Title: The Effects of COVID-19 on the World Trend of Childhood Vaccination: A Systematic Review

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Abstract

Background: The global COVID-19 epidemic has significantly impeded children's vaccination programs, endangering the public's health. Concerns have risen about the impact on vaccination coverage rates and the need for effective strategies to overcome these obstacles.

Objective: The aim of this study is to comprehend COVID-19's effects on the worldwide trend of childhood immunization.

Methods: A comprehensive search of the Web of Science database was conducted, covering the period from January 2020 to July 2023. The keywords used in English were TS = (("SARS-CoV-2" OR "COVID-19" OR "coronavirus") AND ("pediatric immunization" OR "childhood vaccination" OR "vaccine coverage")). Two authors independently assessed each study that satisfied the inclusion criteria. The PRISMA checklist guided the systematic review process, and VOSviewer software was used for bibliometric analysis.

Results: The initial search yielded 624 articles, leaving 62 articles for analysis. The most frequent keyword searches were COVID-19 (n = 37, Total Ling Strength =78). America was the most productive country (Documents n = 19, Citations =411). Furthermore, visualization mapping shows that The Journal of Vaccine was the top source, with Total Ling Strength = 1560 and citations =139. The disruptions were multifaceted and resulted from factors such as changes in vaccination coverage rates, vaccine hesitancy, missed or delayed vaccinations, catch-up immunization efforts, and disruptions to routine immunization programs. Declines in vaccination coverage were observed for various vaccines, including measles, polio, and diphtheria-tetanus-pertussis.

Conclusions: The results show the critical need for action to minimize the COVID-19 pandemic's negative effects on childhood immunization. Policymakers and healthcare providers should prioritize restoring and strengthening immunization services, addressing vaccine hesitancy, and implementing catch-up vaccination programs.

Key words: COVID-19, Immunization programs, Global health, Vaccination, Child

Introduction

Vaccination stands as a cornerstone in the edifice of public health, playing a pivotal role in mitigating the spread of infectious diseases and averting their potentially severe consequences (1). The development and health of youngsters are positively impacted by vaccinations. According to data released by the World Health Organization (WHO), pediatric immunization prevents 2.5 million deaths globally each year in children under the age of five (2). As we confront new public health challenges and infectious agents, the continued importance of vaccination in preserving the well-being of populations cannot be overstated (3). The global coronavirus disease 2019 pandemic, which began as a localized outbreak in December 2019, has over 634 million confirmed cases and around 6.6 million fatalities as of November 2022 (4)(5). Early in 2020, when SARS-CoV-2 spread quickly over the world and governments worked to stop the spread, many health systems, including regular immunization, experienced major interruptions. These impacts were a result of a number of variables, including travel restrictions and laws intended to limit interaction with others and socializing, cancellation or postponement of patient appointments, as well as the deployment of medical staff for the COVID-19 reaction due to viral exposure worries, among others (6) (7)(8). The COVID-19 pandemic has significantly impacted public health, economic systems, socio-cultural patterns, and political institutions. Negative effects include halting routine vaccination programs due to resource demands and quarantine measures. Uptake is impacted for older children, while positive effects include influencing people's perceptions of vaccination (9). The World Health Organization (WHO) recently performed a national pulse survey with 135 participating nations, and it was revealed that 94% of the countries that responded suffered an interruption of essential healthcare services from January to March 2021 (10). The suspension of immunization programs in more than 68 countries has put at least 80 million infants under the age of one in danger, according to information compiled by the WHO, UNICEF, and the Sabin Vaccine Institute. (11) (12) In addition, the WHO estimates that the COVID-19 epidemic prevented 23 million youngsters from receiving their immunizations in 2020 (13). Between January and December 2020, 30.0 million children failed to receive the third dose of the diphtheria, tetanus, and pertussis vaccination, and 27.2 million youngsters failed to receive the

first dose of the vaccine that contained measles (14). In Pakistan and Afghanistan, there have been several reports of polio and diphtheria (15) (16), and instances of illnesses that may be prevented by vaccination, such as measles, diphtheria, and pertussis, have increased outbreaks that are making headlines. Measles cases are increasing globally (17)(18). These outbreaks serve as a stark reminder that public health concerns are just as important, if not more so, during pandemics. The significance of preserving vital health services, including vaccination, has been emphasized by drawing on analyses of historical and epidemiological data as well as information from current modelling efforts (19). One of the most efficient and affordable public health programs that might lower the rates of morbidity and death for illnesses that can be prevented by vaccination is childhood immunization (20). In this article, we discuss probable COVID-19 pandemic consequences on global immunization rates as well as possible causes. The findings of this study would offer insight on how pandemics affect existing immunization efforts and help to design policies for effective future pandemic and other crisis preparation.

Materials and Methods

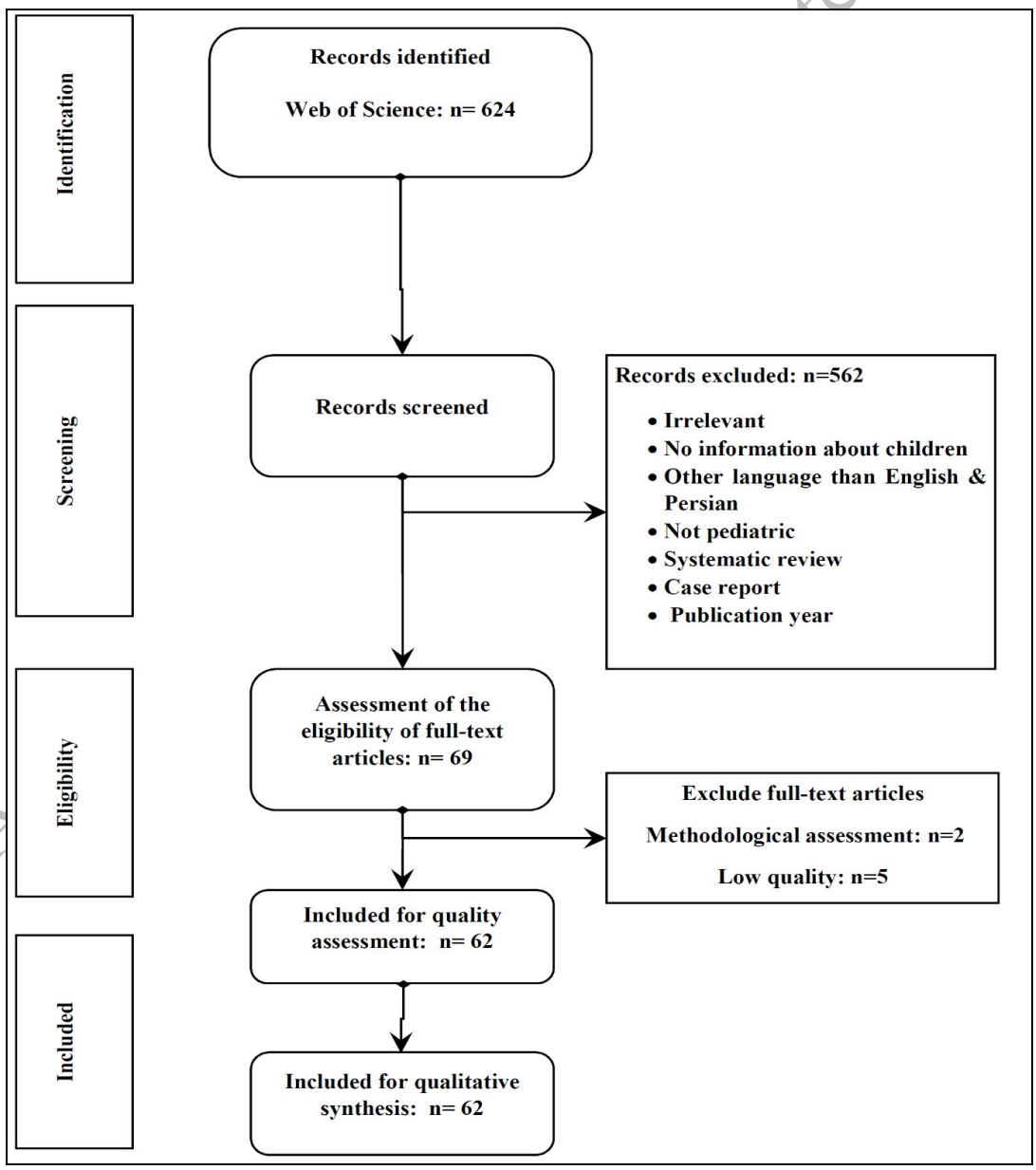
It is necessary to assess the field's cumulative advancements and keep track of the current level of knowledge in this area because of the rising volume of literature on COVID-19 and childhood vaccination. We used the PRISMA checklist to ensure that the systematic review's reporting was of high quality (21), which is available at http://prisma-statement.org/PRISMAstatement/checklist.aspx. The checklist, which includes four sequential processes (identification, screening, eligibility, and inclusion) and 27 elements, is intended to help writers perform more effective systematic reviews (see Figure 1). In addition, the scientific literature was visualized and analysed using VOSviewer, a popular piece of software for bibliometric research.

Search Technique

Between January 1st, 2020, and July 13th, 2023, a comprehensive search of pertinent literature was conducted on the Web of Science. The keywords used in English were TS = (("SARS-CoV-2" OR

"COVID-19" OR "coronavirus") AND ("pediatric immunization" OR "childhood vaccination" OR "vaccine coverage")). The initial search yielded 624 articles, out of which 569 were removed for not meeting the inclusion criteria, leaving 62 articles for analysis. Downloads were made of the "Full Record and Cited References" for these publications, so that we may use them as input data for our VOSviewer-based bibliometric analysis and science mapping. The main applications of VOSviewer in this review research were the analysis of word co-occurrences, citations, and bibliographies.

Figure 1. The PRISMA guidelines-compliant study selection procedure is shown in the flow diagram.



Inclusion Criteria

Studies were eligible for inclusion if they: 1) were clinical trials, observational, quasi-experimental, and qualitative studies; 2) studies investigating the worldwide effects of COVID-19 on childhood immunization; 3) studies reporting on vaccination coverage rates, vaccine hesitancy, missed or delayed vaccinations, catch-up immunization efforts, and disruptions to routine immunization programs; 4) were published from 2020 to 2023 in English; and 5) had a code of ethics.

Exclusion Criteria

Exclusion criteria were: 1) lack of access to full texts; 2) individual case reports, systematic reviews, and meta-analyses; and 3) unrelated objectives. The PRISMA guidelines were followed to ensure a rigorous and transparent review process.

Quality Assessment of the Articles

A critical appraisal was performed according to the study design of the articles. The Critical Appraisal Skills Program (CASP) was used for analysis. To ensure consistency and reliability in the critical appraisal process, two independent reviewers conducted the assessments. Any discrepancies in their evaluations were resolved through consensus, guaranteeing a thorough and unbiased analysis.

Extraction of data

The PRISMA guidelines were followed to ensure a rigorous and transparent review process. In order to ensure comprehensive coverage of relevant articles, a thorough manual search of relevant publications was conducted. The screening process was carried out using EndNote X7 (Clarivate Analytics). Data was extracted from the final set of included full texts, encompassing information such as the first author, publication year, research design, geographic location, objectives, sample size, age range of children included, changes in vaccination coverage rates, strategies to cope, and key results related to the effect of COVID-19 on the global trend of childhood immunization (Table 1).

Table 1. : features the included some studies

no	Reference	Study ID	Article Title	Design	Aim (s)	Sample size	Participants	country	Type of challenge	Strategies to cope	Main Results
1	(22)	(Aguinaga-Ontoso et al., 2023)	A Join point Regression Analysis of COVID-19's Effect on DTP Vaccination Trends in Africa	Retrospective Study	Analyse the patterns of DTP3 vaccine coverage in Africa (2012–2021).	10 countries	African children	Africa	The vaccination rate decreased in several regions of Sub-Saharan Africa, especially in Eastern and Southern Africa.	-	DTP3 coverage decreased from 2019 to 2021.
2	(23)	(Gelagay et al., 2023)	At the Dabat demographic and health survey location in Ethiopia, 2022, All recommended immunizations have been given to youngsters 12 to 23 months old.	Cross-sectional Study	Analyze the Dabat district's level of full childhood immunization coverage and any related factors.	857 mothers with 12–23 months old children	children aged 12 to 23 months	Ethiopia	Lower vaccination rates in Dabat district are a result of the COVID-19 epidemic and systemic disturbances.	provide more immunization services in rural locations	Lower vaccination rates in Dabat district are a result of the COVID-19 epidemic and systemic disturbances.
3	(24)	(Luchesi et al., 2023)	Vaccination Against Influenza and Some Risk Factors During the COVID-19 Pandemic	Cross-sectional Research	Examine the prevalence of influenza vaccination and variables that may affect the vaccine	380	-	Brazil	Pandemic of COVID-19 and related issues impacting vaccination	-	Data indicate that influenza vaccination coverage in 2020 fell short of what Brazilian officials had advised.
4	(25)	(Martinez-Marcos et al., 2023)	A public health register-based research examined how COVID-19 shutdown affected the percentage of children in Catalonia (Spain) who received their recommended childhood vaccinations.	Register-Based Study	Analyse the impact of the COVID-19 pandemic lockdown on the percentage of children in Catalonia (Spain) who received their recommended childhood	393 primary care centres	Routine childhood vaccination recipients	Catalonia (Spain)	Routine children vaccination coverage rates are impacted by the COVID-19 pandemic and related lockdown measures. .	Strategies for immediate and long-term assistance in restoring and maintaining routine childhood immunization coverage.	The lock down steady vaccination rates; post-lockdown drops in vaccination rates, notably for measles, mumps, and rubella. Pertussis.

no	Reference	Study ID	Article Title	Design	Aim (s)	Sample size	Participants	country	Type of challenge	Strategies to cope	Main Results
					vaccinations.						
5	(26)	(Saidu et al., 2023)	Effects of the COVID-19 Pandemic on Cameroon's Regular Childhood Immunization Coverage	A Cross-Sectional Study	Investigate the effects of COVID-19 pandemic on children vaccination in Cameroon's hotspot regions and give context-specific information for planning immunization recovery.	specifically, 32 from the Centre Region and 24 from the Littoral Region	Children receiving DTP vaccines	Cameroon	Pandemic of COVID-19 and issues with children vaccinations	Informing policy on future pandemic preparedness and response, building an immunization recovery strategy, and continuing to provide vaccination services during public health emergency	Across the country, DTP-1 and DTP-3 coverage rose, although hotspot locations saw a decline in availability, necessitating context-specific recovery programs.
6	(27)	(Humble et al., 2023)	A national longitudinal research examined how the COVID-19 pandemic affected parents' attitudes toward and acceptance of regular children immunization in Canada.	Longitudinal Analysis	Determine how Canadian parents' attitudes on routine childhood vaccinations	650	Canadian parents	Canada	the COVID-19 pandemic's effects on routine childhood vaccination	tailored marketing tactics for certain vaccinations that assist parents in making decisions	Between December 2020 and November/December 2021, parents' trust in routine kid vaccinations grew thanks to higher engagement and lower stress.
7	(28)	(Khan et al., 2022)	A cross-sectional analysis of parental attitudes and obstacles to childhood COVID-19 vaccination in Saudi Arabia	a web-based cross-sectional survey from February to March	Examine impediments to paediatric vaccination	444	Parent	Saudi Arabia	Vaccination intentions and obstacles in children for COVID-19	addressing parents' vaccine-related worries	Due to worries about the safety and adverse effects of vaccinations, just 42% of parents intended to vaccinate their children.

no	Reference	Study ID	Article Title	Design	Aim (s)	Sample size	Participants	country	Type of challenge	Strategies to cope	Main Results
				2022							
8	(29)	(Deerin et al., 2022)	United States Indian Health Service evaluation of the Catch Up to Get Ahead program's attempts to administer the recommended kids vaccines during the COVID-19	Observational Study	Examine the impact of the COVID-19 pandemic on immunization rates for children in the US and the efficacy of the initiative. Catch Up to Advance, and take note of any challenges.	117 federal health centers	Children age range in the US: 19-35 months	USA	Due to the COVID-19 epidemic, regular children vaccination rates have decreased. .	The US Department of Health and Human Services (HHS) is putting its "Catch Up to Get Ahead" strategy into action to support regular childhood vaccination.	The combined 7-vaccination rate for children aged 19 to 35 months decreased albeit it declined less at IHS federal health centres.
9	(30)	(Melkonyan et al., 2022)	Effects of the pandemic on regular vaccination campaigns in Yerevan and COVID-19 vaccinations in Armenia	Retrospective Review	Examine how the COVID-19 epidemic has affected Yerevan's routine vaccines.	children	Children	Armenia	Regular vaccination programs being interrupted because of the COVID-19 pandemic.	Implementing catch-up immunizations and rapidly expanding vaccination programs.	Decrease in the number of regular vaccination doses delivered during the first wave, second wave, and vaccine delivery interruptions.
10	(31)	(Herdea et al., 2022)	Are We Ready for New Outbreaks? Vaccination of Children Under One Year of Age During High Epidemiological Risk Periods?	Retrospective Observational Cohort Study	Analyse the factors that influence parental vaccination practices and choices for young children	2,850 children from	Parents or legal guardians of infants aged 0-1 year.	Romania	Influencing vaccination rates and raising the danger of recurrence are the measles and COVID-19 pandemics. .	Family doctors speak with parents, resolve vaccine worries, and raise awareness through educational initiatives and federal regulations.	The analysis shows a drop in Romanian vaccination rates during the measles and COVID-19 pandemics, raising the possibility of further breakouts.

Questions and Research Objectives

This study conducted a systematic review and bibliometric analysis to investigate the impact of COVID-19 on the global trend of child immunization in light of the rapidly expanding requirements during the pandemic. In order to address the difficulties in maintaining children vaccination rates throughout the pandemic, the goal was to develop insights for important research issues, tactics, and policies. The available literature from 2020 to 2023 was analysed using statistical approaches. The following research questions (RQs) were utilized in our bibliometric analysis to examine the effect of COVID-19 on childhood immunization:

RQ1: How have worldwide child immunization rates been impacted by the COVID-19 pandemic?

RQ2: In terms of publications published and citations, what was the yearly frequency of research on the worldwide trend of child immunization during the COVID-19 pandemic?

Which representative nations or regions participated in the research on children immunizations for COVID-19?

RQ4: During the COVID-19 pandemic, what terms were most often used in studies on child immunization?

Results

Figure 1 presents an overview of the search strategy's outcomes. Initially, 624 articles were identified, and after screening, 562 references were excluded. 69 articles met the initial inclusion criteria based on their English titles, abstracts, and full texts. The inclusion and exclusion criteria were then carefully reviewed for the full texts of these 69 articles, resulting in the exclusion of 7 papers. Ultimately, 62 papers were included in this study, and information was systematically extracted from each paper, as presented in Table 1, which includes data on the first author, publication year, research design, geographic location, objectives, sampling size, age range of children included, changes in vaccination coverage rates, strategies to cope, and important results relating to the influence of COVID-19 on the global trend of child immunization. From the WoS database, a total of 62 items that qualified were discovered. For our bibliometric analysis and scientific mapping with VOSviewer, the "Full Record and Cited References" of these works were downloaded. In this review research,

VOSviewer was primarily used for citation analysis, bibliographic coupling, and word co-occurrence analysis (Table 2).

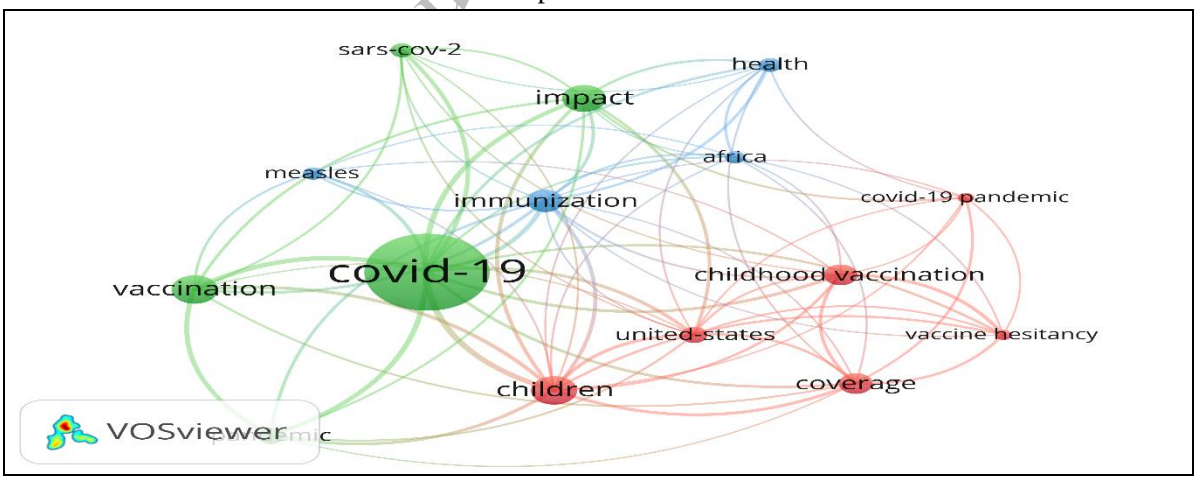
Table 2. An outline of articles published between 2020 and 2023 on childhood immunization during the COVID-19 pandemic

Category	N	%
Journals		
Vaccine	9	14.5%
Vaccines	6	9.7%
Front. Pediatr.	3	4.8%
Int. J. Environ. Res. Public Health	3	4.8%
Arch. Dis. Child.	2	3.2%
BMC Med.	2	3.2%
BMJ Open	2	3.2%
Expert Rev. Vaccines	2	3.2%
Human Vaccines Immunother.	2	3.2%
Other	31	50.0%
Country		
England	27	43.5%
Swiss	15	24.2%
United States	11	17.7%
Other	9	14.5%
Most Published Author		
Kitano, T	3	4.8%
Wang, Q	2	3.2%
Most Cited Author		
Abbas, K	164	18.0%
McDonald, HI	145	15.9%
Causey, K	97	10.6%
Daniels, V	41	4.5%
Urashima, M	36	3.9%
Sidiq, KR	34	3.7%
Bell, S	33	3.6%
de Chaisemartin, C	30	3.3%
Kinoshita, M	29	3.2%
Vogt, TM	23	2.5%
Moreno-Montoya, J	22	2.4%
Piche-Renaud, PP	21	2.3%
Sato, APS	19	2.1%
Kitano, T	18	2.0%
Alrabiaah, AA	16	1.8%
Yu, JH	15	1.6%
Other	170	18.6%
Publication Year		
2022	27	43.5%
2021	17	27.4%
2020	11	17.7%
2023	7	11.3%

Co-occurrence author keywords

The keywords assist in finding the most significant information associated with the study topics. The subjects that are most prevalent in publications in a certain field may be ascertained using the co-occurrence analysis of keywords (32). We conducted a keyword co-occurrence analysis using the VOSviewer. 228 keywords in all were looked up in WoS papers. In the WoS database, fifteen terms on this subject were displayed more than five times, as shown in Figure 2. COVID-19 is the most used keyword, with 37 repetitions. In the COVID-19 pandemic research, the terms "children," "vaccination," "impact," "coverage education," and "childhood vaccination" were each used more than 10–14 times. Furthermore, measles was important while considering childhood vaccination during the COVID-19 epidemic, as shown by the observation that it was used as a keyword six times. “United States" (used as a keyword eight times) and Africa (6 times) were also found to be significant. Meanwhile, Figure 2 shows the chronological order of the appearance of words from 2021 to 2022. that these words: vaccine, COVID-19, children, immunization, United States, childhood vaccination, coverage, and vaccine hesitancy appeared in the articles in order.

Figure 2. The most-used keywords of research on Childhood Vaccination during the COVID-19 pandemic.

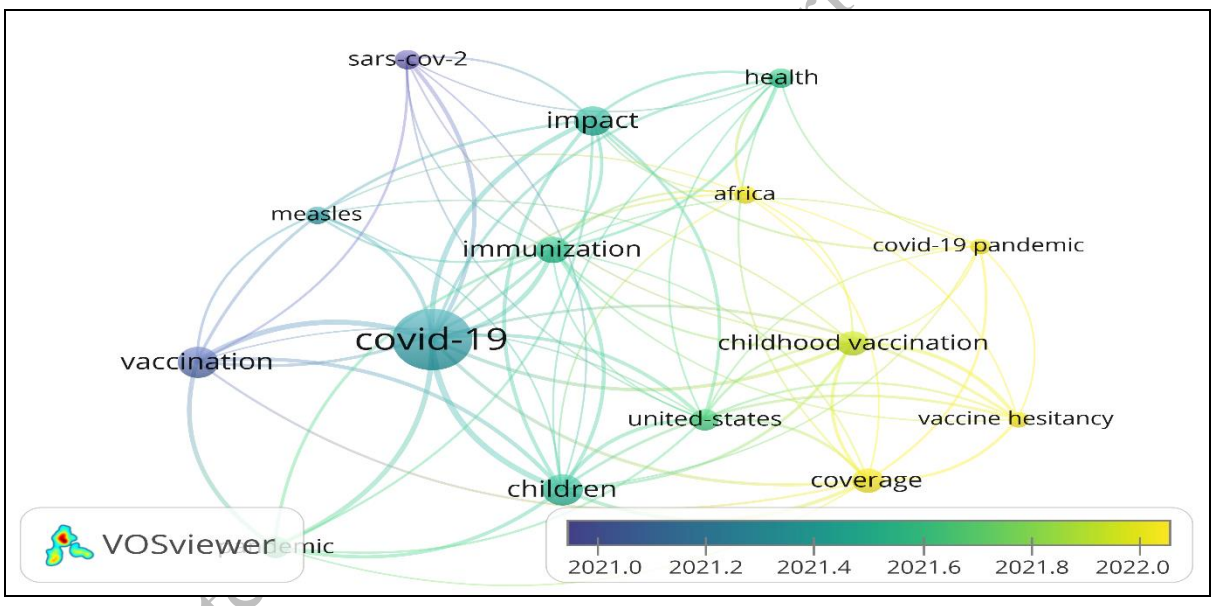


Keyword Clustering

We could identify and categorize concepts that are closely connected in the chosen literature because of their arrangement and connections between the main words. Three major groups were identified by

the study (Figure 3). The node size reflects the keyword frequency. The strength of connections between nodes is inversely correlated with the thickness of the interconnections between them. The research led to the formation of three groups. The words "COVID-19," “immunization," and "children" had the highest number of links and overall link strength. All three clusters had a total of 74 linkages, with a total link strength of 210. The two terms that predominated Cluster 1 (green) were COVID-19 and immunization. The topics in Cluster 2 (blue) were vaccination, measles, Africa, and health. Cluster 3(red) focused on children, childhood vaccination, coverage, vaccination hesitancy and the United States, which emerged as highly visible keywords.

Figure 3. The most frequent keywords for research on Childhood Vaccination during the COVID-19 pandemic Based on the chronological order.



Co-authorship Countries/Regions

During the COVID-19 epidemic, 47 countries conducted studies on child immunization according to WoS databases. Six countries, including the USA, England, Canada, Switzerland, China, Japan, and Brazil, published more than three publications from WoS databases. The United States and England have made 19 and 12 publications to WoS, respectively. The United States and England were the two major nations that demonstrated international cooperation in the field of childhood immunization throughout the COVID-19 epidemic, according to the database (Table 3).

Table 3. Top-11 most productive countries.

Ranking	Country strength	Articles	Citations	Total link strength
1	United States	19	411	19
2	England	12	381	16
3	Switzerland	4	270	12
4	Canada	12	88	11
5	Australia	3	8	5
6	China	4	170	544
7	Cameroon	3	3	4 3
8	Italy	3	14	1
9	Japan	7	103	19
10	Brazil	5	33	16
11	Saudi Arabia	3	23	1

Discussion

This study used the WoS databases to analyse a number of recent publications to identify trends in childhood vaccination research that are connected to the COVID-19 pandemic. In order to analyse the included studies, descriptive and quantitative statistics were employed. The research papers were examined using the bibliometric approach in terms of article counts, prolific nations and regions, categories, and keyword distributions. According to this study, the COVID-19 pandemic had a considerable influence on child immunization internationally and caused large pauses in scheduled vaccination programs. The disruptions can be attributed to various factors in the following five categories: 1. Changes in Vaccination Coverage Rates: Most research indicated that during the COVID-19 pandemic, rates of child immunization coverage significantly decreased (29) (33) (34). These declines were observed across various vaccines, including routine vaccines such as measles, (25) (35), (36) polio, and diphtheria-tetanus-pertussis (22) (26). Different nations and regions saw different levels of the reduction, with some locations seeing greater declines in vaccination coverage than others. (37) (38) (39). The results of one previous study support our study. study indicated that the South-East Asia and Western Pacific regions, where 18 of the 19 (95%) countries included in the study reported disruptions to vaccination, especially infancy and school-entry-age vaccinations (40). Similar findings were reported in the Spanish Association of Pediatrics, which also recorded a decline in vaccination coverage (range: 5.0%–60.0%) in March 2020 compared with the monthly average from January 2019 to February 2020 (41). Similar findings were reported in Pakistan, where a 52.5%

decrease was observed in the daily average total number of vaccinations administered from September 2019 to March 2020 (16).

2. Vaccine Hesitancy and Parental Concerns: The pandemic has amplified vaccine hesitancy (42) and parental concerns(43), (28) regarding the safety and efficacy of vaccines. According to several studies, there was an increase in vaccination reluctance during the COVID-19 pandemic, which was brought on by false information, worry about getting COVID-19 in healthcare facilities, and worries about the quick development of COVID-19 vaccines. These factors have contributed to a reluctance among parents to seek routine immunization services for their children (44). 3. Missed or Delayed Vaccinations: The disruptions caused by the pandemic, including lockdown measures and restricted healthcare access, have resulted in missed (45) or delayed vaccinations for many children (46), (45) Studies reported that children have not been able to receive vaccines according to the recommended schedule, leading to potential gaps in immunity and a greater possibility of illnesses with vaccination protection (47). Similarly, study In England, during the coronavirus disease, the measles-mumps-rubella (MMR) vaccination started falling in 2020 before the introduction of physical distancing measures implemented in response to the COVID-19 epidemic. In the first 3 weeks of physical distancing, MMR vaccination counts were 19.8% lower than for the same period in 2019. There was a general decrease in hexavalent vaccinations delivered in 2020 compared with 2019 (48).

4. Catch-up Immunization Efforts: Some countries and healthcare systems implemented catch-up immunization strategies to address the gaps in vaccination coverage caused by the pandemic (49). These strategies involved targeted campaigns, outreach programs, and extended clinic hours to ensure that missed vaccinations are administered and immunization schedules are brought up to date (31). 5. Disruptions to Routine Immunization Programs: The COVID-19 epidemic has disrupted regular vaccination campaigns throughout the world. Health system challenges, including reallocation of resources(50), a reduced healthcare workforce, and disruptions in vaccine supply chains, have impacted the delivery of immunization services (30). Additionally, reduced healthcare-seeking behavior and fear of visiting healthcare facilities have further contributed to the disruption of routine immunization programs (51) (52). The findings highlight the magnitude of the problem, with

estimates indicating that millions of infants are now at risk due to the suspension of vaccination services in multiple countries. The pandemic resulted in a substantial number of children missing out on essential vaccines such as the measles-containing vaccination (MCV1) and the diphtheria, tetanus, and pertussis (DTP3) vaccine. Disruptions like this have previously caused epidemics of illnesses like polio, diphtheria, pertussis, and measles that can be prevented by vaccination (31). The results of some previous studies support our study. One study reported that diphtheria-tetanus-pertussis (DTP) vaccine coverage decreased by 42.0%, oral polio vaccine coverage decreased by 79.0%, and measles vaccine coverage decreased by 9.0% among the school-entry age group (40). The largest decline was 40.6% for the BCG vaccine (16).

The review found the following restrictions: We only found a relatively small number of papers that looked at how the COVID-19 pandemic has affected vaccine coverage, especially those that described the obstacles or other variables that have affected the interruptions from the standpoint of users or providers. We probably missed a large number of non-English publications throughout our search. Furthermore, the existing body of evidence was further constrained by using the inclusion criteria first. The cost of vaccinations and the rules governing immunization have not been examined, nevertheless, as we strive to emphasize the effects of COVID-19 on immunization programs.

Conclusions:

The current review summarizes and analyses the global impact of the COVID-19 pandemic on childhood vaccination. These disruptions included: disruptions in vaccination coverage, increased hesitancy, missing or delayed vaccinations, compensatory efforts and disruptions to routine programs. Based on the evidence presented in this review, this coverage compromises immunization and endangers the health of millions of babies worldwide. Urgent action is needed, emphasizing targeted interventions, resilient health care systems, and public health awareness. This may help protect children from vaccine-preventable diseases during or after the COVID-19 pandemic. Policymakers and public health officials need restore disrupted immunization services, implement targeted catch-up vaccination programs, and address vaccine hesitancy through community engagement and tailored

awareness campaigns. Strengthening global collaboration, investing in research, and incorporating immunization into crisis preparedness plans are essential steps to safeguard childhood immunization after the COVID-19 pandemic.

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Ethics approval and consent to participate: not applicable

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Authors' contributions: All authors contributed to designing, running, and writing all parts.

Conflicts of interest: The authors declared no conflicts of interest.

Abbreviation: MV1, "Measles Vaccine, First Dose."

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