Vol. 3, No. 2, 1-13. DOI: 10.47909/ijsmc.534

Pro-Metrics

ORIGINAL ARTICLE

Analyzing the influence of differential equations in mathematical modeling approaches for COVID-19: A bibliometric perspective

Dr. Gavirangaiah K.

Assistant Professor, Dept. of Mathematics, Government First Grade College, Tumkur.
Email: gavirangayya@gmail.com

ABSTRACT

Objective. This study aims to provide a comprehensive analysis of global publications on differential equations in mathematical modeling approaches for understanding and combating the COVID-19 pandemic.

Design/Methodology/Approach. The study analyses a dataset of 964 documents from 353 sources from 2020-2023. Various parameters, such as publication growth rate, citation impact, collaboration patterns, document types, and distribution of citations, are examined. The analysis utilizes tables and figures to present the findings effectively.

Results/Discussion. The analysis reveals a decline in publication output over the years, indicated by a negative annual growth rate. However, the dataset remains comprehensive and contributes valuable insights to the field. The publications have made significant contributions, evidenced by the average citations per document and the extensive reference list. Collaboration among authors is prevalent, with a substantial portion of co-authorships being international. The study identifies prominent papers with high citation counts, emphasizing their influence and recognition within the academic community.

Conclusions. The findings highlight the need for continued research efforts and advancements in differential equations in mathematical modeling approaches for COVID-19. The study emphasizes the importance of maintaining a robust scientific impact and contributing effectively to the ongoing fight against the pandemic. It underscores the significance of collaboration and highlights countries and institutions with notable productivity and impact in the field.

Originality/Value. This study provides a comprehensive analysis of global publications on the role of differential equations in mathematical modeling for COVID-19. It presents novel insights into publication trends, citation impact, collaboration patterns, and distribution of citations. The findings contribute to understanding the research landscape and offer valuable information for researchers and practitioners seeking to advance the field and combat the COVID-19 pandemic effectively

Keywords: differential equations; mathematical modelling; COVID-19; bibliometric analysis; citation impact; influential papers.

Received: 17-03-2023. **Accepted:** 03-08-2023

Editor: Carlos Luis González-Valiente

How to cite: K, G.. (2023). Analyzing the influence of differential equations in mathematical modeling approaches for COVID-19: A bibliometric perspective. *Iberoamerican Journal of Science Measurement and Communication; 3*(2), 1-13. DOI: 10.47909/ijsmc.534

1. INTRODUCTION AND BACKGROUND STUDY

The COVID-19 pandemic has presented unprecedented challenges worldwide, eliciting a global response from the scientific community (Kappi *et al.,* 2021). Mathematical modeling has emerged as a powerful tool for comprehending and predicting the transmission of infectious diseases, enabling policymakers to make informed decisions (Behera *et al.,* 2021; Keeling & Rohani, 2008; Kucharski *et al.,* 2020; Sweileh, 2022). Differential equations have played a crucial role in capturing the intricate dynamics of epidemic outbreaks and will be the focus of this comprehensive analysis of their influence on mathematical modeling approaches for COVID-19, employing a bibliometric perspective (Adiga *et al.,* 2020; Altaf & Atangana, 2022; Panovska-Griffiths, 2020).

In recent years, there has been a significant surge in mathematical modeling techniques to study infectious diseases, with particular emphasis on epidemics. These models employ differential equations to describe the interactions between distinct population compartments, such as susceptible, infected, and recovered individuals. By encapsulating the disease's spread dynamics, these equations enable researchers to simulate various scenarios and evaluate the effectiveness of different control measures.

The COVID-19 pandemic, caused by the novel coronavirus SARS-CoV-2, presented unique challenges due to its rapid global dissemination and the absence of pre-existing immunity in the population (Dayal *et al.,* 2022; Gupta *et al.,* 2021; Kappi *et al.,* 2021; Kappi *et al.,* 2021). Mathematical modeling quickly became essential for comprehending the disease's transmission patterns, estimating critical epidemiological parameters, and guiding public health interventions. Consequently, a significant volume of literature has emerged, utilizing differential equations to model COVID-19 dynamics across various scales, ranging from individual-level to regional and global models.

Bibliometric analysis is a valuable means to evaluate and quantify the impact of scientific research within a specific field. By examining publication trends, citation patterns, and collaborations among researchers, bibliometric analysis provides insights into knowledge, identifies research gaps, and highlights influential studies. In the context of COVID-19 research, adopting a bibliometric perspective becomes crucial to assessing the prevalence and impact of differential equations in mathematical modeling approaches (K *et al.,* 2021; Kappi *et al.,* 2021).

This research will contribute to a better understanding of the role of differential equations in mathematical modeling approaches for COVID-19. By identifying the most influential studies and researchers, this paper will fill the gap in existing research by shedding light on state-of-the-art modeling techniques and potentially guiding future research directions. Additionally, the analysis will uncover interdisciplinary collaborations and knowledge exchange among researchers from different fields, fostering a more comprehensive and integrated approach to tackling the challenges posed by the pandemic.

2. OBJECTIVES OF THE STUDY

The objectives of the studies are:

- To conduct a comprehensive bibliometric analysis exploring the influence of differential equations in mathematical modeling approaches for COVID-19.
- Quantify publication output, citation metrics, and collaboration networks to identify key researchers, institutions, and countries driving research in this field.
- Identify the most influential studies and researchers, shedding light on state-of-the-art modeling techniques and potentially guiding future research directions.

3. METHODOLOGY

The Web of Science database was used as the primary data source for this study. The search terms "Differential Equations" OR "Mathematical Models" AND "covid 19" OR "2019 novel coronavirus" OR "coronavirus 2019" OR "coronavirus disease 2019" OR "2019-novel CoV" OR "2019 nov" OR covid 2019 OR corvidae OR "corona virus 2019" OR ncov-2019 OR ncov2019 OR "nov 2019" OR 2019-ncov OR covid-19 OR "Severe acute respiratory syndrome coronavirus

2" OR "SARS-CoV-2" were used to search for relevant literature published between 2020 and 2023. 964 documents were found, including articles, books, and conference papers. The bibliographic records of the resulting documents were tabulated in MS Excel.

The VOS viewer software and Bibliometrix R tool were used for network visualization. Annual Growth Rate (AGR) and authorship pattern indicators were used for analysis. The study also analyzed the yearly research performance, citation analysis, most prolific authors, corresponding authors' countries, institutions, most preferred journals, and highly cited papers.

4. RESULTS

This study comprehensively analyzes global publications on differential equations in mathematical modeling approaches for understanding and combating the COVID-19 pandemic. Table 1 presents the dataset includes 964 documents from 353 sources, spanning 2020 to 2023. The analysis reveals significant trends, such as a negative annual growth rate of -8.5%, indicating a decline in publication output yet highlighting the dataset's comprehensive nature. The publications have made significant contributions to the field, reflected by an average of 12.32 citations per document and an extensive list of 28,935 references. Collaboration among 3657 authors was evident, with an average of 4.51 co-authors per document and 48.96% of co-authorships being international. The dataset encompasses various document types, primarily articles (900), review articles, editorial materials, and a meeting abstract. These findings contribute valuable insights for researchers and practitioners seeking to understand the role of differential equations in mathematical modeling for COVID-19.

Description	Results
Timespan	2020-2023
Sources (Journals, Books, etc.)	353
Documents	964
Annual Growth Rate %	-8.5
Document Average Age	1.55
Average citations per doc	12.32
References	28935
DOCUMENT CONTENTS	
Keywords Plus (ID)	1051
Author's Keywords (DE)	2676
AUTHORS	
Authors	3657
Authors of single-authored docs	51
AUTHORS COLLABORATION	
Single-authored docs	52
Co-Authors per Doc	4.51
International co-authorships %	48.96
DOCUMENT TYPES	
Article	900
Review	50
Editorial Material	13
Meeting Abstract	1

Table 1. Main information about data.

4.1. Yearly Scientific Production and Impact

Table 2 and Figure 1 comprehensively analyze the annual scientific production performance and impact of global publications. The findings reveal notable variations in publication trends and their citation impact over the four years. In 2020, 181 publications were recorded, representing 18.776% of the cumulative publications. These publications garnered significant attention, receiving 6,452 citations, resulting in an impressive average of 35.646 CPP and a yearly citation count of 9.430. This indicates the publications' substantial influence and high citation rate during that year. However, in the subsequent years, there was a decline in both the number of publications and their citation impact.

Year	TP	% of TP	TC	CPP	TCpY
2020	181	18.776	6452	35.646	9.430
2021	344	35.685	4195	12.195	4.370
2022	333	34.544	1121	3.366	1.640
2023	106	10.996	109	1.028	0.830

Table 2. Annual scientific production performance and their impact. Note: TP = Total Publications; TC = Total Citations; CPP = Citations Per Paper; TCpY = Total Citations per Year

In 2021, the total publications increased to 344, accounting for 35.685% of the overall publications, but the total citations dropped to 4,195, resulting in an average of 12.195 CPP and a yearly citation count of 4.370. This downward

trend continued in 2022, with 333 total publications (34.544% of the total) and a further decrease in total citations to 1,121, yielding an average of 3.366 CPP and a yearly citation count of 1.640. The decline persisted in 2023, with 106 total publications, representing 10.996% of the overall publications, and a minimal total citation count of 109, resulting in an average of 1.028 CPP and a yearly citation count of 0.830. These findings highlight a substantial decrease in the number of publications and their citation impact over the years. This analysis emphasizes the need for continued research efforts and advancements in differential equations in mathematical modeling approaches for COVID-19 to maintain a robust scientific impact and contribute effectively to the ongoing fight against the pandemic.

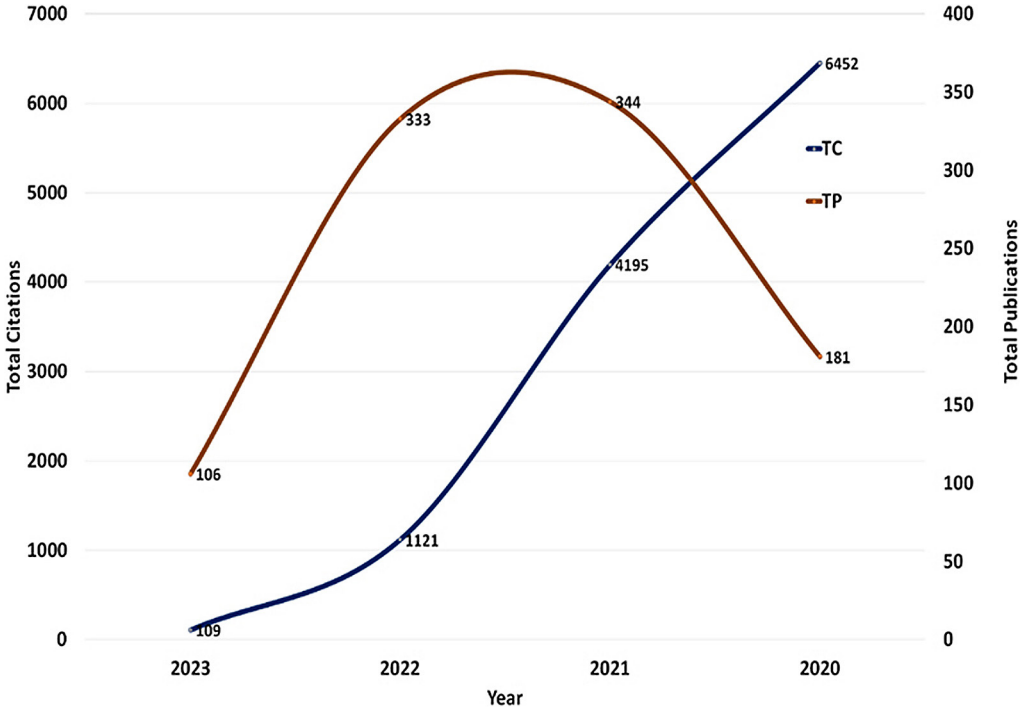

Figure 1. Yearly scientific production and impact.

4.2. Distribution of Citations and Highly Cited Papers

Table 3 depicts the distribution of citations for publications, corresponding citation counts and cumulative citations. Among the 964 papers analyzed, the majority (237) received no citations. It is important to consider that citation counts alone may not adequately reflect the quality or impact of a publication, particularly for recent papers that may not have had sufficient time to accumulate citations. In the 1-9 citation slab, 475 papers received 1,735 citations, indicating a moderate level of attention within the academic community. Moving to higher citation slabs, the number of papers decreases while the citation counts and cumulative citations increase. Within the 10-19 citation slab, 108 papers amassed 1,521 citations, contributing to a cumulative citation count of 3,256.

Similarly, in the 20-29 slab, 45 papers accumulated 1,058 citations, resulting in a cumulative citation count of 4,314. This trend persists, with diminishing numbers of papers and increasing citation counts and cumulative citations in subsequent slabs. Notably, a few papers stand out with exceptionally high citation counts, exemplified by one paper that received 1,332 citations, significantly impacting the cumulative citation count of 11,877. These prominently cited papers underscore their substantial influence and recognition within the academic community, highlighting their noteworthy contributions to differential equations in mathematical modeling approaches for COVID-19.

Citation Slab	Papers	Citations	Cum Citations
0	237	0	0
1-9	475	1735	1735
10-19	108	1521	3256
20-29	45	1058	4314
30-39	35	1200	5514
40-49	19	845	6359
50-99	32	2372	8731
100-149	7	858	9589
150-199	4	684	10273
200-299	1	272	10545
1332	1	1332	11877
0-1332	964	11877	11877

Table 3. Distribution of citations.

Among the 964 publications analyzed, a subset of 13 papers met the criteria for being highly cited papers (HCPs), defined as having a total citation (TC) count of 100 or more. These 13 HCPs accounted for approximately 26.49% of the total citations received. Among the HCPs, there were 12 articles and one editorial material. The paper by *Eubank et al.* (2020) ranked first in TC, with a count of 1332, corresponding to a TC per year (TCpY) of 333. The second-ranked paper was by *Moore et al.* (2021), with a TC of 272 and a TCpY of 90.67. The 13 HCPs involved a total of 110 authors and 54 institutions. The distribution of authors varied across the papers, with one paper having a single author and the rest in collaborations. (Having 3 to 26 authors each) respectively. Two papers had three authors each, and three papers had 5 authors each. The paper by *"Kerr et al. titled "Covasim: An agent-based model of COVID-19 dynamics and interventions"* (2021) had the highest number of collaborators (n=26) and a TC of 176.

The 13 HCPs were published in 12 journals, with the journal Chaos, Solitons & Fractals publishing two of the papers. Additionally, eight of the papers received funding from various agencies. Among the HCPs, 11 papers had citations ranging from 100 to 200, while two papers stood out with counts of 272 and 1332, respectively (table 4).

Paper	DOI	TC	TCpY	Normalized TC
EUBANK S, 2020, BULL MATH BIOL	10.1007/s11538-020-00726-x	1332	333.00	35.30
MOORE S, 2021, LANCET INFECT DIS	10.1016/S1473-3099(21)00143-2	272	90.67	20.75
JEWELL BL, 2020, LANCET HIV	10.1016/S2352-3018(20)30211-3	187	46.75	4.96
KERR CC, 2021, PLOS COMPUT BIOL	10.1371/journal.pcbi.1009149	176	58.67	13.43
NAIK PA, 2020, EUR PHYS J PLUS	10.1140/epjp/s13360-020-00819-5	167	41.75	4.43
JEWELL NP, 2020, JAMA-J AM MED ASSOC	10.1001/jama.2020.6585	154	38.50	4.08
STUTT ROJH, 2020, PROC R SOC A-MATH PHYS ENG SCI	10.1098/rspa.2020.0376	141	35.25	3.74
MANDAL S, 2020, INDIAN J MED RES	10.4103/ijmr.IJMR_504_20	126	31.50	3.34
BLACH S, 2021, J HEPATOL	10.1016/j.jhep.2020.07.042	125	41.67	9.54
CUEVAS E, 2020, COMPUT BIOL MED	10.1016/j.compbiomed.2020.103827	125	31.25	3.31
ABDO MS, 2020, CHAOS SOLITONS FRACTALS	10.1016/j.chaos.2020.109867	122	30.50	3.23
CILLONI L, 2020, ECLINICALMEDICINE	10.1016/j.eclinm.2020.100603	116	29.00	3.07
SAMUI P, 2020, CHAOS SOLITONS FRACTALS	10.1016/j.chaos.2020.110173	103	25.75	2.73

Table 4. Highly cited papers.

4.3. Countries' Scientific Production and Impact

The analysis compares the top 20 most productive countries regarding scientific production and impact (Table 5). A total of 110 countries contributed to all these 964 publications. TThe USA leads with 235 publications and 4,276 citations, showing a significant impact. Saudi Arabia ranks second with 127 publications, 1,652 citations, and a higher impact per publication (CPP) value of 13.008. China is third with 112 publications, 1,184 citations, and a CPP value of 10.571. India, England, and Pakistan also demonstrate notable productivity and impact. India has 99 publications and a high CPP value

Country	TP	TC	CPP	TLS
USA	235	4276	18.196	169
Saudi Arabia	127	1652	13.008	196
China	112	1184	10.571	106
India	99	1299	13.121	85
England	91	2221	24.407	99
Pakistan	81	1676	20.691	146
Italy	76	896	11.789	83
Spain	49	549	11.204	38
Germany	47	617	13.128	41
Taiwan	46	805	17.500	99
Canada	45	369	8.200	50
Egypt	45	513	11.400	65
Turkey	43	923	21.465	87
France	39	271	6.949	42
South Africa	32	422	13.188	59
UAE	27	516	19.111	41
Jordan	20	259	12.950	46
Switzerland	20	434	21.700	36
Nigeria	18	349	19.389	37
Romania	17	208	12.235	35

Table 5. Top 20 most productive countries. Note: TP = Total Publications; TC = Total Citations; CPP= Citations Per Paper; TLS = Total Link Strength.

of 13.121. England has 91 publications and a CPP value of 24.407, while Pakistan has 81 publications and a CPP value of 20.691. Other countries, including Italy, Spain, Germany, Taiwan, Canada, Egypt, Turkey, France, South Africa, UAE, Jordan, Switzerland, Nigeria, and Romania, exhibit varying productivity and impact. Figure 2 illustrates the co-authorship collaboration network map of the top 20 countries in the field. The network consists of three clusters, with Saudi Arabia positioned centrally in the largest cluster. This central position indicates Saudi Arabia's significant role in fostering collaborations and forming a prominent research community. The top 20 countries have 139 links and 780 total link strengths.

Table 6 and Figure 3 focus on the top 20 most relevant countries by the corresponding author. The USA leads with 154 articles but a higher prevalence of single-country publications. China follows with 82 articles and a greater emphasis on collaborative research. Saudi Arabia ranks third with 66 articles and a strong focus on international collaborations. India and England are fourth and fifth, with 64 and 52 articles, respectively. England has made a significant contribution to collaborative research. Italy, Spain, Brazil, Pakistan, Canada, Germany, Mexico, France, Egypt, Portugal, Iran, Japan, Turkey, Korea, and the UAE are notable contributors. Each country has varying levels of emphasis on single-country publications and collaboration.

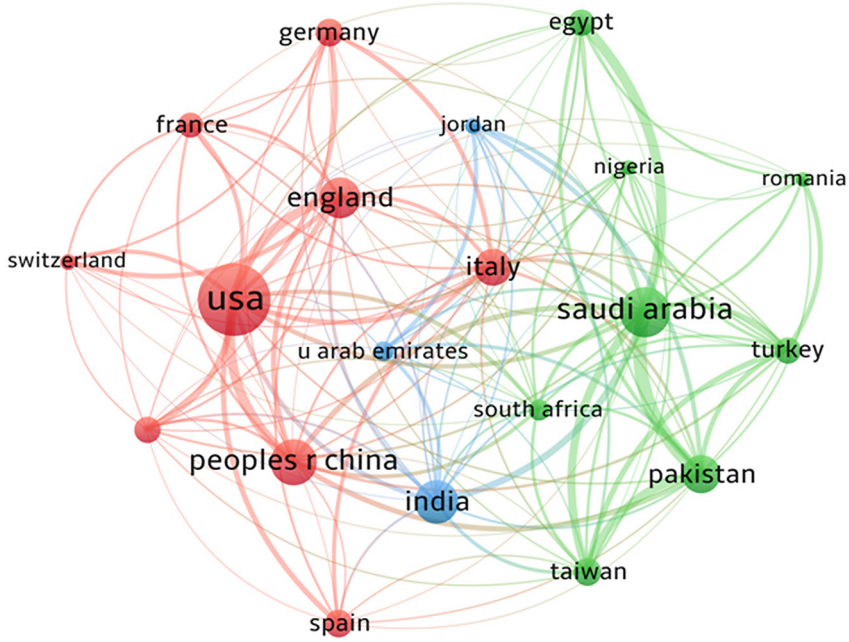

Figure 2. Top 20 countries collaboration visualization.

Country	Articles	SCP	MCP	Freq	MCP Ratio
USA	154	102	52	0.160	0.338
China	82	44	38	0.085	0.463
Saudi Arabia	66	14	52	0.068	0.788
India	64	41	23	0.066	0.359
England	52	16	36	0.054	0.692
Italy	37	22	15	0.038	0.405
Spain	33	17	16	0.034	0.485
Brazil	28	23	5	0.029	0.179
Pakistan	28	5	23	0.029	0.821
Canada	24	15	9	0.025	0.375
Germany	24	20	4	0.025	0.167
Mexico	20	10	10	0.021	0.500
France	17	6	11	0.018	0.647
Egypt	15	4	11	0.016	0.733
Portugal	15	6	9	0.016	0.600
Iran	14	8	6	0.015	0.429
Japan	14	11	3	0.015	0.214
Turkey	14	3	11	0.015	0.786
Korea	13	10	3	0.013	0.231
UAE	13	3	10	0.013	0.769

Table 6. Top 20 most relevant countries by the corresponding author. Note: SCP = Single Country Publications; MCP = Multiple Country Publications.

This comparative analysis provides insights into the global research landscape of the influence of differential equations in mathematical modeling approaches for COVID-19 publications. It highlights the research strategies and collaboration patterns employed by different countries in addressing the pandemic's challenges.

4.4. Institutions Scientific Production and Impact

Table 7 presents the top 20 most productive institutions in the field of the influence of differential equations, focusing on their contributions to the study. Out of 1,726 institutions globally, China Medical University in China is the most productive institution, with 36 publications and 602 citations. It boasts an impressive average CPP of 16.722, indicating the substantial impact of its research. Following closely is King Abdulaziz University from Saudi Arabia, with 31 publications and 390 citations and a relatively higher CPP ratio of 12.581. Other notable institutions include Prince Sultan University (Saudi Arabia), the London School of Hygiene & Tropical Medicine (UK), and the University of Malakand (Pakistan) in the third, fourth, and fifth positions,

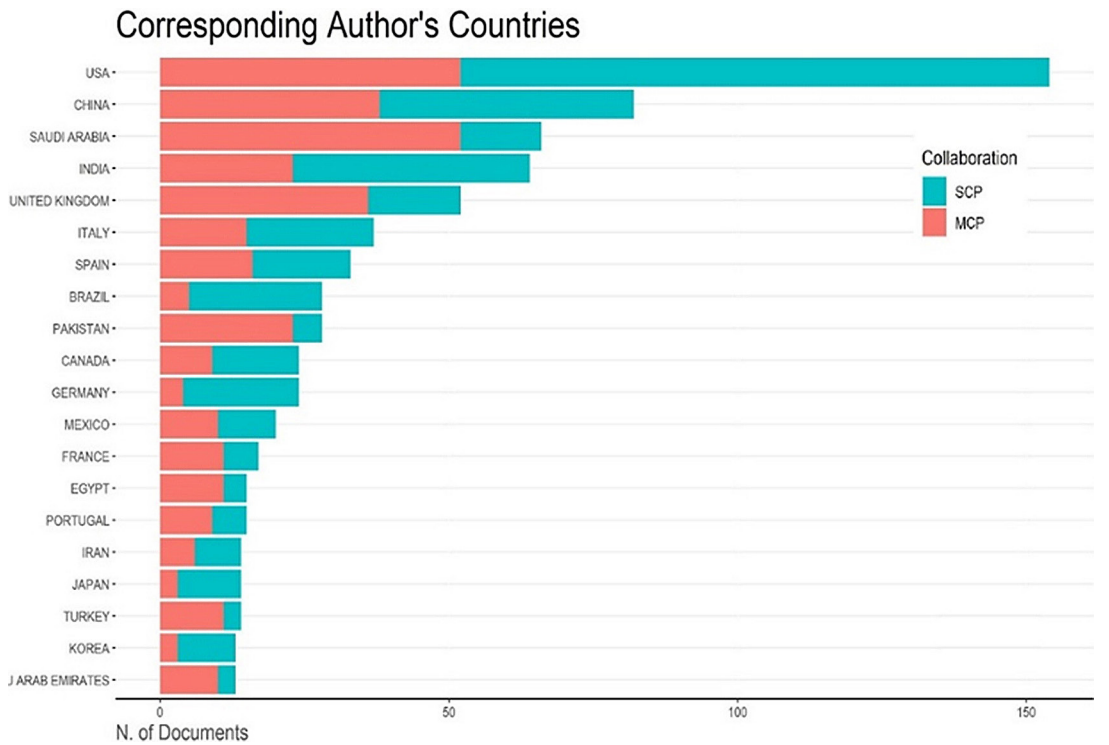

Figure 3. Top 20 most relevant countries by corresponding author.

respectively. These institutions have substantially influenced the field, with notable publication numbers and respectable citation metrics.

Interestingly, the table reveals various institutions from various countries, such as China, Saudi Arabia, the UK, Pakistan, Egypt, India, Turkey, and South Africa, among others. This highlights the global collaborative effort in studying mathematical modeling approaches for COVID-19. It is noteworthy that while institutions like the University of Oxford (UK) and the Indian Institute of Space Science and Technology (India) have relatively fewer total publications, they have achieved high citations per paper ratios, indicating the significance and impact of their research contributions.

Institution	TP	TC	CPP	TLS
China Medical University, China	36	602	16.722	69
King Abdulaziz University, Saudi Arabia	31	390	12.581	29
Prince Sultan University, Saudi Arabia	22	365	16.591	39
London School of Hygiene & Tropical Medicine, UK	19	335	17.632	3
University of Malakand, Pakistan	18	455	25.278	28
University of Oxford, UK	18	298	16.556	3
Cankaya University, Turkey	15	169	11.267	38
Al-Azhar University, Egypt	14	126	9.000	15
COMSATS University Islamabad, Pakistan	14	465	33.214	12
King Khalid University, Saudi Arabia	14	74	5.286	19
Cairo University, Egypt	13	71	5.462	7
Indian Institute of Space Science and Technology, India	13	174	13.385	34
Free State University, South Africa	13	116	8.923	14
University of Management & Technology, Pakistan	11	46	4.182	30
Prince Sattam Bin Abdulaziz University, Saudi Arabia	10	184	18.400	19
University of Lahore, Pakistan	10	79	7.900	29
Central University of Punjab, India	9	114	12.667	34
Air University, Pakistan	8	73	9.125	21
Asia University, Taiwan	8	135	16.875	17
National College of Business Administration and Economics, Pakistan	5	90	18.000	22

Table 7. Top 20 Most Productive Institutions. Note: TP = Total Publications; TC = Total Citations; CPP = Citations Per Paper; TLS = Total Link Strength.

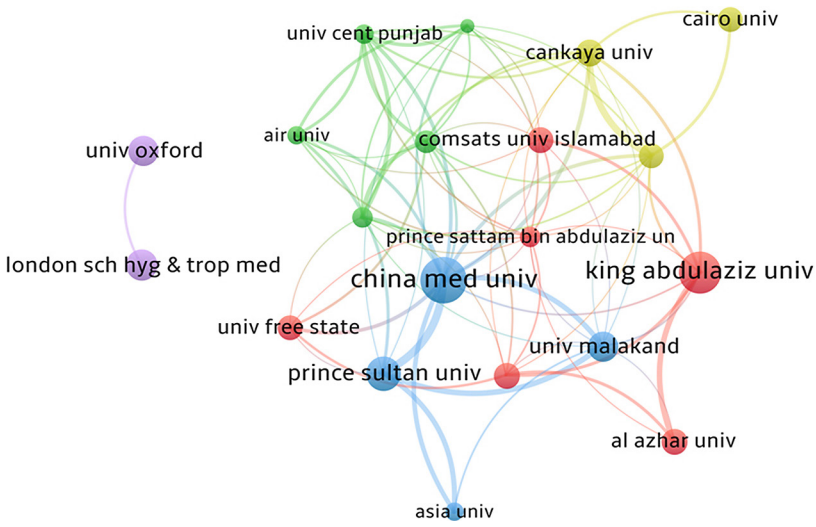

Figure 4. Top 20 institutions collaboration visualization.

Figure 4 depicts a network analysis of 20 interconnected institutions in the field of the influence of differential equations. Each institution is represented as a node, sized proportionally to the number of publications contributed. Thicker lines indicate higher levels of collaboration, resulting in 80 links and a link strength of 241. The network is organized into five distinct clusters, reflecting specific patterns of cooperation between the institutions.

4.5. Authors' Scientific Production and Impact

Table 8 lists the top 20 productive and impactful authors in the field of the influence of differential equations. Kamal Shah from the University of Malakand, Pakistan, leads with 16 publications, 503 citations, and a CPP of 31.438. Thabet Abdeljawad from Asia University, Taiwan, follows closely with 12 publications, 149 citations, and a CPP of 12.417. Other notable authors include Dumitru Baleanu from Cankaya University, Turkey; Muhammad Altaf Khan from Free State University, South Africa, and Muhammad Rafiq from the Central University of Punjab, India. Pakistani institutions have several authors on the list, such as Ali Raza and Muhammad Shoaib Arif from Air University, Nauman Ahmed from the University of Lahore, and Muhammad Asif Zahoor Raja from COMSATS University. International collaboration is evident, with authors from the UK, Saudi Arabia, Portugal, Algeria, and the UAE. Institutions like the University of Warwick (UK) and Prince Sattam bin Abdulaziz University (Saudi Arabia) have multiple representatives.

A total of 3657 authors contributed to all the 964 publications. Collaboration of authors analysis with a minimum of 3 publications was considered, and 20 authors met the threshold. The authors have been categorized into different clusters based on their link strength, and each cluster has been assigned a specific color code. The analysis categorized authors into five different colored clusters with 34 links and 102 total link strengths.

Author	Affiliation	TP	TC	CPP	h index	g index	TLS
Shah, Kamal	University of Malakand, Pakistan	16	503	31.438	9	15	14
Abdeljawad, Thabet	Asia University, Taiwan	12	149	12.417	6	9	7
Baleanu, Dumitru	Cankaya University, Turkey	12	122	10.167	8	13	11
Khan, Muhammad Altaf	Free State University, South Africa	10	155	15.500	4	9	3
Rafiq, Muhammad	Central University of Punjab, India	9	114	12.667	5	9	24
Raza, Ali	Air University, Pakistan	8	114	14.250	5	8	23
Arif, Muhammad Shoaib	Air University, Pakistan	7	71	10.143	3	7	11
Ahmed, Nauman	University of Lahore, Pakistan	6	48	8.000	2	6	15
Keeling, Matt J.	University of Warwick, UK	6	368	61.333	4	6	12
Nisar, Kottakkaran Sooppy	Prince Sattam Bin Abdulaziz University, Saudi Arabia	6	142	23.667	2	3	7
Tildesley, Michael J.	University of Warwick, UK	6	366	61.000	3	4	12
Shatanawi, Wasfi	Prince Sattam Bin Abdulaziz University, Saudi Arabia	5	54	10.800	2	3	9
Ouannas, Adel	University of Oum El Bouaghi, Algeria	5	25	5.000	2	3	5
Raja, Muhammad Asif Zahoor	COMSATS University, Pakistan	5	216	43.200	2	3	1
Rhodes, Tim	London School of Hygiene & Tropical Medicine, UK	5	72	14.400	3	5	5
Shatanawi, Wasfi	Prince Sattam Bin Abdulaziz University, Saudi Arabia	5	54	10.800	2	3	9
Silva, Cristiana J.	University of Aveiro, Portugal	5	111	22.200	3	5	4
Yousef, Ali	Kuwait College of Science and Technology	5	35	7.000	3	5	3
Alrabaiah, Hussam	Al Ain University, UAE	4	177	44.250	4	4	5
Dyson, Louise	University of Warwick, UK	4	355	88.750	3	3	12

Table 8. Top 20 most productive and impactful authors. Note: TP = Total Publications; TC = Total Citations; CPP = Citations Per Paper; TLS = Total Link Strength.

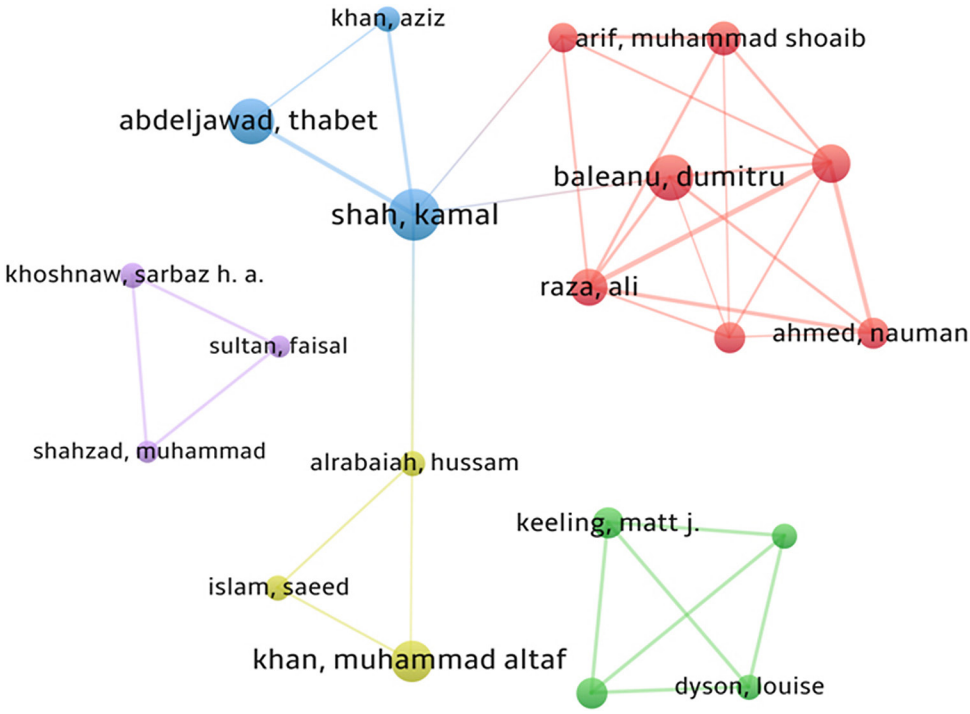

Figure 5. Top 20 Most Collaborative Authors Visualization.

4.6. Most Relevant Sources and their Impact

Table 9 provides information on the field's top 20 most productive journals. 964 research papers were published across 353 journals, indicating a wide distribution of papers among reporting journals. Chaos Solitons & Fractals leads the pack with 46 highly influential publications in the field and 1,346 citations, boasting a high CPP ratio of 29.261 and a substantial total link strength of 112. Results in Physics and Mathematics closely follow with 35 and 33 publications, respectively. Other notable journals include PLOS One, Mathematical Biosciences and Engineering, and Mathematical Methods in The Applied Sciences, each with a moderate number of publications, citations, and CPP ratios ranging from 5.045 to 8.656. Few journals show varying strengths in terms of total link strength, indicating the interconnectedness of their publications within the field. Journals like Chaos Solitons & Fractals, Alexandria Engineering Journal, and Advances in Difference Equations display higher link strengths, suggesting their articles are frequently referenced and play important roles in the scientific discourse. The table also shows that some journals have a high TLS but a low TP or TC. For example, Symmetry-Basel has a TLS of 21 but only 66 citations. This suggests that Symmetry-Basel is a relatively new journal that is quickly gaining influence in the field.

Additionally, Figure 6 illustrates the co-citation network of journals, showcasing three distinct colored clusters with 25 journals meeting the threshold. The network encompasses 108 links and a total link strength of 347, emphasizing the interconnected nature of these journals within the field.

5. DISCUSSION AND CONCLUSION

This study comprehensively analyzes global publications on differential equations in mathematical modeling approaches for understanding and mitigating the COVID-19 pandemic. Valuable insights and key trends in this domain are identified. Despite a decline in published works, the dataset remains extensive, with an average citation count of 12.32 per document, reflecting the significant impact of these publications. Collaboration among authors is prominent, emphasizing global cooperative efforts. The dataset primarily comprises diverse scholarly articles. Annual scientific

Journal	TP	TC	CPP	TLS
Chaos Solitons & Fractals	46	1346	29.261	112
Results in Physics	35	527	15.057	95
Mathematics	33	117	3.545	63
PLOS One	32	277	8.656	18
Mathematical Biosciences and Engineering	22	111	5.045	30
Mathematical Methods in The Applied Sciences	21	181	8.619	30
Alexandria Engineering Journal	20	385	19.250	51
Advances in Difference Equations	19	340	17.895	59
Frontiers in Public Health	19	53	2.789	14
Scientific Reports	18	187	10.389	16
Nonlinear Dynamics	15	265	17.667	24
PLOS Computational Biology	15	341	22.733	13
Symmetry-Basel	12	66	5.500	21
AIMS Mathematics	10	10	1.000	28
CMC-Computers Materials & Continua	10	130	13.000	16
Computer Methods and Programs in Biomedicine	8	206	25.750	15
Fractal And Fractional	7	20	2.857	16
Annual Reviews in Control	6	180	30.000	17
European Physical Journal Plus	6	323	53.833	31
Bulletin of Mathematical Biology	5	1374	274.800	25

Table 9. Top 20 most relevant sources. Note: TP = Total Publications; TC = Total Citations; CPP = Citations Per Paper; TLS = Total Link Strength.

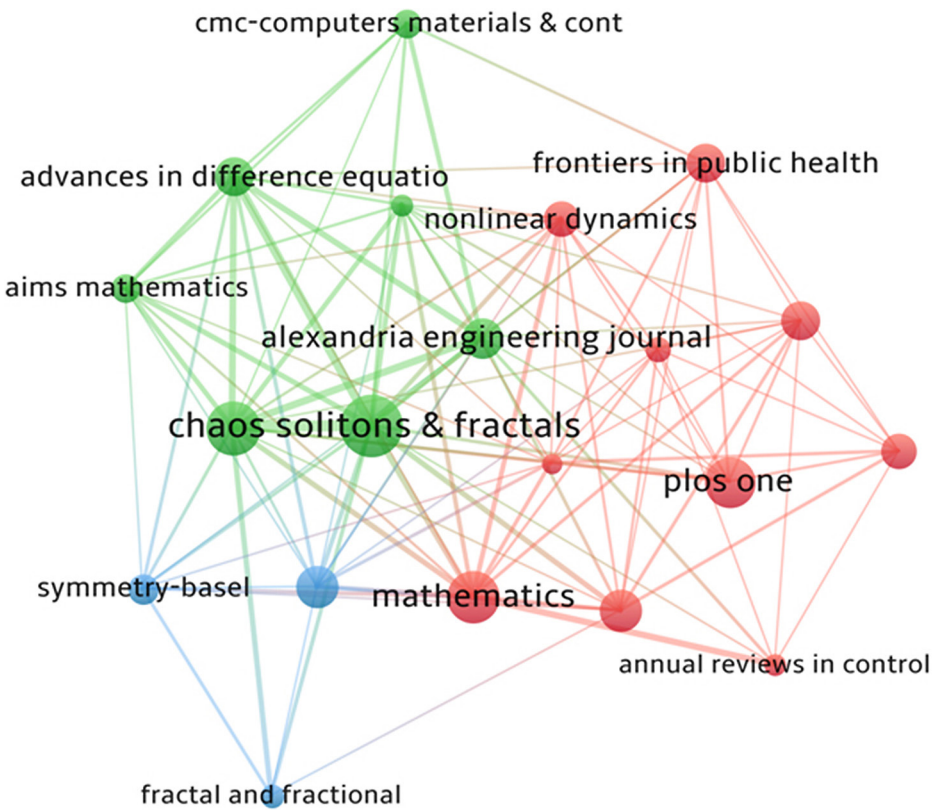

Figure 6. Journal co-citation analysis.

production and impact exhibit a downward trajectory, underscoring the need to sustain research efforts. Highly cited papers (HCPs), including a subset of 13 identified influential works, shape the field. The contributions of countries like the United States, Saudi Arabia, China, India, England, and Pakistan are notable. Productivity and impact are evident across institutions and authors from various nations, highlighting the global research landscape. The top 20 most productive journals, particularly Chaos Solitons & Fractals, play a crucial role. The co-citation network reveals the interconnectedness of journals and their significance in the scientific discourse on differential equations in COVID-19 modeling. In conclusion, this comprehensive analysis offers valuable insights, emphasizing sustained research efforts, global collaborations, and advancements to address the pandemic effectively. The findings serve as a vital resource for researchers and stakeholders combating COVID-19, contributing to the collective understanding of this critical study area.

6. RESEARCH RECOMMENDATIONS

- Encourage and support sustained research efforts in differential equations in mathematical modeling approaches for COVID-19.
- Foster global collaborations among researchers from different countries to enhance knowledge exchange and comprehensive solutions.
- Promote interdisciplinary approaches by collaborating with experts in epidemiology, public health, computer science, and social sciences.
- Promote open-access publishing and data sharing to facilitate knowledge exchange and foster collaboration.
- Address citation distribution disparities by actively disseminating research findings, engaging with the scientific community, and promoting high-quality publications.
- Encourage journal engagement by submitting high-quality manuscripts, reviewing papers, and participating in editorial.
- Emphasize the need for continued research efforts, global collaborations, and advancements to address the ongoing COVID-19 pandemic effectively.

Conflict of Interest

The author declares that there is no conflict of interest.

Statement of data consent

The data generated during the development of this study has been included in the manuscript.

REFERENCES

Adiga, A., Dubhashi, D., Lewis, B., Marathe, M., Venkatramanan, S., & Vullikanti, A. (2020). Mathematical Models for COVID-19 Pandemic: A Comparative Analysis. *Journal of the Indian Institute of Science, 100*(4), 793-807. https://doi.org/10.1007/s41745-020-00200-6

Altaf, M., & Atangana, A. (2022). Mathematical modeling and analysis of COVID-19: A study of new variant Omicron. *Physica A, 599*(127452). https://doi.org/10.1016/j.physa.2022.127452

Behera, J., Rauta, A. K., Rao, Y. S., & Patnaik, S. (2021). *Mathematical Modeling on Double Quarantine Process in the Spread and Stability of COVID-19 BT - Sustainability Measures for COVID-19 Pandemic* (R. Agrawal, M. Mittal, & L. M. Goyal (eds.); pp. 37-57). Springer Nature Singapore. https://doi.org/10.1007/978-981-16-3227-3_3

Dayal, D., Gupta, B. M., & Kappi, M. (2022). Scientometric Mapping of Mucormycosis Research in Relation to The COVID-19 Pandemic. International *Journal of Medicine and Public Health, 12*(2), 1-6. https://doi.org/10.5530/ijmedph.2021.4.37

Gupta, B., Dhawan, S., Mueen Ahmed, K., & Mamdapur, G. M. (2021). Use of Convalescent Plasma Therapy for COVID-19: A Scientometric Assessment of Global Publications during 2020-21. International *Journal of Medicine and Public Health, 11*(2), 65-75. https://doi.org/10.5530/ijmedph.2021.2.13

K, G., Kappi, M., & B.M.R, P. (2021). A Scientometric Review and Visualization of Global research productivity on Graph Theory during 2001-2020. *Gradiva Review Journal, 7*(9), 315-330. https://doi.org/10.37897.GRJ.2021.V7I9.21.365

Kappi, M., B, M., & T, V. (2021). Bibliometric Visualisation of Research Performance of Post COVID -19 and Mucormycosis: Where Do We Stand? *Journal of Drug Delivery and Therapeutics, 11*(6), 31-39. https://doi.org/10.22270/jddt.v11i6.5127

Kappi, M., Chaman, S. M., Biradar, B. S., & Bagalkoti, V. T. (2021). Coronavirus: A scientometric study of worldwide research publications. In U. Kose, D. Gupta, V. H. C. de Albuquerque, & A. Khanna (Eds.), *Data Science for COVID-19: Volume 2: Societal and Medical Perspectives* (Vol. 2019, pp. 433-448). Elsevier Inc. https://doi.org/10.1016/B978-0-323-90769-9.00019-0

Kappi, M., Chaman Sab, M., Sankrappa Biradar, B., & Bagalkoti, V. T. (2021). Bibliometric Study of World COVID-19 Publication Output. *Shanlax International Journal of Arts, Science and Humanities, 8*(3), 86-95. https://doi.org/10.34293/sijash.v8i3.3489

Kappi, M., Gupta, B. M., & Sharma, J. (2021). Covid-19 and Cancer: A Scientometric Assessment of India's Publications During 2020-21. *Library Herald, 59*(4), 1-18. https://doi.org/10.5958/0976-2469.2021.00

Keeling, M. J., & Rohani, P. (2008). *Modeling Infectious Diseases in Humans and Animals*. Princeton University Press. https://doi.org/doi:10.1515/9781400841035

Kucharski, A. J., Russell, T. W., Diamond, C., Liu, Y., Edmunds, J., Funk, S., Eggo, R. M., Sun, F., Jit, M., Munday, J. D., Davies, N., Gimma, A., van Zandvoort, K., Gibbs, H., Hellewell, J., Jarvis, C. I., Clifford, S., Quilty, B. J., Bosse, N. I., ... Flasche, S. (2020). Early dynamics of transmission and control of COVID-19: a mathematical modelling study. *The Lancet Infectious Diseases, 20*(5), 553-558. https://doi.org/10.1016/S1473-3099(20)30144-4

Panovska-Griffiths, J. (2020). Can mathematical modelling solve the current Covid-19 crisis? *BMC Public Health,* 20(1), 551. https://doi.org/10.1186/s12889-020-08671-z

Sweileh, W. M. (2022). Global research activity on mathematical modeling of transmission and control of 23 selected infectious disease outbreak. *Globalization and Health, 18*(1), 4. https://doi.org/10.1186/s12992-022-00803-x.