The Evolution of COVID-19 Publications in Pediatrics: A Bibliometric Analysis with Research Trends and Global Productivity

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ABSTRACT

Objective: Despite the increase in the number of global studies on COVID-19 that has been increasingly contagious among children, no comprehensive bibliometric studies have been found in the literature concerning COVID-19 in pediatrics. This study aimed to perform a holistic analysis of the scientific outputs about COVID-19 in pediatrics using various statistical methods.

Methods: The articles published in the research area of pediatrics on COVID-19 between January 1st, 2020 and February 13th, 2022 were downloaded from the Web of Science (WoS) and analysed using various statistical methods. Spearman's correlation analysis was performed for related research. Bibliometric network visualization diagrams were generated to reveal trending topics and cross-country collaborations.

Results: A total of 5315 publications were found. Among these publications, 47.7% (n=2540) were articles. The top 5 contributors to the literature were the USA (955), Italy (278), the UK (219), Turkey (148), and China (137). The top 3 most productive institutions were Harvard University (n=107), the University of California System (n=85), and the University of London (n=75). The top 3 journals with the highest number of articles were Frontiers in Pediatrics (n=163), Pediatric Infectious Disease Journal (n=121), and Pediatrics (n=106). The top 3 most effective journals based on the mean number of citations per article were Pediatria i Medycyna Rodzinna, Lancet Child Adolescent Health, and JAMA Pediatrics.

Conclusion: Topics studied on COVID-19 in pediatrics in recent months were screen time, sleep, physical activity, Type 1 diabetes, obesity, vaccine, neonatology, congenital heart disease, qualitative research, school closure, and pediatric emergency medicine.

Keywords: COVID-19, coronavirus, SARS-CoV-2; pediatrics; bibliometric analysis; trends

INTRODUCTION

The COVID-19 disease was first reported in December 2019 in Wuhan in the Hubei Province of China. After that, an outbreak started in other parts of the country and around the world. It was declared a global public health emergency by WHO on March 11, 2020 [1-3]. COVID-19 is a respiratory infection caused by the novel coronavirus [2].

Symptoms are usually less severe in children with COVID-19 compared to adults, manifesting mostly with cough and fever, sore throat, nasal congestion, fatigue, headache, and muscle pain. Fatigue can be experienced in children with COVID-19, albeit not as common as in adults [2,4]. Based on the information obtained from the beginning of the pandemic, it was stated that many SARS-CoV-2 infections in childhood were asymptomatic without causing symptoms and complaints [2,4]. On the other hand, the recently emerged Omicron variant has been associated with a milder disease despite its increased contagiousness in children [5]. The exact reason why the COVID-19 agent does not cause severe illness in children is not fully known; however, it has been explained that children have fewer ACE-2 receptors, a more active immune system, and some different physiologic characteristics [6-8].

Recent reports have defined a novel syndrome as a multisystem inflammatory syndrome (MIS-C) associated with SARS-CoV-2 in children presenting with the characteristics of Kawasaki disease (KD), and many clinical manifestations of MIS-C overlap with Kawasaki disease [9-11]. MIS-C syndrome and severe COVID-19 pediatric cases in children due to SARS-CoV-2 infection have recently been and continue to be reported in many countries and regions with a global COVID-19 pandemic [11,12].

COVID-19 infection can potentially cause severe illness in newborns with insufficiently developed immunity. Dong et al. (2020) reported that the percentages of severe and critical cases for <1, 1- 5, 6-10, 11-15, and ≥16 age groups as 10.6%, 7.3%, 4.2%, 4.1%, and 3.0%, respectively, stating that young children, especially infants, were vulnerable to 2019-nCoV infection [1]. Possible transmission routes of SARS-CoV-2 infection in newborns can be counted as vertical transmission from mother to fetus, transmission through close contact, droplet transmission (family members, visitors), and hospital-acquired infections. Vertical transmission can occur through the placenta in the intrauterine period, aspiration or swallowing of cervicovaginal secretions during delivery, and breast milk in the postpartum period. Vertical transmission could not be demonstrated in many studies since SARS-CoV-2 was not found in the analysis of amniotic fluid, cord blood, newborn throat swab samples, and breast milk samples [13-16]. Evidence for the transmission of COVID-19 from the mother to the infant is limited. The current guidelines and WHO recommend continued breastfeeding by COVID-19 positive mothers. In cases with SARS-CoV-2 positivity in childhood, there is currently no proven treatment approach or a treatment approach proven with strong scientific data, and supportive treatments are commonly administered.

Bibliometrics refers to the analysis of many scientific publications using various statistical technics [17-19]. Through bibliometric research, researchers can learn about the literature more quickly by reading the summary findings of thousands of articles [17]. In addition, bibliometric studies can provide researchers with ideas for new works by demonstrating the current trends [18]. Parallel to the rise in the number of studies published in the literature, bibliometric research has been conducted on many medical subjects [17-19]. Due to the COVID-19 pandemic, various bibliometric studies have been carried out on COVID-19, especially in recent years [20-22].

Despite the rise in the number of global research on COVID-19, which is increasingly contagious in children, there is yet no bibliometric study on COVID-19 in pediatrics in the literature. This study aimed to perform a holistic analysis of the scientific articles about COVID-19 published in the field of pediatric research between 2020 and 2022 by utilizing various bibliometric and statistical technics.

MATERIAL and METHODS

Web of Science Core Collection (WoS by Clarivate Analytics) database was utilized for the literature search. The search process was determined as 01 January 2020 - 13 February 2022. All publications indexed in the Pediatrics research field and containing any of the expressions related to the novel coronavirus (coronavirus, COVID-19, COVID19, COVID-2019, SARS-CoV-2, 2019-nCoV, nCoV19, nCOVID-19, nCov2019, nCoV2) in the title and keywords were accessed. Researcher access codes for repeatable documents (Due to various access dates, search results may change): ((TI=(coronavirus) OR TI=(COVID*) OR TI=(nCoV*) OR TI=(SARS-CoV-2)) and SU=(Pediatrics) and DOP=2020-2022).

The website (https://app.datawrapper.de) was used to create the world map showing the distribution of publications by

country. VOSviewer (Version 1.6.16, CWTS of Leiden University in the Netherlands) software was used for bibliometric network visualizations, trend, clustering and citation analysis [23]. SPSS software (Version 22.0, SPSS Inc., Chicago, IL, USA, License: Hitit University) was used to conduct the statistical analysis. The Kolmogorov-Smirnov test was used to determine whether the data had a normal distribution. Correlation analyses between world publication productivity in the field of Pediatrics and some development metrics of nations (Gross Domestic Product (GDP), Gross Domestic Product per capita (GDP per capita), Human Development Index (HDI)) were analyzed with Spearman correlation coefficient since the data were not normally distributed (data obtained from world bank [24]). $P<0.05$ was accepted for a statistically significant correlation.

RESULTS

As a result of the literature review, a total of 5315 publications on COVID-19 in the field of Pediatrics, which were published in the WoS database during the pandemic, were obtained. 47.7% (n=2540) of these publications were Articles, 17.9% (n=956) were Letters, 8.6% (458) were Review Articles, 7.8% (419) were Meeting Abstracts, and the rest were in other publication types (Editorial Materials, Early Access, Corrections, News Items, Book Reviews, Retractions, Proceedings Papers, Biographical-Items). Bibliometric analyses were carried out with 2540 articles published in the Article category out of a total of 5315 publications. The 95.4% (n=2424) of these articles were published in English and the remainder in other languages (Spanish (80, 3.15%), German (25, 0.9%), Turkish (5, 0.1%), Polish (4, 0.1%), and Portuguese (2, 0.07%)). The h-index of 2540 articles was 66, the average numbers of citations per article were 10.2, and the total number of citations was 26011 (without self-citations: 21857).

Most of the articles were indexed in SCI-Expanded (n=2222, 87.5%). 12.6% (n=321) of the articles were indexed in the Social Sciences Citation Index (SSCI), and 12% (n=304) were indexed in the Emerging Sources Citation Index (ESCI) (Since some studies indexed in the SCI-Expanded are also indexed in the SSCI, the number and percentage of articles may be higher than the total numbers). The 33.5% (n=853) of the articles were published in 2020, 61.9% (n=1573) in 2021 and 4.4% (n=114) in 2022. The other top 15 research areas in which 2540 articles were indexed together with the field of Pediatrics were Obstetrics Gynecology (206, 8.1%), Infectious Diseases (189, 7.4%), Immunology (153, 6%), Psychology Developmental (128, 5%), Public Environmental Occupational Health (83, 3.2%), Respiratory System (78, 3%), Psychiatry (60, 2.3%), Hematology (52, 2%), Oncology (52, 2%), Nursing (51, 2%), Cardiac Cardiovascular Systems (47, 1.8%), Surgery (37, 1.4%), Allergy (32, 1.2%), Otorhinolaryngology (30, 1.1%), and Nutrition Dietetics (28, 1.1%), respectively.

Active Countries

The distribution of the number of articles by world countries is shown in Figure 1. The top 20 countries with the most articles were USA (955, 37.5%), Italy (278, 10.9%), UK (219, 8.5%), Turkey (148, 5.8%), China (137, 5.3%), India (132, 5.1%), Spain (131, 5.1%), Germany (99, 3.8%), Canada (94, 3.7%), Iran (84, 3.3%), Australia (73, 2.8%), France (68,

2.6%), Brazil (61, 2.4%), Mexico (53, 2%), Israel (49, 1.9%), Switzerland (45, 1.7%), Netherlands (37, 1.4%), Japan (36, 1.4%), Argentina (31, 1.2%), and Austria (28, 1.1%), respectively.

There were 64 countries that produced at least 5 articles from 116 countries that published articles on COVID-19 in Pediatrics and had international cooperation among their authors. Figure 2.a shows the network visualization map displaying the outcomes of the clustering analysis conducted between these nations. Five different clusters were formed for international cooperation as a consequence of the clustering analysis (Cluster 1: Bangladesh, Brazil, Canada, Egypt, Ghana, India, Indonesia, Iran, Japan, Kenya, Malaysia, New Zealand, Nigeria, Pakistan, China, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Thailand, USA. Cluster 2: Austria, Belgium, Croatia, Cyprus, Czech Republic, Finland, Germany, Israel, Italy, Lithuania, Luxembourg, Poland, Portugal, Slovenia, Switzerland.

Cluster 3: France, Greece, Malta, Netherlands, Qatar, Romania, Serbia, South Korea, Sweden, Turkey. Cluster 4: Argentina, Chile, Colombia, Mexico, Morocco, Paraguay, Peru, Spain, United Arab Emirates, Uruguay. Cluster 5: Australia, Denmark, England (in UK), Ireland, Norway, Scotland, Wales).

Additionally, the international collaboration density map constructed using the scores from the calculation of the total link strength scores representing the degree of cooperation in 64 nations is displayed in Figure 2.b. (Top 20 countries with the highest scores: USA=406, England=344, Italy=322, Spain=263, Germany=192, Switzerland=168, France=165, India=160, Canada=140, Australia=123, Netherlands=121, Belgium=118, Brazil=102, Greece=99, China=93, Poland=90, Austria=86, Turkey=85, Argentina=79, Mexico=75).

Correlation Analysis

A high level of positive correlation was found between the number of articles produced by countries on COVID-19 in Pediatrics and GDP and GDP per capita values, and a moderate statistically significant correlation was found with HDI values ($r=0.745$, $p<0.001$; $r=0.700$, $p<0.001$, $r=0.517$, $p<0.001$, respectively).

Active Authors

The most productive authors who have published 10 or more articles on COVID-19 in pediatrics were Buonsenso D. (21), Calvo C. (15), Villani A. (15), Cohen R. (12), Lanari M. (10), Marseglia GL. (10), and Shao JB. (10), respectively.

Active Institutions

The most productive institutions that have published 40 or more articles on COVID-19 in Pediatrics were Harvard University (107), University of California System (85), University of London (75), Harvard Medical School (72), Boston Children's Hospital (70), University of Pennsylvania (67), Children's Hospital of Philadelphia (57), University College London (56), Columbia University (52), Baylor College of Medicine (48), Bambino Gesù Children's Hospital (46), Newyork Presbyterian Hospital (46), Ohio State University (44), and University of Milan (41), respectively.

Active Journals

2540 articles on COVID-19 in Pediatrics were published in 165 different journals. Table 1 shows the overall number of citations the journals received, the mean number of citations per publication, and the first 68 productive journals that made the biggest contributions to the literature that published 12 or more papers from these journals.
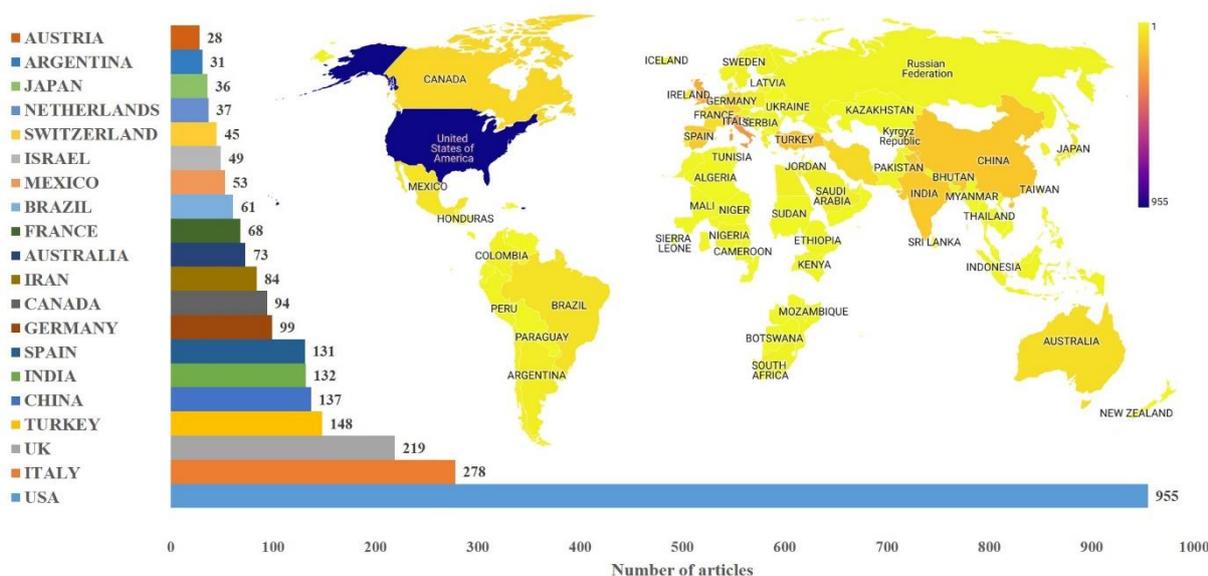

Figure 1. World map showing the distribution of articles published on COVID-19 in Pediatrics by countries and the top 20 countries that have published the most articles
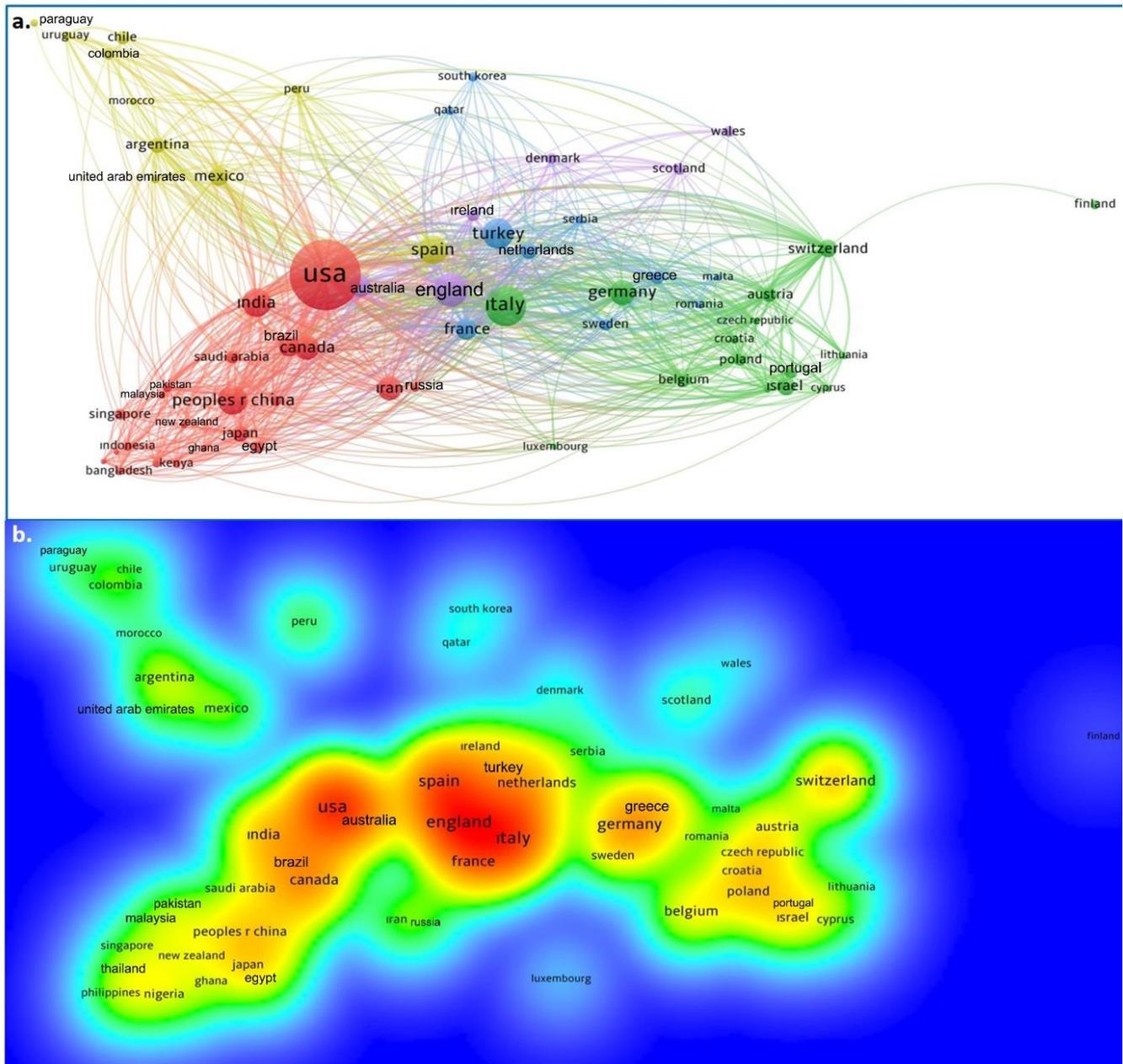
Figure 2.a. Network visualization map of cluster analysis showing cooperation between countries on COVID-19 in Pediatrics. Footnote: Clustering is indicated by the colours. The size of the circle indicates the large number of articles. The larger the size of the circle, the more articles the country publishes. **b.** Density map showing the intensity of international cooperation of countries on COVID-19 in Pediatrics. Footnote: The strength of the international collaboration score increases from blue to red (blue-green-yellow-red)

Table 1. The 68 most productive journals that have published more than 12 articles on COVID-19 in Pediatrics

Journals	RC	C	AC	Journals	RC	C	AC
Frontiers in Pediatrics	163	707	4.3	Journal of Pediatric Hematology Oncology	20	18	0.9
Pediatric Infectious Disease Journal	121	1646	13.6	Pediatric Transplantation	20	87	4.4
Pediatrics	106	4018	37.9	Acta Pediatrica de Mexico	19	7	0.4
Journal of Adolescent Health	75	1396	18.6	Translational Pediatrics	19	694	36.5
Children-Basel	73	269	3.7	World Journal of Pediatrics	19	454	23.9
American Journal of Perinatology	70	996	14.2	Case Reports in Pediatrics	18	43	2.4
Pediatric Pulmonology	67	972	14.5	Archives de Pediatrie	17	104	6.1
European Journal of Pediatrics	64	425	6.6	Journal of Human Lactation	17	117	6.9
Journal of the Pediatric Infectious Diseases Society	57	701	12.3	Journal of Pediatric Endocrinology & Metabolism	17	38	2.2
BMJ Paediatrics Open	46	97	2.1	Monatsschrift Kinderheilkunde	17	32	1.9
Clinical Pediatrics	46	52	1.1	Pediatric Emergency Care	17	55	3.2
Journal of Perinatal Medicine	46	293	6.4	Pediatric Radiology	17	230	13.5
Acta Paediatrica	44	268	6.1	Boletin Medico del Hospital Infantil de Mexico	16	9	0.6
Italian Journal of Pediatrics	43	148	3.4	Child and Adolescent Psychiatry and Mental Health	16	24	1.5
Journal of Paediatrics and Child Health	42	157	3.7	Journal of Perinatology	16	178	11.1
Archivos Argentinos de Pediatria	40	15	0.4	Pediatrics International	16	19	1.2
Indian Pediatrics	39	411	10.5	AJP Reports	15	45	3.0
Journal of Pediatrics	38	912	24.0	Anales de Pediatria	15	69	4.6
Archives of Disease in Childhood	33	287	8.7	Breastfeeding Medicine	15	89	5.9
Cardiology in the Young	30	56	1.9	Child Psychiatry & Human Development	14	174	12.4
International Journal of Pediatric Otorhinolaryngology	30	174	5.8	Journal of Pediatric Surgery Case Reports	14	82	5.9
BMC Pediatrics	29	191	6.6	Journal of Pediatric Intensive Care	14	7	0.5
Pediatric Blood & Cancer	29	255	8.8	Pediatric Nephrology	14	138	9.9
Pediatric Allergy and Immunology	26	268	10.3	Journal of Pediatric Rehabilitation Medicine	13	37	2.8
JAMA Pediatrics	25	1255	50.2	Pediatria I Medycyna Rodzinna-Paediatrics and Family Medicine	13	1585	121.9
Pediatric Dermatology	25	383	15.3	Pediatric Reports	13	22	1.7
Pediatric Research	23	92	4.0	Pediatric Surgery International	13	21	1.6
Pediatric Critical Care Medicine	22	212	9.6	Revista Chilena de Pediatria-Chile	13	6	0.5
European Child & Adolescent Psychiatry	21	778	37.0	Indian Journal of Pediatrics	13	154	11.8
Journal of Tropical Pediatrics	21	22	1.0	International Journal of Pediatrics-Mashhad	13	4	0.3
Lancet Child & Adolescent Health	21	1480	70.5	Journal of Aapos	12	82	6.8
Pediatric Anesthesia	21	46	2.2	Pediatric Cardiology	12	179	14.9
Pediatric Annals	21	26	1.2	Pediatric Clinics of North America	12	9	0.8
Journal of Pediatric Gastroenterology and Nutrition	20	203	10.2	International Journal of Paediatric Dentistry	12	76	6.3

Citation Analysis

The first 25 articles with the highest amount of citations (according to the overall number of citations) among the 2540 COVID-19 articles published in Pediatrics are shown in Table 2. In addition, the last column of Table 2 gives the annual average number of citations received by each study.

Co-citation Analysis

There were a total of 37035 studies cited in the references section of all 2540 articles published on COVID-19 in Pediatrics. Among these studies, the 5 most influential studies with more than 150 citations and the most co-citations were Dong et al. (2020) (Number of citation: NC=428), Lu et al. (2020) (NC=241), Bialek et al. (2020) (NC=180), Ludvigsson (2020) (NC=172), and Riphagen et al. (2020) (NC=156), respectively [1,25-27,9].

Trending Topics

The 3491 different keywords were used in all 2540 articles published on COVID-19 in Pediatrics. Among these keywords, 95 different keywords used in at least 10 different articles are shown in **Table 3**.

Figure 3 shows the cluster network visualization map displaying the outcomes of the clustering analysis carried out between these keywords. As a result of the cluster analysis, it was determined that the COVID-19 topics in the Pediatrics research area formed 6 different clusters (Cluster 1: red colour, Cluster 2: green colour, Cluster 3: blue colour, Cluster 4: yellow colour, Cluster 5: purple colour, Cluster 6: turquoise colour). **Figure 4.a** displays a trend network visualization map that was created to determine trend subjects. **Figure 4.b** displays a visualization of the citation network created to determine the most cited subjects.

Table 2. The top 25 most cited articles on COVID-19 in Pediatrics by total number of citations

No	Article	Author	Journal	PY	TC	AC
1	Epidemiology of COVID-19 among children in China	Dong Y. et al.	Pediatrics	2020	1877	625.7
2	Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected. Interim guidance	World Health Organization	Pediatria I Medycyna Rodzinna-Paediatrics and Family Medicine	2020	1584	528
3	Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia	Zhu H. et al.	Translational Pediatrics	2020	658	219.3
4	Clinical and CT features in pediatric patients with COVID-19 infection: Different points from adults	Xia W. et al.	Pediatric Pulmonology	2020	515	171.7
5	Coronavirus infections in children including COVID-19 an overview of the epidemiology, clinical features, diagnosis, treatment and prevention options in children	Zimmermann P. et al.	Pediatric Infectious Disease Journal	2020	450	150
6	COVID-19 in children and adolescents in Europe: a multinational, multicentre cohort study	Goetzinger F. et al.	Lancet Child & Adolescent Health	2020	427	142.3
7	Characteristics and outcomes of children with coronavirus disease 2019 (COVID-19) infection admitted to US and Canadian pediatric intensive care units	Shekerdemian LS. et al.	JAMA Pediatrics	2020	390	130
8	Prevalence and socio-demographic correlates of psychological health problems in Chinese adolescents during the outbreak of COVID-19	Zhou SJ. et al.	European Child & Adolescent Psychiatry	2020	341	113.7
9	Clinical features of severe pediatric patients with coronavirus disease 2019 in Wuhan: a single center's observational study	Sun D. et al.	World Journal of Pediatrics	2020	308	102.7
10	Severe COVID-19 during pregnancy and possible vertical transmission	Claudia AM. et al.	American Journal of Perinatology	2020	288	96
11	Well-being of parents and children during the COVID-19 pandemic: a national survey	Patrick SW. et al.	Pediatrics	2020	244	81.3
12	Epidemiology, clinical features, and disease severity in patients with coronavirus disease 2019 (COVID-19) in a children's hospital in New York city, New York	Zachariah P. et al.	JAMA Pediatrics	2020	203	67.7
13	Multisystem inflammatory syndrome in children during the coronavirus 2019 pandemic: a case series	Chiotos K. et al.	Journal of the Pediatric Infectious Diseases Society	2020	198	66
14	Infants born to mothers with a new coronavirus (COVID-19)	Chen Y. et al.	Frontiers in Pediatrics	2020	190	63.3
15	Intensive care admissions of children with paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 (PIMS-TS) in the UK: a multicentre observational study	Davies P. et al.	Lancet Child & Adolescent Health	2020	178	59.3
16	Clinical characteristics and outcomes of hospitalized and critically Ill children and adolescents with coronavirus disease 2019 at a tertiary care medical center in New York city	Chao JY. et al.	Journal of Pediatrics	2020	156	52
17	Placental pathology in COVID-19 positive mothers: preliminary findings	Baergen RN. and Heller DS.	Pediatric and Developmental Pathology	2020	156	52
18	Multisystem inflammatory syndrome in children associated with severe acute respiratory syndrome coronavirus 2 infection (MIS-C): a multi-institutional study from New York city	Kaushik S. et al.	Journal of Pediatrics	2020	143	47.7
19	Pediatric severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): clinical presentation, infectivity, and immune responses	Yonker LM. et al.	Journal of Pediatrics	2020	141	47
20	Transmission of SARS-CoV-2 in Australian educational settings: a prospective cohort study	Macartney K. et al.	Lancet Child & Adolescent Health	2020	141	47
21	Initial challenges of caregiving during COVID-19: caregiver burden, mental health, and the parent-child relationship	Russell BS. et al.	Child Psychiatry & Human Development	2020	140	46.7
22	Adolescents' motivations to engage in social distancing during the COVID-19 pandemic: associations with mental and social health	Oosterhoff B. et al.	Journal of Adolescent Health	2020	140	46.7
23	Clinical characteristics of novel coronavirus disease 2019 (COVID-19) in newborns, infants and children	Hong H. et al.	Pediatrics and Neonatology	2020	140	46.7
24	Two X-linked agammaglobulinemia patients develop pneumonia as COVID-19 manifestation but recover	Soresina A. et al.	Pediatric Allergy and Immunology	2020	137	45.7
25	COVID-19 in children, pregnancy and neonates: a review of epidemiologic and clinical features	Zimmermann P. and Curtis N.	Pediatric Infectious Disease Journal	2020	135	45
26	Paediatric inflammatory multisystem syndrome: temporally associated with SARS-CoV-2 (PIMS-TS): cardiac features, management and short-term outcomes at a UK tertiary paediatric hospital	Ramcharan T. et al.	Pediatric Cardiology	2020	134	44.7
27	Chest computed tomography in children with COVID-19 respiratory infection	Li W. et al.	Pediatric Radiology	2020	131	43.7

PY: Publication year, TC: Total citation, AC: Average citations per year

Table 3. The 95 most frequently used keywords in articles on COVID-19 in Pediatrics

| Keywords	Number of uses	Keywords	Number of uses	Keywords	Number of uses
COVID-19	1420	neonates	22	emergency department	14
SARS-CoV-2	504	COVID	21	management	14
children	366	myocarditis	21	outbreak	14
coronavirus	184	case report	20	pandemics	14
pandemic	159	mortality	20	virology	14
pediatrics	114	paediatrics	20	PIMS-TS	13
coronavirus disease 2019	96	adolescent health	19	quality of life	13
pregnancy	92	education	19	treatment	13
pediatric	91	outcome	19	obesity	12
epidemiology	79	public health	19	personal protective equipment	12
adolescents	73	social distancing	19	quarantine	12
telemedicine	62	stress	19	resilience	12
breastfeeding	61	asthma	18	simulation	12
mental health	59	multisystem inflammatory syndrome	18	transmission	12
COVID-19 pandemic	56	survey	18	young adults	12
child	54	vaccination	18	infants	11
anxiety	50	computed tomography	17	infection	11
MIS-C	47	school	17	lactation	11
newborn	45	screen time	17	multisystem inflammatory syndrome in children (MIS-C)	11
vertical transmission	44	screening	17	prematurity	11
lockdown	41	vaccine	17	qualitative research	11
severe acute respiratory syndrome coronavirus 2	41	parents	16	antibodies	10
telehealth	41	SARS-CoV2	16	coronavirus infections	10
kawasaki disease	38	appendicitis	15	diagnosis	10
neonate	33	coronavirus disease 2019 (covıd-19)	15	paediatric	10
pneumonia	33	hospitalization	15	pediatric emergency department	10
depression	32	neonatology	15	pediatric intensive care unit	10
adolescent	29	pediatric surgery	15	SARS-CoV-2 infection	10
infant	29	sleep	15	school closure	10
health services research	28	type 1 diabetes	15	seroprevalence	10
multisystem inflammatory syndrome in children	24	congenital heart disease	14	trauma	10
physical activity	24	critical care	14		
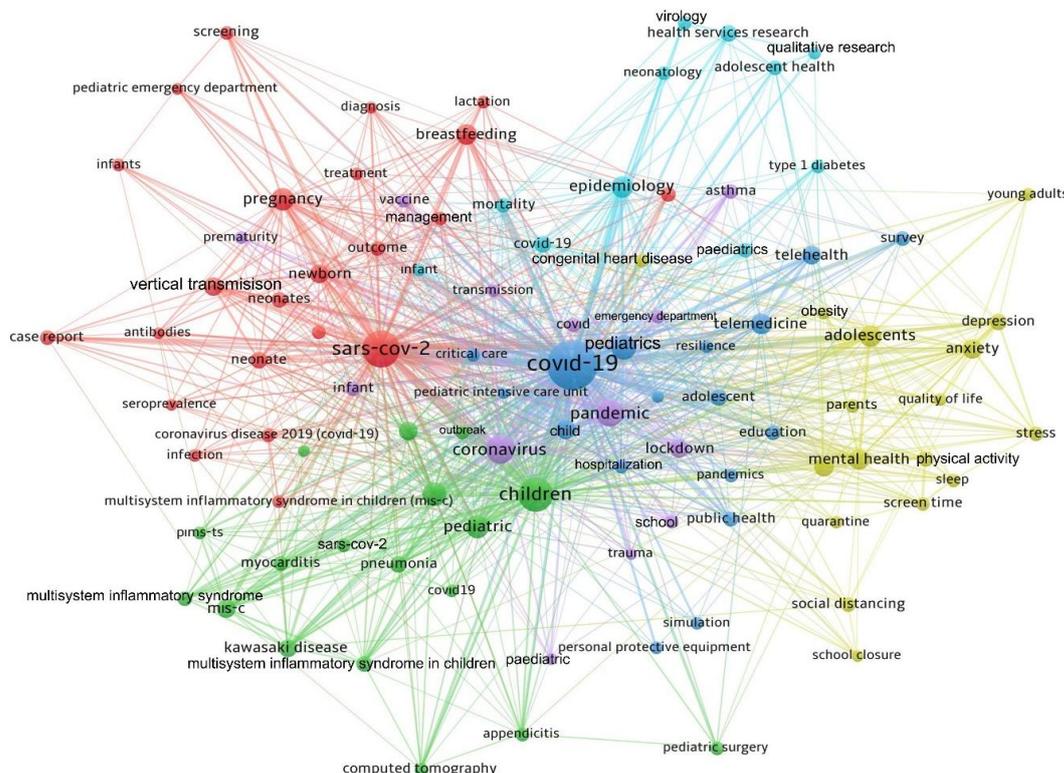
Figure 3. Network visualization map for cluster analysis based on keyword analysis performed to identify clustering of COVID-19 in Pediatrics. Footnote: Clustering is indicated by the colours. Keywords in the same cluster are of the same colour. The size of the circle represents the number of times the keyword has been used.

Figure 4. a. Network visualization map based on keyword analysis to reveal past and current trends on COVID-19 in Pediatrics. Footnote: The indicator in the figure's lower right corner changes from blue to red as the article's currentness (blue-green-yellow-red). The number of uses of the keyword is represented by the size of the circle. **b.** Network visualization map based on keyword analysis performed to identify the most cited topics on COVID-19 in Pediatrics. **Footnote:** The indicator in the figure's lower right corner changes from blue to red as the topic receives more citations (blue-green-yellow-red). The number of uses of the keyword is represented by the size of the circle.

DISCUSSION

Looking at the distribution of publications among the countries, 13 of the top 20 active countries that contributed the most to the literature by producing articles on COVID-19 in pediatrics were the developed countries (the USA, Italy, the UK, Spain, Germany, Canada, Australia, France, Israel, Switzerland, Netherlands, Japan, and Austria). Among the 20 active countries, there were 7 developing countries with large economies (Turkey, China, India, Iran, Brazil, Mexico, and Argentina). When the results of the correlation analysis are evaluated, it can be argued that article productivity has a high level of correlation with GDP and GDP per capita values, and a moderate correlation with HDI values. In addition, the economic size and development level of countries are effective in publication productivity. It is thought that the reason why Turkey, China, India, Iran, Brazil, Mexico, and Argentina are among the 20 most active countries is related to the high prevalence of COVID-19 in these countries in addition to economic development. According to the density map obtained based on the overall cooperation score among the nations, it was observed that the nations that cooperated most intensively were the USA, the UK, Italy, Spain, Germany, Switzerland, France, India, Canada, and Australia. This could be explained by the scientific development of these countries and the high number of infected populations during the pandemic. When the international collaboration of countries concerning COVID-19 in pediatrics was examined, collaborations were observed between countries with no geographical neighbors (the USA, Canada, China, India, and Japan); however, it was determined that collaboration based on the geographical neighborhood was primarily effective in research carried out during the pandemic (Italy, Germany, Belgium, Austria, Switzerland, Poland, Croatia, and the Czech Republic), (England, Ireland, Wales, Scotland, and Denmark), (Paraguay, Uruguay, Chile, Colombia, Argentina, Mexico, and Peru), (Turkey and Greece).

The Journals with the highest number of articles on COVID-19 in pediatrics were found to be Frontiers in Pediatrics, Pediatric Infectious Disease Journal, Pediatrics, Journal of Adolescent Health, Children-Basel, American Journal of Perinatology, Pediatric Pulmonology, European Journal of Pediatrics, and Journal of the Pediatric Infectious Diseases Society. We may suggest that researchers conducting studies to publish on COVID-19 in pediatrics consider the journals presented in Table 1, particularly the journals mentioned above. Looking at the citation analysis results of the journals, the most influential journals based on the mean number of citations per article published were Pediatria i Medycyna Rodzinna-Paediatrics and Family Medicine, Lancet Child & Adolescent Health, JAMA Pediatrics, Pediatrics, European Child & Adolescent Psychiatry, Translational Pediatrics, Journal of Pediatrics, World Journal of Pediatrics, Journal of Adolescent Health, Pediatric Cardiology, Pediatric Cardi Pediatric Pulmonology, and the American Journal of Perinatology. We may advise researchers to take priority on these journals if they want their published papers to receive more citations.

When the articles under consideration were assessed based on the overall number of citations and the annual average number of citations, it was determined that the influential study with the highest number of citations was the study of Dong et al. (2020) entitled "Epidemiology of COVID-19 among children in China", which was published in Pediatrics [1]. The second most effective study was the guideline of the World Health Organization (WHO, 2020), which was entitled "Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: Interim guidance" and published in Pediatria I Medycyna Rodzinna-Paediatrics and Family Medicine [2]. The third most effective study was the article by Zhu et al. (2020), which was entitled "Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia" and published in Translational Pediatrics [14]. The fourth most effective study was the article by Xia et al. (2020), which was entitled "Clinical and CT features in pediatric patients with COVID-19 infection: Different points from adults" and published in Pediatric Pulmonology [28]. The fifth most effective study was the article by Zimmermann et al (2020) entitled "Coronavirus infections in children including COVID-19 an overview of the epidemiology, clinical features, diagnosis, treatment and prevention options in children", which was published in the Pediatric Infectious Disease Journal [29]. According to the numbers of co-citations concerning the articles analysed, the studies conducted by Dong et al. (2020), Lu et al. (2020), Bialek et al. (2020), Ludvigsson (2020), and Riphagen et al. (2020) were determined as the most effective studies [1,25-27,9]. We can suggest that pediatric medical professionals and academics who are interested in this topic read these works.

When the results of the keyword analysis were evaluated, the cluster analysis concluded that the subject of COVID-19 in pediatrics formed 6 different main clusters (General subjects that the clusters were divided into were as follows: 1: pregnancy/breastfeeding/vertical transmission/newborn/neonates (red), 2: epidemiology/mortality (turquoise), 3: telemedicine/telehealth (blue), 4: MIS-C/Kawasaki disease (green), 5: lockdown (purple), 6: adolescent/mental health/anxiety/depression (yellow)). The most cited keywords were determined as vertical transmission, neonates, adolescents, anxiety, depression, a multisystem inflammatory syndrome in children, PIMS-TS (Paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2), social distancing, quarantine, infection, epidemiology, infant, treatment, outcome, management, pregnancy, and Kawasaki Disease. Based on the analysis findings to explore trend subjects, it can be said that the keywords researched in recent months are screen time, sleep, physical activity, Type 1 diabetes, obesity, vaccine, neonatology, congenital heart disease, qualitative research, school closure, pediatric emergency medicine, lockdown, stress, telehealth, asthma, lactation, multisystem inflammatory syndrome, trauma, antibodies, and infants.

We did not find an exhaustive bibliometric study on COVID-19 in pediatrics as a consequence of our literature search. However, we found 3 different studies related to COVID-19 in pediatrics. In the study of Monzani et al. (2021), bibliometric research was conducted on COVID-19 in the pediatric population between January 1, 2020, and June 11, 2020 [20]. COVID or coronavirus and pediatric or child or children or adolescent were used as keywords in this study. The limitation of this study was that keywords such as SARS-CoV-2, nCoV were not used, and keywords related to pediatrics were used instead of including all studies labelled

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in the field of pediatric research. We can argue that our study was superior to this study in terms of the time, scope, and additional statistical analyses. The study of Morand et al. (2021) performed the bibliometric analysis of only the diseases similar to Kawasaki (MIS-C, PIMS-TS) associated with ARS-CoV-2 [21]. In the study conducted by Grover et al. (2021), bibliometric research was conducted on the impact of COVID-19 on the mental health of children and adolescents [22]. We can argue that the study conducted on the subject was superior to these studies in terms of both time and scope.

The fact that only the WoS was utilized in the literature search could be listed as the limitation of this study. However, citation and co-citation analyses cannot be done using the PubMed. In addition, the Scopus has also indexed Journals with low impact [17,18]. WoS indexes articles published in journals with higher impact (only the journals indexed in the SCI-expanded, ESCI, and SSCI index) compared to the other databases [19,30,31].

CONCLUSION

In this bibliometric research on COVID-19 in Pediatrics, we shared the statistical analysis on 2540 articles published since the beginning of the pandemic. Based on the analysis findings to explore trend subjects, it can be said that the keywords researched in recent months are screen time, sleep, physical activity, Type 1 diabetes, obesity, vaccine, neonatology, congenital heart disease, qualitative research, school closure, and pediatric emergency medicine. More information will be obtained about COVID-19 with the increasing number of articles on pediatrics. Children can be an important target group for the transmission of infection and for measures to be taken to manage the outbreaks. The unintended consequences of pandemic management measures implemented against COVID-19 infection should be examined carefully in terms of the children and their families in the entire world. According to the global productivity findings on COVID-19 in pediatrics, we believe that countries with poor economic development should be supported in terms of research on COVID-19 in pediatrics. Regarding the global COVID-19 output in pediatrics, this article may be a helpful resource for pediatricians, pediatric surgeons, and scientists.

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