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 were 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 techniques [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 techniques.

**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 1.16.16, 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  |
|--------------------------------------------------------------------------|-----|-------|-----|
| Frontiers in Pediatrics                                                  | 163 | 707   | 4.3 |
| Pediatric Infectious Disease Journal                                     | 121 | 1646  | 13.6|
| Pediatrics                                                               | 106 | 4018  | 37.9|
| Journal of Adolescent Health                                             | 75  | 1396  | 18.6|
| Children-Basel                                                           | 73  | 209   | 3.7 |
| American Journal of Perinatology                                         | 70  | 996   | 14.2|
| Pediatric Pulmonology                                                    | 67  | 972   | 14.5|
| European Journal of Pediatrics                                           | 64  | 425   | 6.6 |
| Journal of the Pediatric Infectious Diseases Society                     | 57  | 701   | 12.3|
| BMJ Paediatrics Open                                                     | 46  | 97    | 2.1 |
| Clinical Pediatrics                                                      | 46  | 52    | 1.1 |
| Journal of Perinatal Medicine                                            | 46  | 293   | 6.4 |
| Acta Paediatrica                                                         | 44  | 268   | 6.1 |
| Italian Journal of Pediatrics                                           | 43  | 148   | 3.4 |
| Journal of Paediatrics and Child Health                                  | 42  | 157   | 3.7 |
| Archivos Argentinos de Pediatria                                        | 40  | 15    | 0.4 |
| Indian Pediatrics                                                        | 39  | 411   | 10.5|
| Journal of Pediatrics                                                    | 38  | 912   | 24.0|
| Archives of Disease in Childhood                                         | 33  | 287   | 8.7 |
| Cardiology in the Young                                                  | 30  | 56    | 1.9 |
| International Journal of Pediatric Otorhinolaryngology                   | 30  | 174   | 5.8 |
| BMC Pediatrics                                                           | 29  | 191   | 6.6 |
| Pediatric Blood & Cancer                                                 | 29  | 255   | 8.8 |
| Pediatric Allergy and Immunology                                         | 26  | 268   | 10.3|
| JAMA Pediatrics                                                          | 25  | 1255  | 50.2|
| Pediatric Dermatology                                                    | 25  | 383   | 15.3|
| Pediatric Research                                                       | 23  | 92    | 4.0 |
| Pediatric Critical Care Medicine                                         | 22  | 212   | 9.6 |
| European Child & Adolescent Psychiatry                                   | 21  | 778   | 37.0|
| Journal of Tropical Pediatrics                                           | 21  | 22    | 1.0 |
| Lancet Child & Adolescent Health                                         | 21  | 1480  | 70.5|
| Pediatric Anesthesia                                                     | 21  | 46    | 2.2 |
| Pediatric Annals                                                         | 21  | 26    | 1.2 |
| Journal of Pediatric Gastroenterology and Nutrition                      | 20  | 203   | 10.2|

**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     | Pediatrics          | 2020 | 1584 | 528  |
| 3  | Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia | Zha 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                                       | 304            | 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   | 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             | coronaviruses 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                         | 24             | congenital heart disease              | 14             | trauma                                          | 10             |
| syndrome in children                             |                |                                       |                |                                                 |                |
| physical activity                                 | 24             | critical care                         |                |                                                 |                |

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.

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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 Pediatrics 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 Pediatric 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.
in the field of pediatric research. We can argue that our study was superior to this study in terms of the 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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