136	129	144	104	81	245	**1491**	**1646**	**10.01**	0.71	1.39
4	2017	156	261	154	116	102	109	126	107	87	96	303	**1461**	**1617**	**9.83**	0.70	1.39
5	2018	176	280	133	119	127	111	101	103	101	71	342	**1488**	**1664**	**10.12**	0.69	1.41
6	2019	149	264	105	113	116	97	102	110	87	71	364	**1429**	**1578**	**9.59**	0.71	1.37
7	2020	147	273	161	144	123	136	138	117	88	89	380	**1649**	**1796**	**10.92**	0.72	1.36
8	2021	104	279	159	151	133	149	108	98	91	75	446	**1689**	**1793**	**10.90**	0.74	1.32
9	2022	97	188	181	131	149	95	110	79	78	69	407	**1487**	**1584**	**9.63**	0.74	1.31
10	2023	94	184	147	149	146	131	116	113	86	90	389	**1551**	**1645**	**10.00**	0.75	1.29
	Total	**1353**	**2486**	**1482**	**1291**	**1342**	**1250**	**1165**	**1078**	**891**	**784**	**3327**	**15096**	**16449**	**100**	**0.72**	

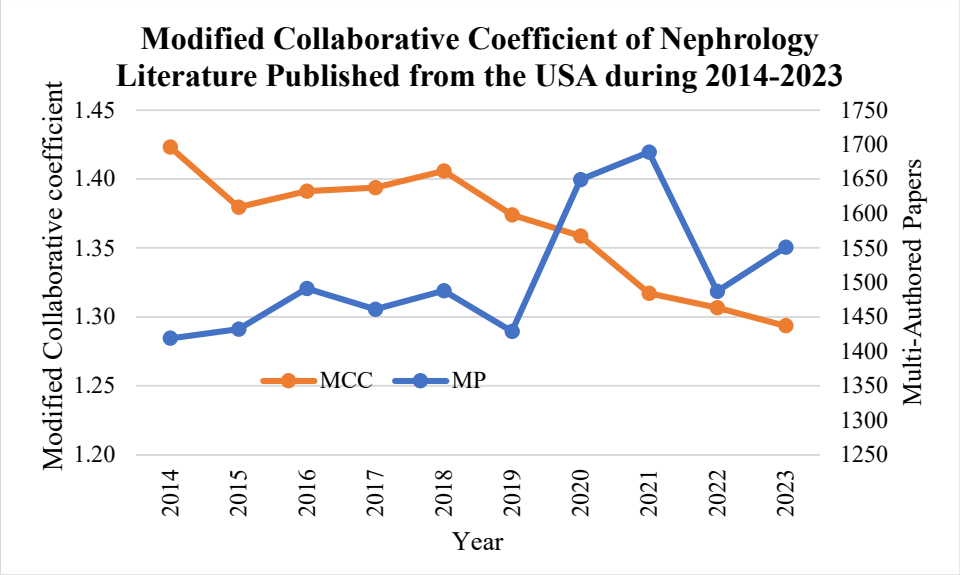

Figure 7: Modified Collaborative Coefficient of Nephrology Literature Published from the USA during 2014-2023

The Modified Collaborative Coefficient (MCC), which provides a more refined measure of collaboration by adjusting for multi-authored contributions, shows a consistent downward trend in the USA's nephrology literature over the decade 2014–2023. Starting at 1.42 in 2014, the MCC steadily decreases to 1.29 by 2023, with the overall decade average around 1.36. While the standard Collaborative Coefficient (CC) increases gradually from 0.69 to 0.75 over the same period — reflecting a rise in co-authored papers — the decline in MCC suggests a shift from moderate-sized teams toward larger author groups, where the degree of individual contribution may diminish due to increasing team sizes. This inverse relationship between CC and MCC highlights that although collaboration is becoming more prevalent and larger in scale, it may be less evenly distributed among contributors. The lower MCC values in the later years (2021–2023), falling below 1.35, indicate that the average individual's share of authorship credit is diluted in increasingly collaborative environments. This reflects a broader trend in biomedical research toward highly collaborative, multi-institutional, and often international studies, particularly evident in large-scale data-driven or clinical research projects. Overall,

while the USA's nephrology research is marked by high collaboration, the MCC nuances this by pointing to evolving authorship dynamics in larger research teams.

Conclusion: -

The present scientometric analysis of nephrology literature published from the United States during 2014–2023 reveals significant insights into the evolution of research collaboration and authorship trends in the field. The study demonstrates a dominant pattern of multi-authored contributions, with single-authored papers constituting a minor share (only 8.23% of total publications). The consistent increase in multi-authored papers underscores the collaborative nature of contemporary nephrology research. The Degree of Collaboration (DC) remained high throughout the period, ranging from 0.89 to 0.94, indicating a strong and sustained trend toward collaborative research. Similarly, the Collaborative Index (CI), which averaged 8.09, and the Collaborative Coefficient (CC) values (ranging from 0.69 to 0.75) support the inference that co-authorship is a well-established norm in the domain. The Modified Collaborative Coefficient (MCC) values further highlighted the growing complexity and strength of these collaborations. The Co-authorship Index (CAI) findings reveal fluctuating but notable contributions from two-author and larger author groups, while single-author publications showed a consistent decline, indicating a shift from individual to team-based research models. Notably, the highest average number of authors per paper was recorded in the later years of the study, suggesting a continued trend toward larger collaborative efforts. Overall, the study confirms that nephrology research in the United States has become increasingly collaborative over the past decade. These findings have important implications for research policy, institutional strategy, and funding allocation, suggesting that collaborative networks, both national and international, play a critical role in advancing nephrology research.

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