

The 100 Most-Cited Articles in COVID-19 Vaccine Hesitancy Based on Web of Science: A Bibliometric Analysis

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Purpose: To perform a bibliometric analysis of the 100 most-cited articles (T100 articles) on COVID-19 vaccine hesitancy to characterize current trends.

Methods: The data of the bibliometric analysis were retrieved from the Web of Science Core Collection (WoSCC) database on January 29, 2023, and the results were sorted in descending order by citations. Two researchers independently extracted the characteristics of the top 100 cited articles, including title, author, citations, publication year, institution, country, author keywords, Journal Cited Rank, and impact factor. Excel and VOSviewer were used to analyze the data.

Results: The T100 articles ranged from 79 to 1125 citations, with a mean of 208.75. The T100 articles were contributed by 29 countries worldwide, of which the USA ranked first with 28 articles and 5417 citations. The T100 articles were published in 61 journals; the top three citations were *VACCINES*, *NATURE MEDICINE*, and *EUROPEAN JOURNAL OF EPIDEMIOLOGY*, and the number of citations was 2690, 1712, and 1644, respectively. Professor Sallam, M(n=4) from Jordan, is the author who participated in the most published articles. Catholic University of the Sacred Heart (n=8) had the most T100 articles.

Conclusion: It is the first bibliometric analysis of the T100 articles in the field of COVID-19 vaccine hesitancy. We carefully analyzed and described the characteristics of these T100 articles, which provide ideas for further strengthening COVID-19 vaccination and fighting against the epidemic in the future.

Keywords: COVID-19, vaccine hesitancy, bibliometric analysis, citation

Introduction

This year marks the fourth year of the Coronavirus Disease 2019 (COVID-19) epidemic, which has had a massive impact on the public health, production, and economies of countries around the world. Vaccination is known to be the most cost-efficient way to prevent infectious diseases and prevent the spread of epidemics.^{1,2} However, vaccine hesitancy is a growing and significant barrier to vaccination. Vaccine hesitancy is defined as a delay in acceptance or refusal of vaccines,^{3,4} despite the availability of vaccine services. Some studies indicate that vaccine hesitancy is influenced by several factors, including but not limited to confidence, complacency, and convenience.⁵⁻⁷ In addition, the COVID-19 vaccine is a novel product, and there may be greater hesitancy with a new vaccine than with other vaccines that are well known. COVID-19 vaccine hesitancy is prevalent worldwide, although the rates vary across countries/regions. A cross-sectional survey of community-based research in Turkey showed that 45.3% of participants hesitated to receive the COVID-19 vaccine.⁸ The Freeman et al⁹ study showed that COVID-19 vaccine hesitancy is up to 28.3% in the UK. In addition, many studies have shown that social media significantly impacts vaccine hesitancy. Misinformation, scandal, or

negative emotions can reduce people's confidence in vaccines, leading to high vaccine hesitancy rates.^{10–14} Choudhary et al¹⁵ report that vaccine hesitancy is reportedly a widespread challenge in India, particularly in rural areas, due to misinformation and mistrust. On August 31st, 2022, the US Food and Drug Administration (FDA) granted emergency authorization to use Pfizer and Moderna's bivalent COVID-19 vaccines. The experts strongly recommend receiving a booster dose with a bivalent COVID-19 vaccine if you are eligible for one to ensure you are protected against the current circulating variants of the virus.¹⁶ However, Pfizer was reported by the media recently to have produced a COVID-19 variant virus, which has generated much discussion. Whether this is true remains to be seen, but it will undoubtedly impact the COVID-19 vaccination.

Several theories or tools have been used to analyze factors contributing to vaccine hesitancy. Such as the Health Belief Model (HBM),¹⁷ Protective Motivation Theory (PMT),¹⁸ Theory of Planned Behavior (TPB),¹⁹ 3Cs model, MoVac-COVID19S,^{20–22} DrVac-COVID19S,^{23,24} VAX scale,²⁵ VHS scale²⁶ and Vaccine Conspiracy Beliefs Scale (VCBS),²⁷ etc. These tools and theories provide a comprehensive understanding of the underlying factors behind vaccine hesitancy, enabling public health officials to develop tailored interventions to address vaccine hesitancy and promote vaccine uptake. On the other hand, some countries/regions also call for multiple vaccinations to ensure that the body's immune system has a continuous defensive role against COVID-19. For example, China implemented 10 new epidemic prevention measures last December, which have significantly impacted both domestically and internationally. Thus, a fourth dose of the COVID-19 vaccine has been called for in China.

Citation analysis is a critical component of bibliometric analysis, which is an important method for assessing the impact of research articles.²⁸ In the context of our rapidly evolving and complex social landscape, coupled with the significant variability in COVID-19 vaccine coverage across countries/regions, it is imperative to identify and review critical articles in the field. It will allow us to improve our understanding of the field and assess the potential impact of such articles on future research directions.

Methods

The study was a retrospective bibliometric analysis, and there was no need for institutional review board approval.

Data Extraction

The Web of Science Core Collection (<https://www.webofscience.com/wos/>) was searched on January 29, 2023, for all COVID-19 vaccine hesitancy-related articles, and the results were sorted in descending order according to their citations. The search strategy is as follows: $(TS=(COVID-19) OR TS=(Corona Virus Disease 2019) OR TS=(SARS-CoV-2) OR TS=(2019-nCoV)) AND (TS=(Vaccine hesitancy))$. Inclusion criteria: The literature topic is related to COVID-19 vaccine hesitancy. Exclusion criteria: animal literature, book chapters, book reviews, conferences. Two researchers carefully and independently used the same search strategy to search and review the abstracts or full texts of the retrieved articles in several rounds, excluding articles unrelated to COVID-19 vaccine hesitancy. In case of ambiguity, a third researcher would judge again to resolve the disagreement. After screening out the T100 articles, a pre-established data collection form was used to collect the following information: Title, author, journal, author keywords, publication year, institution, country (subject to the first author), Journal Citation Reports (JCR Q1–Q4), the impact factor (IF), citation number, article type, the average number of citations.

Statistical Analysis

Microsoft EXCEL 2019 calculated descriptive statistical analysis, including title, years, journal, country (subject to the first author), total citation, average citation, and IF. In addition, using Microsoft Excel to analyze the T100 articles' characteristics, we classified North Ireland, Wales, and England into the UK. The T100 articles categories and document types were analyzed by the "Analyze Results" function module in Web of Science. VOSviewer 1.6.18 was used for Visual analysis, including the co-countries/regions network, co-institutions network, and the T100 articles source. Nodes represented specific elements such as country, author, or institution. The size of the node indicated the quantity or frequency of publication. The larger the node, the more often the element was present. A line between nodes meant that these appeared together in an article in the T100. The thicker the line, the more often they appeared together.

Results

Characteristics of the T100 Articles

A total of 3167 COVID-19 vaccine hesitancy-related articles fit the Web of Science search strategy, and the T100 articles were sorted in descending based on the number of their citations (Table 1). The T100 articles ranged from 79 to 1125

Table 1 Top 100 Articles Cited Article in COVID-19 Vaccine Hesitancy

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
1	Lazarus, JV	A global survey of potential acceptance of a COVID-19 vaccine	NATURE MEDICINE	2021	1225	Spain
2	Dror, AA	Vaccine hesitancy: the next challenge in the fight against COVID-19	EUROPEAN JOURNAL OF EPIDEMIOLOGY	2020	798	Israel
3	Sallam, M	COVID-19 Vaccine Hesitancy Worldwide: A Concise Systematic Review of Vaccine Acceptance Rates	VACCINES	2021	749	Jordan
4	Fisher, KA	Attitudes Toward a Potential SARS-CoV-2 Vaccine A Survey of US Adults	ANNALS OF INTERNAL MEDICINE	2020	626	USA
5	Murphy, J	Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom	NATURE COMMUNICATIONS	2021	527	UK
6	Loomba, S	Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA	NATURE HUMAN BEHAVIOUR	2021	459	UK
7	Khubchandani, J	COVID-19 Vaccination Hesitancy in the United States: A Rapid National Assessment	JOURNAL OF COMMUNITY HEALTH	2021	450	USA
8	Puri, N	Social media and vaccine hesitancy: new updates for the era of COVID-19 and globalized infectious diseases	HUMAN VACCINES & IMMUNOTHERAPEUTICS	2020	379	Canada
9	Kreps, S	Factors Associated With US Adults' Likelihood of Accepting COVID-19 Vaccination	JAMA NETWORK OPEN	2020	371	USA
10	Roozenbeek, J	Susceptibility to misinformation about COVID-19 around the world	ROYAL SOCIETY OPEN SCIENCE	2020	368	UK
11	Sherman, SM	COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey	HUMAN VACCINES & IMMUNOTHERAPEUTICS	2021	361	UK
12	Lin, C	Confidence and Receptivity for COVID-19 Vaccines: A Rapid Systematic Review	VACCINES	2021	346	USA

(Continued)

Table I (Continued).

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
13	Schwarzinger, M	COVID-19 vaccine hesitancy in a representative working-age population in France: a survey experiment based on vaccine characteristics	LANCET PUBLIC HEALTH	2021	345	France
14	Kwok, KO	Editor's Choice: Influenza vaccine uptake, COVID-19 vaccination intention and vaccine hesitancy among nurses: A survey	INTERNATIONAL JOURNAL OF NURSING STUDIES	2021	320	China
15	Detoc, M	Intention to participate in a COVID-19 vaccine clinical trial and to get vaccinated against COVID-19 in France during the pandemic	VACCINE	2020	319	France
16	Lin, YL	Understanding COVID-19 vaccine demand and hesitancy: A nationwide online survey in China	PLOS NEGLECTED TROPICAL DISEASES	2020	305	China
17	Arce, JSS	COVID-19 vaccine acceptance and hesitancy in low- and middle-income countries	NATURE MEDICINE	2021	299	Germany
18	Al-Mohaithef, M	Determinants of COVID-19 Vaccine Acceptance in Saudi Arabia: A Web-Based National Survey	JOURNAL OF MULTIDISCIPLINARY HEALTHCARE	2020	296	Saudi Arabia
19	Wilson, SL	Social media and vaccine hesitancy	BMJ GLOBAL HEALTH	2020	291	USA
20	Gagneux-Brunon, A	Intention to get vaccinations against COVID-19 in French healthcare workers during the first pandemic wave: a cross-sectional survey	JOURNAL OF HOSPITAL INFECTION	2021	290	France
21	Troiano, G	Vaccine hesitancy in the era of COVID-19	PUBLIC HEALTH	2021	289	Italy
22	Sallam, M	High Rates of COVID-19 Vaccine Hesitancy and Its Association with Conspiracy Beliefs: A Study in Jordan and Kuwait among Other Arab Countries	VACCINES	2021	289	Jordan
23	Peretti-Watel, P	A future vaccination campaign against COVID-19 at risk of vaccine hesitancy and politicisation	LANCET INFECTIOUS DISEASES	2020	288	France
24	Freeman, D	COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II	PSYCHOLOGICAL MEDICINE	2022	283	UK
25	Freeman, D	Injection fears and COVID-19 vaccine hesitancy	PSYCHOLOGICAL MEDICINE	2021	283	UK

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Table 1 (Continued).

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
26	Ruiz, JB	Predictors of intention to vaccinate against COVID-19: Results of a nationwide survey	VACCINE	2021	274	USA
27	Chou, WYS	Considering Emotion in COVID-19 Vaccine Communication: Addressing Vaccine Hesitancy and Fostering Vaccine Confidence	HEALTH COMMUNICATION	2020	269	USA
28	Robertson, E	Predictors of COVID-19 vaccine hesitancy in the UK household longitudinal study	BRAIN BEHAVIOR AND IMMUNITY	2021	251	UK
29	Pogue, K	Influences on Attitudes Regarding Potential COVID-19 Vaccination in the United States	VACCINES	2020	234	USA
30	Wang, KL	Intention of nurses to accept coronavirus disease 2019 vaccination and change of intention to accept seasonal influenza vaccination during the coronavirus disease 2019 pandemic: A cross-sectional survey	VACCINE	2020	229	China
31	Palamenghi, L	Mistrust in biomedical research and vaccine hesitancy: the forefront challenge in the battle against COVID-19 in Italy	EUROPEAN JOURNAL OF EPIDEMIOLOGY	2020	227	Italy
32	Barello, S	"Vaccine hesitancy" among university students in Italy during the COVID-19 pandemic	EUROPEAN JOURNAL OF EPIDEMIOLOGY	2020	223	Italy
33	Nzaji, MK	Acceptability of Vaccination Against COVID-19 Among Healthcare Workers in the Democratic Republic of the Congo	PRAGMATIC AND OBSERVATIONAL RESEARCH	2020	223	Congo
34	Soares, P	Factors Associated with COVID-19 Vaccine Hesitancy	VACCINES	2021	221	Portugal
35	Lucia, VC	COVID-19 vaccine hesitancy among medical students	JOURNAL OF PUBLIC HEALTH	2021	217	USA
36	Harrison, EA	Vaccine confidence in the time of COVID-19	EUROPEAN JOURNAL OF EPIDEMIOLOGY	2020	211	USA
37	Karlsson, LC	Fearing the disease or the vaccine: The case of COVID-19	PERSONALITY AND INDIVIDUAL DIFFERENCES	2021	201	Finland
38	Robinson, E	International estimates of intended uptake and refusal of COVID-19 vaccines: A rapid systematic review and meta-analysis of large nationally representative samples	VACCINE	2021	197	UK

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Table I (Continued).

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
39	Verger, P	Attitudes of healthcare workers towards COVID-19 vaccination: a survey in France and French-speaking parts of Belgium and Canada, 2020	EUROSURVEILLANCE	2021	196	France
40	Machingaidze, S	Understanding COVID-19 vaccine hesitancy	NATURE MEDICINE	2021	188	South Africa
41	Caserotti, M	Associations of COVID-19 risk perception with vaccine hesitancy over time for Italian residents	SOCIAL SCIENCE & MEDICINE	2021	187	Italy
42	Biswas, N	The Nature and Extent of COVID-19 Vaccination Hesitancy in Healthcare Workers	JOURNAL OF COMMUNITY HEALTH	2021	186	USA
43	Skjefte, M	COVID-19 vaccine acceptance among pregnant women and mothers of young children: results of a survey in 16 countries	EUROPEAN JOURNAL OF EPIDEMIOLOGY	2021	185	USA
44	Fridman, A	COVID-19 and vaccine hesitancy: A longitudinal study	PLOS ONE	2021	183	USA
45	Bogart, LM	COVID-19 Related Medical Mistrust, Health Impacts, and Potential Vaccine Hesitancy Among Black Americans Living With HIV	JAIDS-JOURNAL OF ACQUIRED IMMUNE DEFICIENCY SYNDROMES	2021	177	USA
46	Razai, MS	Covid-19 vaccine hesitancy among ethnic minority groups	BMJ-BRITISH MEDICAL JOURNAL	2021	169	UK
47	Goldman, RD	Caregiver willingness to vaccinate their children against COVID-19: Cross sectional survey	VACCINE	2020	164	Canada
48	Saied, SM	Vaccine hesitancy: Beliefs and barriers associated with COVID-19 vaccination among Egyptian medical students	JOURNAL OF MEDICAL VIROLOGY	2021	160	Egypt
49	Taylor, S	A Proactive Approach for Managing COVID-19: The Importance of Understanding the Motivational Roots of Vaccination Hesitancy for SARS-CoV2	FRONTIERS IN PSYCHOLOGY	2020	160	Canada
50	El-Elimat, T	Acceptance and attitudes toward COVID-19 vaccines: A cross-sectional study from Jordan	PLOS ONE	2021	158	Jordan
51	Ward, JK	The French public's attitudes to a future COVID-19 vaccine: The politicization of a public health issue	SOCIAL SCIENCE & MEDICINE	2020	158	France

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Table 1 (Continued).

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
52	Latkin, CA	Trust in a COVID-19 vaccine in the US: A social-ecological perspective	SOCIAL SCIENCE & MEDICINE	2021	146	USA
53	Edwards, B	COVID-19 vaccine hesitancy and resistance: Correlates in a nationally representative longitudinal survey of the Australian population	PLOS ONE	2021	145	Australia
54	Riad, A	Prevalence of COVID-19 Vaccine Side Effects among Healthcare Workers in the Czech Republic	JOURNAL OF CLINICAL MEDICINE	2021	141	Czech Republic.
55	Islam, MS	COVID-19 vaccine rumors and conspiracy theories: The need for cognitive inoculation against misinformation to improve vaccine adherence	PLOS ONE	2021	135	Australia
56	Machida, M	Acceptance of a COVID-19 Vaccine in Japan during the COVID-19 Pandemic	VACCINES	2021	134	Japan
57	Yoda, T	Willingness to Receive COVID-19 Vaccination in Japan	VACCINES	2021	134	Japan
58	Cascini, F	Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: A systematic review	ECLINICALMEDICINE	2021	130	Italy
59	Wang, KL	Change of Willingness to Accept COVID-19 Vaccine and Reasons of Vaccine Hesitancy of Working People at Different Waves of Local Epidemic in Hong Kong, China: Repeated Cross-Sectional Surveys	VACCINES	2021	129	China
60	Aw, J	COVID-19 Vaccine Hesitancy-A Scoping Review of Literature in High-Income Countries	VACCINES	2021	128	Singapore
61	Khan, YH	Threat of COVID-19 Vaccine Hesitancy in Pakistan: The Need for Measures to Neutralize Misleading Narratives	AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE	2020	118	Arabia
62	Bendau, A	COVID-19 vaccine hesitancy and related fears and anxiety	INTERNATIONAL IMMUNOPHARMACOLOGY	2021	116	Germany
63	Bono, SA	Factors Affecting COVID-19 Vaccine Acceptance: An International Survey among Low-and Middle-Income Countries	VACCINES	2021	113	Malaysia

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Table I (Continued).

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
64	Head, KJ	A National Survey Assessing SARS-CoV-2 Vaccination Intentions: Implications for Future Public Health Communication Efforts	SCIENCE COMMUNICATION	2020	112	USA
65	Jennings, W	Lack of Trust, Conspiracy Beliefs, and Social Media Use Predict COVID-19 Vaccine Hesitancy	VACCINES	2021	111	UK
66	Blakeway, H	COVID-19 vaccination during pregnancy: coverage and safety	AMERICAN JOURNAL OF OBSTETRICS AND GYNECOLOGY	2022	110	UK
67	Qattan, AMN	Acceptability of a COVID-19 Vaccine Among Healthcare Workers in the Kingdom of Saudi Arabia	FRONTIERS IN MEDICINE	2021	108	Arabia
68	Latkin, CA	Mask usage, social distancing, racial, and gender correlates of COVID-19 vaccine intentions among adults in the US	PLOS ONE	2021	107	USA
69	Willis, DE	COVID-19 vaccine hesitancy: Race/ethnicity, trust, and fear	CTS-CLINICAL AND TRANSLATIONAL SCIENCE	2021	106	USA
70	Viswanath, K	Individual and social determinants of COVID-19 vaccine uptake	BMC PUBLIC HEALTH	2021	106	USA
71	Dzieciolowska, S	Covid-19 vaccine acceptance, hesitancy, and refusal among Canadian healthcare workers: A multicenter survey	AMERICAN JOURNAL OF INFECTION CONTROL	2021	105	Canada
72	Schoch-Spana, M	The public's role in COVID-19 vaccination: Human-centered recommendations to enhance pandemic vaccine awareness, access, and acceptance in the United States	VACCINE	2021	102	USA
73	Kashte, S	COVID-19 vaccines: rapid development, implications, challenges and future prospects	HUMAN CELL	2021	102	India
74	Coustasse, A	COVID-19 and Vaccine Hesitancy A Challenge the United States Must Overcome	JOURNAL OF AMBULATORY CARE MANAGEMENT	2021	102	USA
75	Graffigna, G	Relationship between Citizens' Health Engagement and Intention to Take the COVID-19 Vaccine in Italy: A Mediation Analysis	VACCINES	2020	102	Italy

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Table I (Continued).

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
76	Alqudeimat, Y	Acceptance of a COVID-19 Vaccine and Its Related Determinants among the General Adult Population in Kuwait	MEDICAL PRINCIPLES AND PRACTICE	2021	101	Kuwait
77	Al-Qerem, WA	COVID-19 Vaccination Acceptance and Its Associated Factors Among a Middle Eastern Population	FRONTIERS IN PUBLIC HEALTH	2021	101	Jordan
78	Freeman, D	Effects of different types of written vaccination information on COVID-19 vaccine hesitancy in the UK (OCEANS-III): a randomised controlled trial	LANCET PUBLIC HEALTH	2021	100	UK
79	Chu, HR	Integrating health behavior theories to predict American's intention to receive a COVID-19 vaccine	PATIENT EDUCATION AND COUNSELING	2021	99	USA
80	Germani, F	The anti-vaccination infodemic on social media: A behavioral analysis	PLOS ONE	2021	98	Switzerland
81	Rutten, LJF	Evidence-Based Strategies for Clinical Organizations to Address COVID-19 Vaccine Hesitancy	MAYO CLINIC PROCEEDINGS	2021	98	USA
82	Ayhan, SG	COVID-19 vaccine acceptance in pregnant women	INTERNATIONAL JOURNAL OF GYNECOLOGY & OBSTETRICS	2021	97	Turkey
83	Verger, P	Restoring confidence in vaccines in the COVID-19 era	EXPERT REVIEW OF VACCINES	2020	95	France
84	Li, M	Healthcare workers' (HCWs) attitudes and related factors towards COVID-19 vaccination: a rapid systematic review	POSTGRADUATE MEDICAL JOURNAL	2021	94	China
85	Abedin, M	Willingness to vaccinate against COVID-19 among Bangladeshi adults: Understanding the strategies to optimize vaccination coverage	PLOS ONE	2021	92	Bangladesh
86	Yigit, M	Evaluation of COVID-19 Vaccine Refusal in Parents	PEDIATRIC INFECTIOUS DISEASE JOURNAL	2021	91	Turkey
87	Kaplan, RM	Influence of a COVID-19 vaccine's effectiveness and safety profile on vaccination acceptance	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	2021	90	USA
88	Chen, MS	An online survey of the attitude and willingness of Chinese adults to receive COVID-19 vaccination	HUMAN VACCINES & IMMUNOTHERAPEUTICS	2021	87	China

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Table I (Continued).

Rank	First Author	Title	Journal	Publication Years	Total citations	Country
89	Wang, W	Global, regional, and national estimates of target population sizes for covid-19 vaccination: descriptive study	BMJ-BRITISH MEDICAL JOURNAL	2020	86	China
90	Dai, HC	Behavioural nudges increase COVID-19 vaccinations	NATURE	2021	85	USA
91	Di Gennaro, F	Attitudes towards Anti-SARS-CoV2 Vaccination among Healthcare Workers: Results from a National Survey in Italy	VIRUSES-BASEL	2021	85	Italy
92	Joshi, A	Predictors of COVID-19 Vaccine Acceptance, Intention, and Hesitancy: A Scoping Review	FRONTIERS IN PUBLIC HEALTH	2021	83	USA
93	Wiysonge, CS	Vaccine hesitancy in the era of COVID-19: could lessons from the past help in divining the future?	HUMAN VACCINES & IMMUNOTHERAPEUTICS	2022	83	South Africa
94	Mercadante, AR	Will they, or Will not they? Examining patients' vaccine intention for flu and COVID-19 using the Health Belief Model	RESEARCH IN SOCIAL & ADMINISTRATIVE PHARMACY	2021	82	USA
95	Al-Amer, R	COVID-19 vaccination intention in the first year of the pandemic: A systematic review	JOURNAL OF CLINICAL NURSING	2022	82	Jordan
96	Klugar, M	Side Effects of mRNA-Based and Viral Vector-Based COVID-19 Vaccines among German Healthcare Workers	BIOLOGY-BASEL	2021	81	Germany
97	Kourlaba, G	Willingness of Greek general population to get a COVID-19 vaccine	GLOBAL HEALTH RESEARCH AND POLICY	2021	81	Greece
98	Vergara, RJD	Building public trust: a response to COVID-19 vaccine hesitancy predicament	JOURNAL OF PUBLIC HEALTH	2021	80	Philippines
99	Szilagy, PG	Parents' Intentions and Perceptions About COVID-19 Vaccination for Their Children: Results From a National Survey	PEDIATRICS	2021	79	USA
100	Sallam, M	Low COVID-19 Vaccine Acceptance Is Correlated with Conspiracy Beliefs among University Students in Jordan	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	2021	79	Jordan

citations; the total number of citations reached 20875, with a mean of 208.75. The publication years were concentrated in 2021 (n=71). Only one article was cited more than 1000 times, written by Lazarus, JV, and published in *NATURE MEDICINE* in 2021, describing potential COVID-19 vaccine acceptance and influence factors.

A total of 29 countries participated in the T100 articles, of which 8 countries had ≥ 3 T100 articles (Table 2). The USA ranked first with 28 T100 articles and 5417 citations. The UK ranked second with 12 T100 articles and 3229 citations,

Table 2 Countries of Origin of the T100

Country	Total Citations	Articles	Average Citations/Article
USA	5417	28	193
UK	3219	12	268
France	1691	7	242
Jordan	1458	6	243
China	1250	7	179
Italy	1243	7	178
Spain	1225	1	1225
Canada	808	4	202
Israel	798	1	798
Germany	496	3	165
Saudi Arabia	296	1	296
Australia	280	2	140
South Africa	271	2	136
Japan	268	2	134
Arabia	226	2	113
Congo	223	1	223
Portugal	221	1	221
Finland	201	1	201
Turkey	188	2	94
Egypt	160	1	160
Czech Republic.	141	1	141
Singapore	128	1	128
Malaysia	113	1	113
India	102	1	102
Kuwait	101	1	101
Switzerland	98	1	98
Bangladesh	92	1	92
Greece	81	1	81
Philippines	80	1	80

followed by France (1691 citations), China (1250 citations), and Italy (1243 citations), tied for third with 7 T100 articles. For information on all countries of T100 articles can be found in [Table 2](#).

The T100 articles were published in 61 different journals. The *VACCINES* published the most T100 articles and had 2690 citations, followed by *PLOS ONE*, with 7 T100 articles and 918 citations. *VACCINE* ranked third, with 6 T100 articles and 1285 citations. The journal of Quartile in category was mainly distributed in Q1–Q3, including 36 journals in Q1, 16 in Q2, and 5 in Q3. In addition, 3 journals were not in the 2021 edition of JCR. The impact factors of the journals ranged from 2.1322–96.2167, and the number of citations ranged from 79–2690. The *ANNALS OF INTERNAL MEDICINE* has the most average citations per article, with 626 citations ([Table 3](#)).

Table 3 Journals Publishing the Top 100

Journal	Articles	IF (2021)	Quartile in Category	Total Citations	Average Citations/Article
VACCINES	12	4.9608	Q2	2690	224
PLOS ONE	7	3.7521	Q2	918	131
VACCINE	6	4.1686	Q3	1285	214
EUROPEAN JOURNAL OF EPIDEMIOLOGY	5	12.442	Q1	1644	329
HUMAN VACCINES & IMMUNOTHERAPEUTICS	4	4.5257	Q2	910	228
NATURE MEDICINE	3	87.2448	Q1	1712	571
SOCIAL SCIENCE & MEDICINE	3	8.5134	Q1	491	164
JOURNAL OF COMMUNITY HEALTH	2	6.2855	Q1	636	318
PSYCHOLOGICAL MEDICINE	2	10.5915	Q1	566	283
LANCET PUBLIC HEALTH	2	72.4283	Q1	445	223
JOURNAL OF PUBLIC HEALTH	2	5.0583	Q1	297	149
BMJ-BRITISH MEDICAL JOURNAL	2	96.2167	Q1	255	128
FRONTIERS IN PUBLIC HEALTH	2	6.4608	Q1	184	92
ANNALS OF INTERNAL MEDICINE	1	51.5993	Q1	626	626
NATURE COMMUNICATIONS	1	17.6939	Q1	527	527
NATURE HUMAN BEHAVIOUR	1	24.253	Q1	459	459
JAMA NETWORK OPEN	1	13.3593	Q1	371	371
ROYAL SOCIETY OPEN SCIENCE	1	3.653	Q2	368	368
INTERNATIONAL JOURNAL OF NURSING STUDIES	1	6.6119	Q1	320	320
PLOS NEGLECTED TROPICAL DISEASES	1	4.7807	Q1	305	305
JOURNAL OF MULTIDISCIPLINARY HEALTHCARE	1	2.9193	Q3	296	296
BMJ GLOBAL HEALTH	1	8.0614	Q1	291	291
JOURNAL OF HOSPITAL INFECTION	1	8.9445	Q1	290	290
PUBLIC HEALTH	1	4.9844	Q1	289	289
LANCET INFECTIOUS DISEASES	1	71.4217	Q1	288	288

(Continued)

Table 3 (Continued).

Journal	Articles	IF (2021)	Quartile in Category	Total Citations	Average Citations/ Article
HEALTH COMMUNICATION	1	3.5007	Q2	269	269
BRAIN BEHAVIOR AND IMMUNITY	1	19.2273	Q1	251	251
PRAGMATIC AND OBSERVATIONAL RESEARCH	1	-	-	223	223
PERSONALITY AND INDIVIDUAL DIFFERENCES	1	3.9503	Q2	201	201
EUROSURVEILLANCE	1	21.2862	Q1	196	196
JAIDS-JOURNAL OF ACQUIRED IMMUNE DEFICIENCY SYNDROMES	1	3.7709	Q3	177	177
FRONTIERS IN PSYCHOLOGY	1	4.2319	Q1	160	160
JOURNAL OF MEDICAL VIROLOGY	1	20.6927	Q1	160	160
JOURNAL OF CLINICAL MEDICINE	1	4.9643	Q2	141	141
ECLINICAL MEDICINE	1	17.0321	Q1	130	130
AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE	1	3.7073	Q2	118	118
INTERNATIONAL IMMUNOPHARMACOLOGY	1	5.7142	Q1	116	116
SCIENCE COMMUNICATION	1	7.4411	Q1	112	112
AMERICAN JOURNAL OF OBSTETRICS AND GYNECOLOGY	1	10.6931	Q1	110	110
FRONTIERS IN MEDICINE	1	5.0583	Q2	108	108
BMC PUBLIC HEALTH	1	4.1353	Q2	106	106
CTS-CLINICAL AND TRANSLATIONAL SCIENCE	1	4.5159	Q2	106	106
AMERICAN JOURNAL OF INFECTION CONTROL	1	4.3029	Q2	105	105
HUMAN CELL	1	4.3739	Q3	102	102
JOURNAL OF AMBULATORY CARE MANAGEMENT	1	-	-	102	102
MEDICAL PRINCIPLES AND PRACTICE	1	2.1322	Q3	101	101
PATIENT EDUCATION AND COUNSELING	1	3.4669	Q1	99	99
MAYO CLINIC PROCEEDINGS	1	12.2131	Q1	98	98
INTERNATIONAL JOURNAL OF GYNECOLOGY & OBSTETRICS	1	4.4474	Q1	97	97
EXPERT REVIEW OF VACCINES	1	5.6826	Q2	95	95
POSTGRADUATE MEDICAL JOURNAL	1	4.9731	Q2	94	94
PEDIATRIC INFECTIOUS DISEASE JOURNAL	1	3.8059	Q1	91	91
PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	1	12.7784	Q1	90	90
NATURE	1	69.5026	Q1	85	85
VIRUSES-BASEL	1	5.8184	Q2	85	85

(Continued)

Table 3 (Continued).

Journal	Articles	IF (2021)	Quartile in Category	Total Citations	Average Citations/ Article
JOURNAL OF CLINICAL NURSING	1	4.4231	Q1	82	82
RESEARCH IN SOCIAL & ADMINISTRATIVE PHARMACY	1	3.3481	Q2	82	82
BIOLOGY-BASEL	1	5.1678	Q1	81	81
GLOBAL HEALTH RESEARCH AND POLICY	1	-	-	81	81
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	1	4.6141	Q1	79	79
PEDIATRICS	1	9.7031	Q1	79	79

A total of 283 institutions worldwide participated in the research of the T100 articles, of which 14 institutions participated in more than 3 articles, as seen in Table 4. The *Catholic University of the Sacred Heart* from Italy participated in 8 T100 articles, ranking first and having 1181 citations. The *University of Jordan* and the *University of Oxford* ranked second, with 7 T100 articles. The *University of Jordan* is the most cited institution, with 2392 citations. It is worth noting that the institutions in which more than 3 T100 articles were involved, of which 7 (50%) were from the UK.

Overall, 672 researchers worldwide participated in the study of the T100 articles, and who participated in more than 3 T100 articles can be seen in Table 5. Sallam, M from the *University of Jordan* and Freeman, D from the *University of Oxford*, with the most T100 articles as the first or corresponding author (Articles that the first author is both corresponding authors). Besides, Sallam, M with the most number of citations. Notably, the 14 researchers ranked

Table 4 Institutions Contributing to the 100 Most Cited Articles (Number of Publication≥3)

Institution	Articles	Country	Citations
Catholic University of the Sacred Heart	8	Italy	1181
University of Jordan	7	Jordan	2392
University of Oxford	7	UK	1443
Aix-Marseille University	4	France	886
Johns Hopkins University	4	USA	727
University of Bristol	4	UK	867
University of Cambridge	4	UK	1034
Laval University	4	Canada	776
Aston University	3	UK	666
Chinese University of Hong Kong	3	China	678
London School of Hygiene & Tropical Medicine	3	UK	1789
Loughborough University	3	UK	666
South African Medical Research Council	3	South African	562
University of Liverpool	3	UK	839

Table 5 The Most Productive Authors in T100 Articles

Author	Articles	Authorship			Affiliation	Country	Citations
		First Author	Corresponding Author	Other			
Lewandowsky, S	4	0	0	4	University of Bristol	UK	867
Sallam, M	3	3	3*	0	University of Jordan	Jordan	1117
Wong, SYS	3	0	0	3	Chinese University of Hong Kong	China	678
Verger, P	3	2	1*	1	Aix-Marseille University	France	579
Freeman, D	3	3	3*	0	University of Oxford	UK	666
Loe, BS	3	0	0	3	University of Cambridge	UK	666
Chadwick, A	3	0	0	3	Loughborough University	UK	666
Vaccari, C	3	0	0	3	Loughborough University	UK	666
Waite, F	3	0	0	3	University of Oxford	UK	666
Rosebrock, L	3	0	0	3	University of Oxford	UK	666
Petit, A	3	0	0	3	University of Oxford	UK	666
Vanderslott, S	3	0	0	3	University of Oxford	UK	666
Innocenti, S	3	0	0	3	University of Oxford	UK	666
Larkin, M	3	0	0	3	Aston University	UK	666
Yu, LM	3	0	0	3	University of Oxford	UK	666
McShane, H	3	0	0	3	University of Oxford	UK	666
Pollard, AJ	3	0	0	3	University of Oxford	UK	666
Lambe, S	3	0	0	3	University of Oxford	UK	666
Barello, S	3	1	1*	2	Catholic University of the Sacred Heart	Italy	552
Graffigna, G	3	1	1	1	Catholic University of the Sacred Heart	Italy	552
Dube, E	3	0	0	3	Laval University	Canada	396

Note: *Articles that the first author is both corresponding author.

5–18 in [Table 5](#) all contributed to 3 T100 similar articles, so they had the same number of citations. Of the T100 articles, 82 were articles, 11 were reviews, 4 were Editorial Material, and 2 were Letters. These articles belong to 30 categories of Web of Science, of which the top 3 are Immunology (n=28), Medicine Research Experimental (n=22), and Public Environmental Occupational Health (n=22) ([Table 6](#)).

Furthermore, we analyzed the T100 articles published per continent. Ten countries in Europe published 35 T100 articles with 8616 citations. There were no publications from South America or Antarctica. It is worth noting that even though only two North American countries published T100 articles, they published 35 articles with 6225 citations ([Table 7](#)).

Co-Countries/Regions Network Visualization

All institutions met the criteria when the minimum number of articles published by the countries/regions was set to 1. The co-countries/regions network is revealed in [Figure 1](#). The co-countries/regions network, including 53 institutions,

Table 6 Web of Science Categories in the T100 Articles

Variable	Number of Studies
Type of study	
Article	83
Review	11
Editorial Material	4
Letter	2
Web of science categories	
Immunology	28
Medicine Research Experimental	22
Public Environmental Occupational Health	22
Multidisciplinary Sciences	12
Medicine General Internal	11
Infectious Diseases	7
Psychiatry	6
Biotechnology Applied Microbiology	5
Psychology	5
Psychology Clinical	5
Cell Biology	4
Health Policy Services	4
Biochemistry Molecular Biology	3
Health Care Sciences Services	3
Social Sciences Biomedical	3
Communication	2
Neurosciences	2
Nursing	2
Obstetrics Gynecology	2
Pediatrics	2
Tropical Medicine	2
Virology	2
Biology	1
Parasitology	1
Pharmacology Pharmacy	1
Psychology Biological	1
Psychology Experimental	1

(Continued)

Table 6 (Continued).

Variable	Number of Studies
Psychology Multidisciplinary	1
Psychology Social	1
Social Sciences Interdisciplinary	1

Note: Because there are articles with more than one category, the total sum of this table exceeds 100.

Table 7 The T100 Articles in per Contient

Continent	Number of Countries/Regions	Articles	Total Citations
Europe	10	35	8616
North America	2	32	6225
Asian	13	27	5100
Africa	3	4	654
Oceania	1	2	280
South America	0	0	0
Antarctica	0	0	0

was divided into 7 clusters represented by different colors. The largest cluster of red and green consists of 15 institutions. In addition, the circles of the USA were significantly larger than others, and total link lines and strength were also significantly more than others, indicating that the USA participated in the most studies in these 100 articles.

Co-Institutions Network Visualization

Using Vosviewer to analyze the co-institutions network of the T100 articles. The co- institutions network can be seen in [Figure 2](#). It involved 124 institutions and was divided into 7 clusters represented by different colors. 24 institutions were included in red clusters, which were the largest. However, from [Figure 2](#), the cooperation strength between the institutions with a large number of publications seems weak.

Citation Source Density Visualization

Previously, we used Microsoft Excel to analyze the published journals of the T100 articles in [Table 3](#). When we used Vosviewer to analyze, the generated density visualization more intuitively reflected the participation of each journal in this field. Each dot has a color and represents a journal. By default, colors range from blue to green to yellow to red, indicating increasing numbers of T100 articles ([Figure 3](#)).

Co-Citation Network of Sources Visualization

A co-citation relationship exists between two journals when they are cited simultaneously in 1 or more of the same publications. The co-citation network of the source is revealed in [Figure 4](#). A total of 1546 journals had co-citation relationships. When setting the minimum number of citations of a source to 10, 54 journals met the criteria. From [Figure 4](#), it is known that *VACCINE* has the highest co-citation frequency (8465 times). In addition, *VACCINE-Basel*, *Human Vaccine & Immunotherapeutics*, and *Plos One* have more than 3000 times co-citations. In general, the above four journals could significantly influence the field.

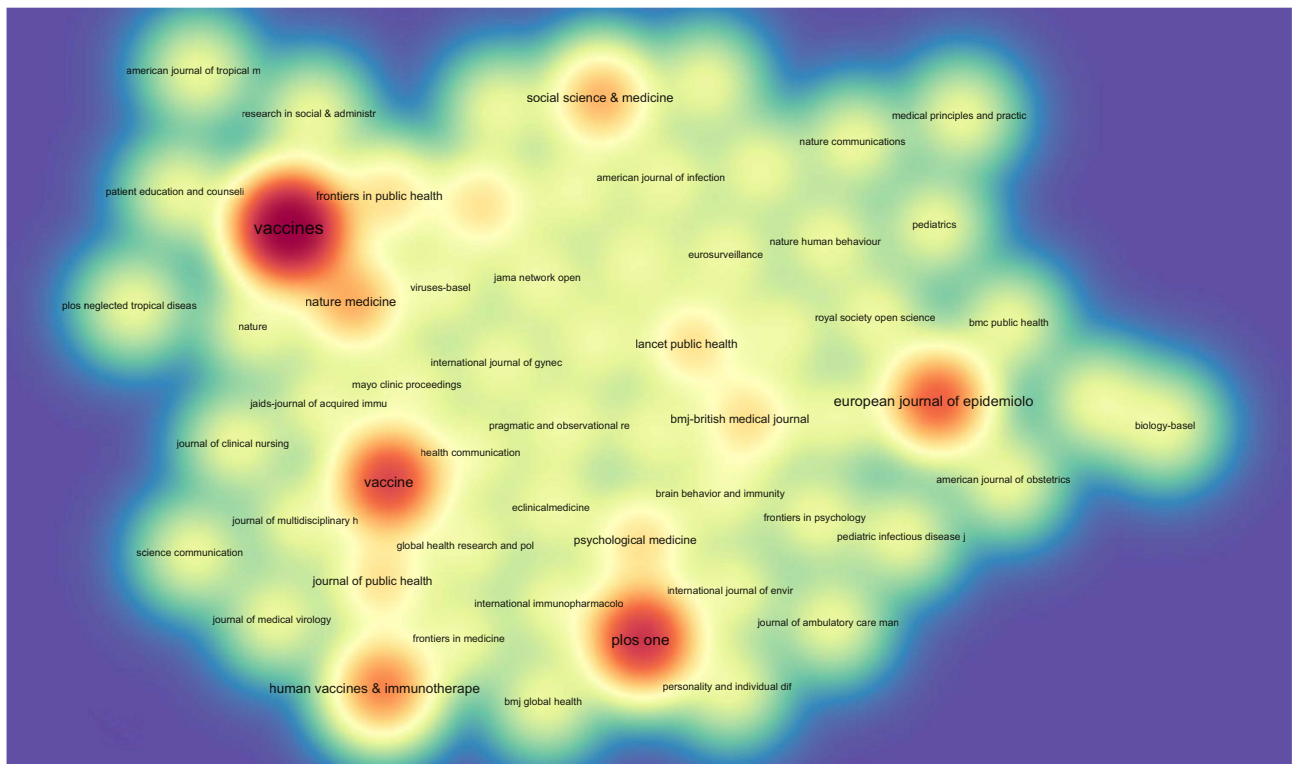


Figure 3 Citation source density visualization.

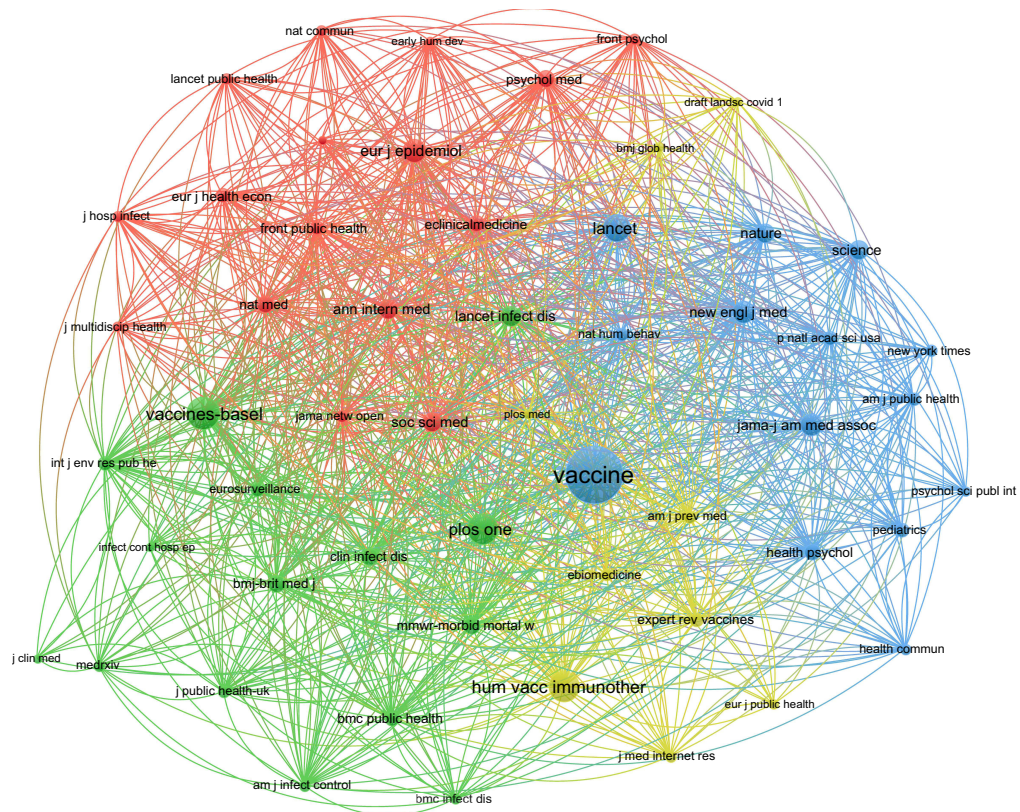


Figure 4 Co-citation network of sources visualization.

Discussion

In this study, we evaluated the current status of T100 articles on COVID-19 vaccine hesitancy by analyzing the field's institutions, authors, countries, and journals. It can help to understand the current information regarding COVID-19 vaccine hesitancy quickly. It can also provide ideas for future research in this area.

With the largest number of T100 articles, the USA is the dominant country in terms of contributions to the development of COVID-19 vaccine hesitancy, and this may have to do with the fact that the USA is a more developed country and has more resources or financial support at its disposal.²⁹ However, it is noteworthy that although there was only one article in Spain, the number of citations was 1225. The *VACCINE* journal published the most T100 articles and the highest number of citations during this multi-year period. In addition, we collected the Quartile in category and impact factor of the journals, most of which were in Q1, and the total impact factor of all the journals is as high as 841.6061. However, there were fewer publications in journals with exceptionally high impact factors, such as *Nature* and *Nature Medicine*. Several factors can influence the decision of which journal to submit manuscripts to, including acceptance rate, impact factor, speed of manuscript processing, and the overall reputation of the journal.³⁰ Authors in the field of COVID-19 vaccine hesitancy tend to publish in corresponding journals rather than general medicine journals. The *Catholic University of the Sacred Heart* in Italy was the largest contributor to the T100 articles, but most institutions involved in the T100 articles were from the UK.

Our study shows that Europe and North America lead in the world's COVID-19 vaccine hesitancy field, with the maximum number of publications and global impacts. It appears that their research receives significant attention and recognition on a global scale. Research platforms with high-quality and advanced technology are critical in promoting research development. Additionally, Europe and North America invest more in research, facilitating its smooth progression. As shown in [Figure 1](#), Europe and North America cooperate closely, enabling them to exchange experiences and resources and expand their research capabilities. The collaborative network density among institutions with many publications is low, suggesting a lack of close collaboration and communication, as seen in [Figure 2](#). Therefore, important to promote more vaccine hesitancy research through cross-national/regional collaborations in the future.

As mentioned above, the USA had the most T100 articles, but vaccine acceptance rates varied from a low of 12% to a high of 91.4%.³¹ One study³² showed that about 20% of Americans have explicitly refused COVID-19 vaccines, not including those who have delayed vaccinations. For those Americans who are already parents, their attitudes influence their decision to vaccinate their children. A study by Ruiz et al³³ showed that accepting the COVID-19 vaccine in children was strongly associated with parents' intentions to receive it for themselves, and up to 1/3 of parents reported pediatric vaccine hesitancy.

Vaccine hesitancy has become one of the most important factors affecting public health.³⁴ The vaccine were potential side effects, safety, how well it works, and not trusting the government, which they were worried about.³⁵ Therefore, measures must be taken to protect public health and quality of life. From the government level, it is necessary to strengthen top-level planning, formulate reasonable vaccination policies, increase the convenience of vaccination, monitor online information, and punish misinformation. Medical institutions and voluntary public health groups should disseminate knowledge about COVID-19 vaccines to the public to increase their understanding and willingness to be vaccinated. A cross-sectional survey³⁶ conducted in India showed that the willingness to be vaccinated increased by 29% among participants who received professional education from medical and health workers. At the same time, health workers' attitudes toward vaccination can impact the public, so health workers should set a good example. Individuals need to learn to distinguish between truth and misinformation, and it is also important to seek professional help or information from official reports.

This study also has some limitations. First, we selected only the Web of Science core collection database as the source of retrieval data and did not consider other databases such as PubMed, Scopus, CNKI, etc. Second, we are and will remain in the era of information explosion, and the information is updated much faster than our cognition, so we cannot guarantee whether some new high-quality articles are excluded. Finally, the software's algorithm is also an important factor affecting the results. We cannot do what software engineers should do but only passively accept the use of the software.

Conclusion

To our knowledge, this study is the first reported attempt to analyze the top 100 most cited articles in the field of COVID-19 vaccine hesitancy. Through the bibliometric analysis, our study sheds light on various aspects of the field, including the most influential journal, country, and author. This information may be useful to researchers, policymakers, and practitioners interested in understanding the field's current state and identifying potential areas for future research. In addition, it is also possible to use our study's findings to address vaccine hesitancy, a critical public health issue. Infectious disease control and prevention efforts can be undermined by vaccine hesitancy. Researchers and policymakers can identify effective strategies to address vaccine hesitancy by identifying the most influential articles and authors in the field, such as developing targeted communication campaigns, addressing misinformation and conspiracy theories, and improving vaccine access.

Overall, the *VACCINE* was the most influential journal, and the USA was the most productive country. Sallam, M was the most influential author. More importantly, this article may support a quick review of the state of the COVID-19 vaccine hesitancy field and direct future research trends.

Abbreviations

COVID-19, Coronavirus disease 2019; FDA, Food and Drug Administration; IF, impact factor; JCR, Journal Citation Reports; HBM, health belief model; PMT, protective motivation theory; TPB, theory of planned behavior.

Data Statement

All data generated or analyzed during this study are included in this published article.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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