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Bibliometric Analysis of Pfizer-BioNTech (BNT162B2): A COVID-19 Vaccine

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Abstract

The objective of the study was to perform a bibliometric analysis of the Pfizer-BioNTech vaccine. For this purpose Scopus database was used. As of 13th May 2021, one hundred and seventy-three (n=173) research documents are published about it. We used Vosviewer and Biblioshiny (Bibliometrix) in the present report. In all publications, 1160 authors have significantly contributed. The documents per author was 0.119, while authors per document was 8.41. Collaborative Index (CI) was found to be 9.47. By biblioshiny we also applied Lotka's law to depict the author's frequency. 1097 authors were involved in only one (n=1) publication. Based on the Scopus record, the highest documents are published by Dormitzer, P.R. (n=6). In universities and countries categories, Tel Aviv University (n=7) and USA (48) are the most productive. By Vosviewer the collaboration pattern among authors, institutes, and countries is graphically presented. For example, 28 authors, 17 departments and 7 countries directly contributed to one publication. The research documents (133) are published in 102 sources or journals. The highest documents are published in Vaccines (n=8), while the highest citations were recorded for the New England Journal of Medicine (n=838). We also applied co-words analysis to understand the main focus of these publications.

Keywords: Bibliometric analysis, COVID-19, Pfizer Vaccine

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INTRODUCTION

Coronavirus disease 2019 (COVID-19), is a highly transmissible global pandemic. It was 1st detected and identified in Wuhan, China, in December 2019. It causes an infection in nose, sinuses, upper throat or lower respiratory tract (windpipe and lungs). Some of the major sympotoms are fever, coughing, shortness of breath, trouble breathing, fatigue, chills, sometimes with shaking, body aches, headache, sore throat, congestion/runny nose, loss of smell or taste, nausea, and diarrhea. The virus can lead to pneumonia, respiratory failure, heart problems, liver problems, septic shock, and ultimately may lead to death. According to WHO, globally, there have been 160,074,267 confirmed cases of COVID-19, including 3,325,260 deaths (till 14th May, 2021).

Bibliometrics is the qualitative and quantitative analysis of scientific articles, books, or the chapters of a book. It is widely used for analysis of the research outputs of individual authors, institutes, and countries. It can also help in identifying the impact of research in a particular field. The new and emerging areas of research can also be explored with the help of bibliometrics. It may help to identify the potential research collaborators and find suitable sources or journal in which the research documents can be published[1-4]. However, there are a few issues related with bibliometric analysis. The citation rates vary by subject or field. For example, the top-ranked journals in mathematics have impact factors of around 3; while, in cell biology the journals may have 30 impact factor. Similarly, the h-index varies by field. The life scientists, physicists and social scientists top out at 200, 100 and 20–30 (h-index), respectively. This indicates the differences between various disciplines. The citation is also database dependent. For example a researcher in Web of Science may have an h-index of 10. But in Google Scholar he/she may have 20 h-index[5-7].

The scientific literature about COVID-19 has exponentially increased and various bibliometric studies are reported in this regard For example, Mao et al., performed the global bibliometric analysis about the coronavirus research. The authors used Web of Science database and analyzed 9294 articles related with SARS, MERS and COVID-19[8]. Similarly, Saed H. Zyoud explored the Arab region's contribution to global COVID-19 research. Precisely, they retreived a total of 143,975 publications about COVID-19. The Arab region contribution was 4.25% or 6131 documents[9]. Its worthy to note that Chinese government has implemented substantial policies to prevent and control the COVID-19 epidemic. Jiang Wu et al., performed bibliometric analysis to understand the transitions and effects of policies over time. A total of 366 policies of epidemic prevention were collected and bibliometrically analyzed[10]. More recently, E. Sachini et al., explored the COVID-19 research publications output of Greek institutions. They identified its advancement over time and analyzed their international collaboration. Bibliometrically, they studied 656 research documents[11]. Similarly, Shaher H. Zyoud and Ahed H. Zyoud performed bibliometric and visualization mapping analysis to understand the hotspots and research trends in COVID-19 and environmental fields. They retrived and studied 729 documents from Scopus database limited to environmental sources only[12]. Kalra, Gagan et al., performed a scientometric analysis of research related with COVID-19 and ophthalmology. They analyzed 616 relevant documents obtained from WoS[13]. While, Ibraín Enrique et al., bibliometrically analyzed 1956 articles about COVID-19 and diabetes[14]. similarly, there are a few more bibliometric studies about COVID-19 to explore the activity and trends[15-17].

Recently, Cascella et al., provided detail information about the significant progress in the development of novel therapeutics and vaccine development for COVID-19. Currently, a variety of therapeutic options are available which are either approved by U.S. Food and Drug Administration (FDA) (Emergency Use Authorization (EUA) or being evaluated for COVID-19. For example the anti-SARS-CoV-2 monoclonal antibodies (e.g., bamlanivimab/etesevimab, casirivimab/imdevimab), anti-inflammatory drugs (e.g., examethasone), immunomodulators agents (e.g., baricitinib, tocilizumab) etc. We will specifically highlight the antiviral drugs[18]. Initially Hydroxychloroquine and chloroquine were proposed as antiviral treatments. However according to recent findings the use of hydroxychloroquine with or without

azithromycin in hospitalized patients did not improve the clinical status or overall mortality compared to placebo[19-20]. Lopinavir/ritonavir is an FDA-approved combo therapy for the treatment of HIV. It was also proposed as antiviral therapy against COVID-19. However a recent data reported no benefit against COVID-19. Currently it is not indicated for the treatment[21]. Ivermectin is an FDA-approved anti-parasitic drug proposed for the treatment of COVID-19. However no significant efficacy was observed in recent trial. Therefore it is currently not indicated for the treatment of COVID-19[22]. Based on three randomized, controlled clinical trials the FDA approved remdesivir for the treatment of COVID-19. Currently, the SII/Covishield and AstraZeneca/AZD1222 vaccines were given EUL on 16 February. The Janssen/Ad26.COV 2.S developed by Johnson & Johnson, was listed for EUL on 12 March 2021. The Moderna COVID-19 vaccine (mRNA 1273) was listed for EUL on 30 April 2021 and the Sinopharm COVID-19 vaccine was listed for EUL on 7 May 2021. While, on December 11, 2020, the Food and Drug Administration (FDA) issued an Emergency Use Authorization (EUA) for the Pfizer-BioNTech COVID-19 Vaccine (also known as BNT162b2, an mRNA vaccine encoding the SARS-CoV-2 spike glycoprotein) for prevention of COVID-19. To the best of our knowledge this is the 1st bibliometric report about Pfizer-BioNTech (vaccine).

MATERIAL AND METHODS

Data sources and visualization

On 13th May, 2021, we retrieved the data from Scopus, one of the largest databases in the world. In search field the following term was used i.e. “Pfizer-BioNTech" OR "BNT162b2". It was searched in article titles, abstracts and keywords i.e. TIT/ABS/KEYWORDS. We quantitatively and qualitatively analyzed in Microsoft Excel 2013. For science mapping and visualization, we used VOSviewer version 1.6.9 and Bibloshiny (Bibliometrix).

RESULTS AND DISCUSSION

Total one hundred and seventy three (n=173) research documents are published about Pfizer-BioNTech vaccine. It majorly comprised of articles (n=91), reviews (n=42), letters (n=22), notes (n=12), editorials (n=6), short surveys (n=4) and errata (n=1). For detail analysis we focused on articles and reviews (n=133) with 1359 citations. One of the advantages of biblioshiny is that it can provide detail information about the local and global citations. Local citations are the citations which are received from documents included in data.While, global citations are the total citations that an article has received from other documents indexed in a database (WOS, Scopus, etc). The local and global citation details of only cited documents are provided in Table 1.

The highest citations are received by three documents which are published in “New England Journal of Medicine”. In the 1st report (TC=686), the authors performed a multinational, placebo-controlled, observer-blinded, pivotal efficacy trial (conducted in USA and Germany) to test the efficacy of BNT162b2 vaccine. 21, 720 participants were given BNT162b2 and 21, 728 with placebo injections. The author claimed and concluded 95% efficacy of BNT162b2 in preventing Covid-19.

In the 2nd most cited document (TC=219), the authors explored the efficacy of two lipid nanoparticle-formulated vaccine candidates (a) BNT162b1 and (b) BNT162b2. Two groups of individuals 18 to 55 years and 65 to 85 years were included in the placebo-controlled, observer-blinded, dose-escalation and phase 1 trial conducted in USA. The author confirmed the safety and immunogenicity data of (BNT162b1) trial conducted in Germany.

In the 3rd highest cited report (TC=51), the authors obtained data from Clalit Health Services (CHS), the largest health care organization in Israel. recisely, they evaluated and discussed the effectiveness of the BNT162b2 mRNA vaccine. 1,163,534 vaccinated cases were included in this study along with 596,618 placebo/control subjects. During the period from 14 to 20 days after the first dose, the authors analyzed effectiveness against, documented infection, symptomatic Covid-19, hospitalization, severe disease and death. 46%, 57%, 74%, 62% and 72% effectiveness were (respectively) noted for above four categories. While, during the period from 21 to 27 days after the first dose, the estimated effectiveness for these outcomes was 60%, 66%, 78%, 80% and

Table 1. The local and global citation details of (only cited) articles and reviews

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Polack F.P et al.,	Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine	2020	New England Journal of Medicine	383	27	2603	2615	77	609	686
Walsh E.E et al.,	Safety and immunogenicity of two RNA-based covid-19 vaccine candidates	2020	New England Journal of Medicine	383	25	2439	2450	32	187	219
Dagan N et al.,	BNT162B2 mRNA covid-19 vaccine in a nationwide mass vaccination setting	2021	New England Journal of Medicine	384	15	1412	1423	9	42	51
Oliver S.E et al.,	The advisory committee on immunization practices' interim recommendation for use of pfizer-BioNTech COVID-19 Vaccine — United States, December 2020	2021	Morbidity and Mortality Weekly Report	69	50	1922	1924	0	40	40
Muik A et al.,	Neutralization of SARS-CoV-2 lineage B.1.1.7 pseudovirus by BNT162b2 vaccine–elicited human sera	2021	Science	371	6534	1152	1153	6	28	34
Wang Z et al.,	mRNA vaccine-elicited antibodies to SARS-CoV-2 and circulating variants	2021	Nature	592	7855	616	622	6	26	32
Xie X et al.,	Neutralization of SARS-CoV-2 spike 69/70 deletion, E484K and N501Y variants by BNT162b2 vaccine-elicited sera	2021	Nature Medicine	27	4	620	621	5	27	32
Na Na et al.,	Allergic reactions including anaphylaxis after receipt of the first dose of Pfizer-BioNTech COVID-19 vaccine — United States, December 14–23, 2020	2021	Morbidity and Mortality Weekly Report	70	2	46	51	0	26	26
Banerji A et al.,	mRNA Vaccines to Prevent COVID-19 Disease and Reported Allergic Reactions: Current Evidence and Suggested Approach	2021	Journal of Allergy and Clinical Immunology: In Practice	9	4	1423	1437	0	15	15
Rosen B et al.,	Israel's rapid rollout of vaccinations for COVID-19	2021	Israel Journal of Health Policy Research	10	1			2	14	16
Khuroo M S et al.,	COVID-19 Vaccines: A Race Against Time in the Middle of Death and Devastation!	2020	Journal of Clinical and Experimental Hepatology	10	6	610	621	0	13	13

Table 1. Cont...

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Chen R E et al.,	Resistance of SARS-CoV-2 variants to neutralization by monoclonal and serum-derived polyclonal antibodies	2021	Nature Medicine	27	4	717	726	0	11	11
Vogel A.B et al.,	BNT162b vaccines protect rhesus macaques from SARS-CoV-2	2021	Nature	592	7853	283	289	4	11	15
Tanne J.H et al.,	Covid-19: FDA panel votes to approve Pfizer BioNTech vaccine	2020	BMJ (Clinical research ed.)	371		m4799		1	9	10
Jabbal K.A et al.,	Impact of age, ethnicity, sex and prior infection status on immunogenicity following a single dose of the BNT162b2 MRNA COVID-19 vaccine: Real-world evidence from healthcare workers, Israel, December 2020 to January 2021	2021	Eurosurveillance	26	6			3	9	12
Mehta N et al.,	Unilateral axillary Adenopathy in the setting of COVID-19 vaccine	2021	Clinical Imaging	75		12	15	1	8	9
Kim J et al.,	Self-assembled mRNA vaccines	2021	Advanced Drug Delivery Reviews	170		83	112	1	6	7
Mishra S.J et al.,	One year update on the COVID-19 pandemic: Where are we now?	2021	Acta Tropica	214				0	6	6
Collier D.A et al.,	Sensitivity of SARS-CoV-2 B.1.1.7 to mRNA vaccine-elicited antibodies	2021	Nature					1	9	10
Rymban E et al.,	Lead SARS-CoV-2 Candidate Vaccines: Expectations from Phase III Trials and Recommendations Post-Vaccine Approval	2020	Viruses	13	1			0	6	6
Roychoudhury S et al.,	Viral pandemics of the last four decades: Pathophysiology, health impacts and perspectives	2020	International Journal of Environmental Research and Public Health	17	24	1	39	0	6	6
Supasa P et al.,	Reduced neutralization of SARS-CoV-2 B.1.1.7 variant by convalescent and vaccine sera	2021	Cell	184	8	2201	2.21E+10	0	5	5

Table 1. Cont...

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Creech Cb et al.,	SARS-CoV-2 Vaccines	2021	JAMA - Journal of the American Medical Association	325	13	1318	1320	2	5	7
Klimek L et al.,	Severe allergic reactions after COVID-19 vaccination with the Pfizer/BioNTech vaccine in Great Britain and USA: Position statement of the German Allergy Societies: Medical Association of German Allergologists (AeDA), German Society for Allergology and Clinical Immunology (DGAKI) and Society for Pediatric Allergology and Environmental Medicine (GPA)	2021	Allergo Journal International	30	2	51	55	0	5	5
Moore S et al.,	Vaccination and non-pharmaceutical interventions for COVID-19: a mathematical modelling study	2021	The Lancet Infectious Diseases					0	5	5
Alexander Jl et al.,	SARS-CoV-2 vaccination for patients with inflammatory bowel disease: a British Society of Gastroenterology Inflammatory Bowel Disease section and IBD Clinical Research Group position statement	2021	The Lancet Gastroenterology and Hepatology	6	3	218	224	1	4	5
Park Ks et al.,	Non-viral COVID-19 vaccine delivery systems	2021	Advanced Drug Delivery Reviews	169		137	151	1	4	5
Garcia-Beltran Wf et al.,	Multiple SARS-CoV-2 variants escape neutralization by vaccine-induced humoral immunity	2021	Cell					0	5	5
Kis Z et al.,	Resources, production scales and time required for producing RNA vaccines for the global pandemic demand	2021	Vaccines	9	1	1	14	0	4	4

Table 1. Cont...

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Gelfand Jm et al.,	National Psoriasis Foundation COVID-19 Task Force guidance for management of psoriatic disease during the pandemic: Version 2—Advances in psoriatic disease management, COVID-19 vaccines, and COVID-19 treatments	2021	Journal of the American Academy of Dermatology	84	5	1254	1268	0	3	3
Carvalho T et al.,	The first 12 months of COVID-19: a timeline of immunological insights	2021	Nature Reviews Immunology	21	4	245	256	0	4	4
Bakhiet M et al.,	SARS-CoV-2: Targeted managements and vaccine development	2021	Cytokine and Growth Factor Reviews	58		16	29	0	3	3
Turner PJ et al.,	COVID-19 vaccine-associated anaphylaxis: A statement of the World Allergy Organization Anaphylaxis Committee	2021	World Allergy Organization Journal	14	2			1	3	4
Hoffmann M et al.,	SARS-CoV-2 variants B.1.351 and P.1 escape from neutralizing antibodies	2021	Cell					0	3	3
Meo S.A et al.,	COVID-19 vaccines: Comparison of biological, pharmacological characteristics and adverse effects of pfizer/BioNTech and moderna vaccines	2021	European Review for Medical and Pharmacological Sciences	25	3	1663	1679	0	3	3
Munavalli Gg et al.,	"COVID-19/SARS-CoV-2 virus spike protein-related delayed inflammatory reaction to hyaluronic acid dermal fillers: a challenging clinical conundrum in diagnosis and treatment"	2021	Archives of Dermatological Research					1	3	4
Kyriakidis Nc et al.,	SARS-CoV-2 vaccines strategies: a comprehensive review of phase 3 candidates	2021	npj Vaccines	6	1			0	2	2
Chilamakuri R et al.,	COVID-19: Characteristics and Therapeutics	2021	Cells	10	2			0	2	2
Xia X et al.,	Domains and Functions of Spike Protein in Sars-Cov-2 in the Context of Vaccine Design	2021	Viruses	13	1			0	2	2

Table 1. Cont...

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Na Na	FDA authorizes Pfizer-BioNTech COVID-19 vaccine	2021	The Medical letter on drugs and therapeutics	63	1615	1	2	0	2	2
Nhamo G et al.,	COVID-19 vaccines and treatments nationalism: Challenges for low-income countries and the attainment of the SDGs	2021	Global Public Health	16	3	319	339	0	2	2
Verbeke R et al.,	The dawn of mRNA vaccines: The COVID-19 case	2021	Journal of Controlled Release	333		511	520	0	1	1
Vasileiou E et al.,	Interim findings from first-dose mass COVID-19 vaccination roll-out and COVID-19 hospital admissions in Scotland: a national prospective cohort study	2021	The Lancet	397	10285	1646	1657	0	1	1
Chakraborty S et al.,	SARS-CoV-2 vaccines in advanced clinical trials: Where do we stand?	2021	Advanced Drug Delivery Reviews	172		314	338	0	1	1
Viana Imdo et al.,	Innate and adaptive immune responses toward nanomedicines	2021	Acta Pharmaceutica Sinica B	11	4	852	870	0	1	1
Munavalli Gg et al.,	Oral angiotensin-converting enzyme inhibitors for treatment of delayed inflammatory reaction to dermal hyaluronic acid fillers following COVID-19 vaccination-a model for inhibition of angiotensin II–induced cutaneous inflammation	2021	JAAD Case Reports	10		63	68	0	1	1
Khani E et al.,	Potential COVID-19 Therapeutic Agents and Vaccines: An Evidence-Based Review	2021	Journal of Clinical Pharmacology	61	4	429	460	0	1	1
Cirillo N et al.,	Reported orofacial adverse effects of COVID-19 vaccines: The knowns and the unknowns	2021	Journal of Oral Pathology and Medicine	50	4	424	427	0	1	1
Lombardi A et al.,	Mini Review Immunological Consequences of Immunization With COVID-19 mRNA Vaccines: Preliminary Results	2021	Frontiers in Immunology	12				0	1	1

Table 1. Cont...

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Gobbi F et al.,	Antibody Response to the BNT162b2 mRNA COVID-19 Vaccine in Subjects with Prior SARS-CoV-2 Infection	2021	Viruses	13	3			1	1	2
Granata V et al.,	Lymphadenopathy after bnt162b2 covid-19 vaccine: Preliminary ultrasound findings	2021	Biology	10	3			0	1	1
Klimek L et al.,	Allergic reactions to COVID-19 vaccinations - What ENT doctors should know. Part 1: General aspects of allergies to vaccines, immunological bases of allergies to vaccines, immune mechanisms of allergic and pseudoallergic reactions; Part 2: Characteristics of the mRNA vaccines BNT162b2 and mRNA-1273 for the prevention of COVID-19 and associated immune phenomena; Part 3: Practical aspects of prevention, diagnosis and treatment of allergies to COVID-19 vaccines [Allergische Reaktionen auf COVID-19-Impfungen-Was HNO-arztewissen sollten-Teil 1: Allgemeine Aspekte von Allergien auf Impfstoffe, immunologische GrundlagenA von Allergien auf Impfstoffe, Immunmechanismen von allergischenA undA pseudoallergischen Reaktionen, Teil 2: Charakteristiken der mRNA-Impfstoffe BNT162b2 und mRNA-1273 zurA Prophylaxe von COVID-19 und assoziierte Immunphänomene, Teil 3: Praktische Aspekte der Prophylaxe, Diagnostik und Therapie von Allergien aufA COVID-19-Impfstoffe]	2021	Laryngo- Rhino- Otologie	100	3	168	173	0	1	1

Table 1. Cont...

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Wise J et al.,	Covid-19: Pfizer BioNTech vaccine reduced cases by 94% in Israel, shows peer reviewed study	2021	BMJ (Clinical research ed.)	372		n567		0	1	1
Ashraf Mu et al.,	Covid-19 vaccines (Revisited) and oral-mucosal vector system as a potential vaccine platform	2021	Vaccines	9	2	1	24	0	1	1
Teo Sp et al.,	Review of covid-19 vaccines and their evidence in older adults	2021	Annals of Geriatric Medicine and Research	25	1	4	9	0	1	1
Shaker M et al.,	A Cost-Effectiveness Evaluation of Hospitalizations, Fatalities, and Economic Outcomes Associated with Universal Versus Anaphylaxis Risk-Stratified COVID-19 Vaccination Strategies	2021	Journal of Allergy and Clinical Immunology: In Practice					0	1	1
Martonosi Se et al.,	Pricing the COVID-19 vaccine: A mathematical approach	2021	Omega (United Kingdom)					0	1	1
Ebinger Je et al.,	Antibody responses to the BNT162b2 mRNA vaccine in individuals previously infected with SARS-CoV-2	2021	Nature Medicine					0	1	1
Cohen D et al.,	Hypermetabolic lymphadenopathy following administration of BNT162b2 mRNA Covid-19 vaccine: incidence assessed by [18F]FDG PET-CT and relevance to study interpretation	2021	European Journal of Nuclear Medicine and Molecular Imaging					0	2	2
Britton A et al.,	Effectiveness of the Pfizer-BioNTech COVID-19 Vaccine Among Residents of Two Skilled Nursing Facilities Experiencing COVID-19 Outbreaks — Connecticut, December 2020-February 2021	2021	MMWR Recommendations and Reports	70	11	396	401	0	1	1

Table 1. Cont...

Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	Local Citations	Global Citations	Tot Citations
Nojszewska M et al.,	COVID-19 mRNA vaccines (Pfizer-BioNTech and Moderna) in patients with multiple sclerosis: A statement by a working group convened by the Section of Multiple Sclerosis and Neuroimmunology of the Polish Neurological Society	2021	Neurologia i Neurochirurgia Polska	55	1	8	11	0	1	1
Rogliani P et al.,	Sars-cov-2 neutralizing antibodies: A network meta-analysis across vaccines	2021	Vaccines	9	3	1	18	1	1	2
Pal R et al.,	COVID-19 vaccination in patients with diabetes mellitus: Current concepts, uncertainties and challenges	2021	Diabetes and Metabolic Syndrome: Clinical Research and Reviews	15	2	505	508	0	1	1
Achiron A et al.,	COVID-19 vaccination in patients with multiple sclerosis: What we have learnt by February 2021	2021	Multiple Sclerosis Journal					1	1	2

84%, respectively. Based on the data, the authors suggested that the BNT162b2 mRNA vaccine is effective against Covid-19.

The 4th most cited document is about the summary of "the advisory committee on immunization practices' interim recommendation for use of pfizer-BioNTech COVID-19 Vaccine — United States, December 2020". "On December 12, 2020, the Advisory Committee on Immunization Practices (ACIP) issued an interim recommendation for use of the Pfizer-BioNTech COVID-19 vaccine in persons aged ≥16 years for the prevention of COVID-19".

The 5th most cited work (TC=34) is published in Science. In background, the authors provided brief information about a novel SARS-CoV-2 variant, lineage B.1.1.7 discovered in UK. The authors tested efficacy of BNT162b2 (30 µg) for neutralization of SARS-CoV-2 Wuhan and lineage B.1.1.7. The data suggested that new line "will not escape" BNT162b2-mediated protection.

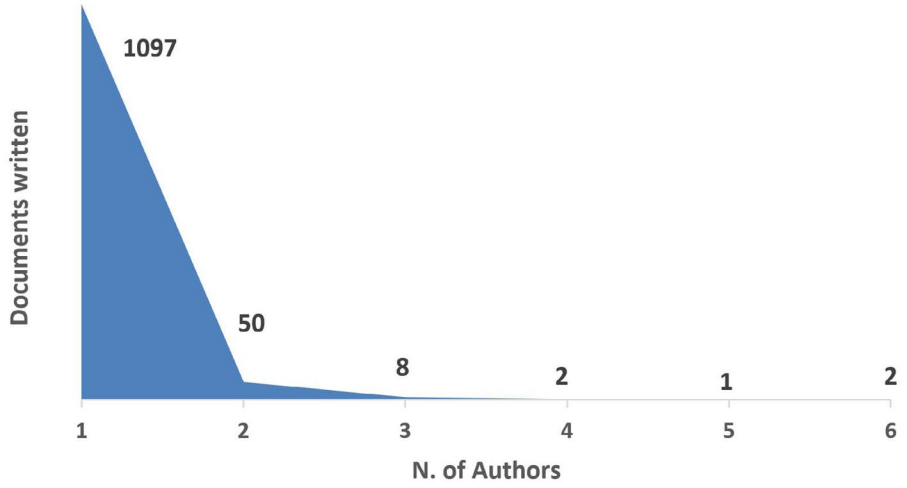


Fig. 1. The authors frequencey by Lotka's law.

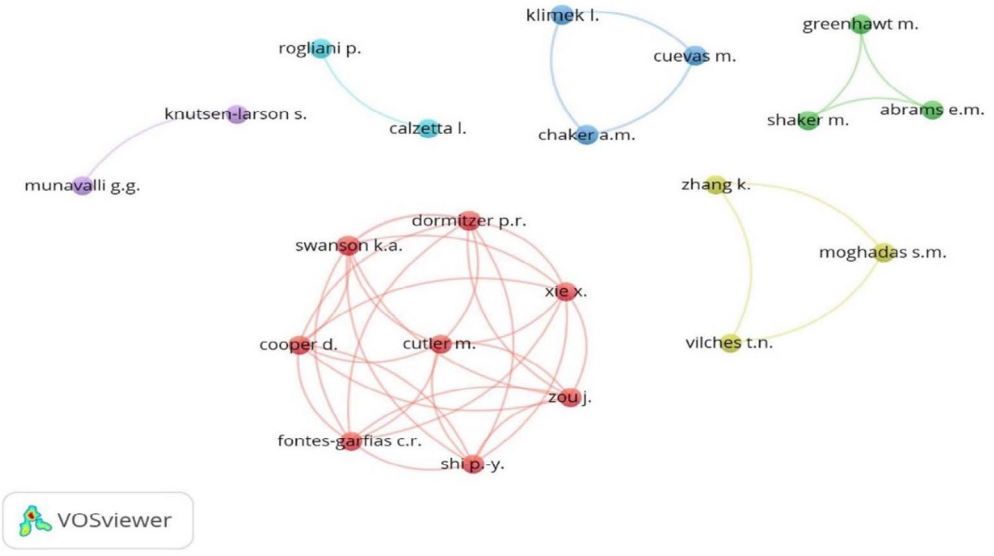
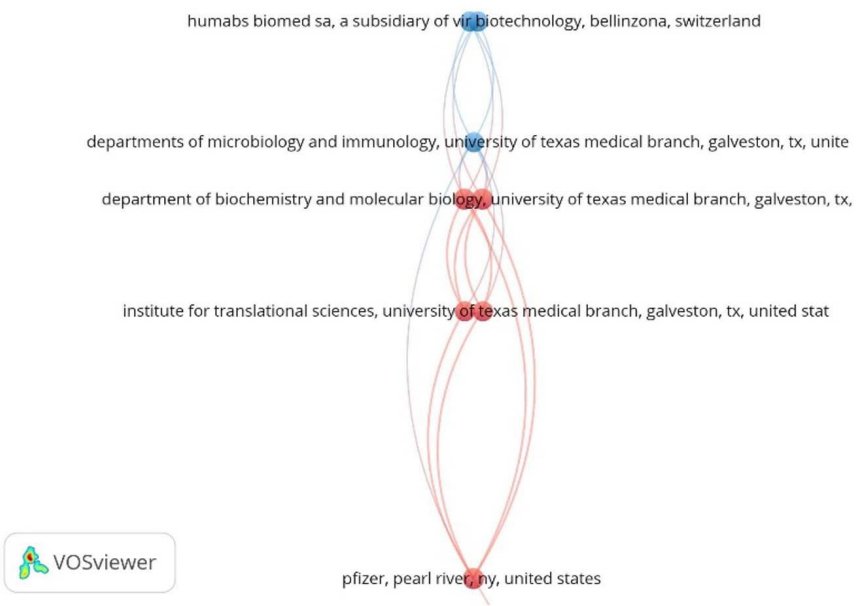
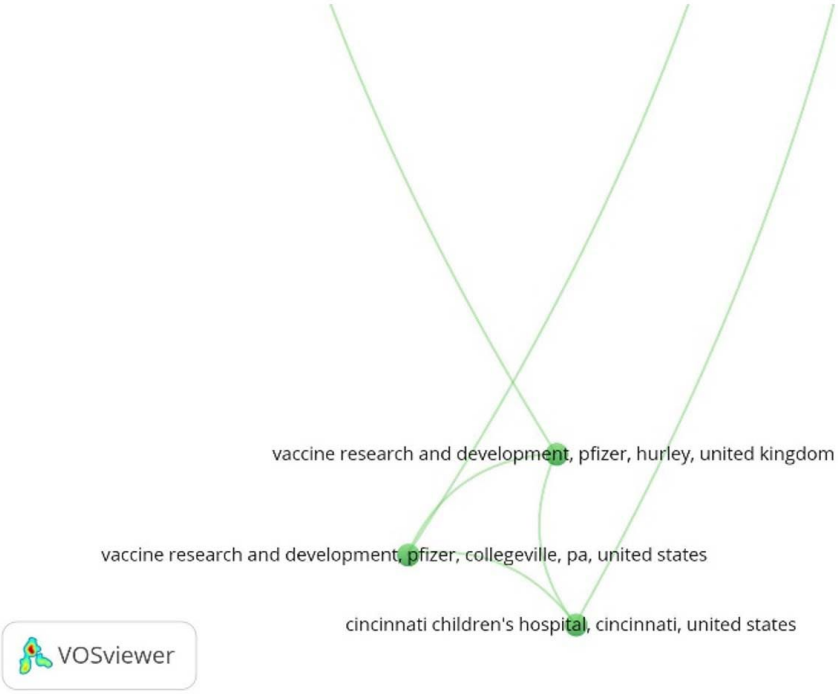


Fig. 2. The co-authorship network for authors.



3A



3B

Fig. 3A,B. The co-authorship network for institutes.

Table 2. The sources/journals details

S#	Source	NP	h_ index	g_ index	m_ index	TC	Rank	Zone
1.	New England Journal Of Medicine	3	3	3	1.5	838	9	Zone 1
2.	Morbidity And Mortality Weekly Report	3	2	3	2	66	7	Zone 1
3.	Nature	3	3	3	3	46	8	Zone 1
4.	Nature Medicine	5	2	5	2	39	2	Zone 1
5.	Science	1	1	1	1	28	94	Zone 3
6.	Journal Of Allergy And Clinical Immunology: In Practice	2	1	2	1	16	16	Zone 2
7.	Israel Journal Of Health Policy Research	1	1	1	1	14	58	Zone 3
8.	Cell	3	3	3	3	13	4	Zone 1
9.	Journal Of Clinical And Experimental Hepatology	1	1	1	0.5	13	62	Zone 3
10.	Advanced Drug Delivery Reviews	3	2	3	2	11	3	Zone 1
11.	Bmj (Clinical Research Ed.)	2	1	2	0.5	10	11	Zone 1
12.	Viruses	3	2	3	1	9	10	Zone 1
13.	Eurosurveillance	2	1	2	1	9	14	Zone 1
14.	Clinical Imaging	1	1	1	1	8	36	Zone 2
15.	Vaccines	8	1	2	1	6	19	Zone 2
16.	Acta Tropica	1	1	1	1	6	21	Zone 2
17.	International Journal Of Environmental Research And Public Health	1	1	1	0.5	6	55	Zone 2
18.	Allergo Journal International	1	1	1	1	5	24	Zone 2
19.	JAMA - Journal Of The American Medical Association	1	1	1	1	5	60	Zone 3
20.	The Lancet Infectious Diseases	1	1	1	1	5	97	Zone 3

AUTHORS, UNIVERSITIES AND COUNTRIES

Based on biblioshiny (bibliometric) analysis, 1160 authors have contributed to all publications. Fourteen (n=14) authors published single-authored documents and 1146 authors published multi-authored documents. The documents per author was 0.119, while authors per document was 8.41. Collaborative Index (CI) can be used as a quantitative measure of research collaboration. It was proosed by Lawani in 1986. It can be calculated by the following formula.

C= Total Number of Authors/ Total Number of Papers

By biblioshiny we calculated the CI, and it was found to be 9.47

Lotka's Law is normally used to provide breif informaqtion about the frequency of publication of authors in a particular research field. Sometimes it is called "inverse square law", which means that there is an inverse relation between the number of publications and the number of authors. It is depicted by $1/n^2$. In other words 60% of authors will have only one publications. $1/n^2$ can be further extrapolated, for example, ($1/2^2$ times 60) and ($1/3^2$ times 60). This means that 15% and 7% authors will have two and three publications, respectively[23-24]. By biblioshiny we applied Lotka's law to depict the authors frequency. Its apparent from the Fig. 1, that 1097 and 50 authors were involved in one (n=1) and two (n-2) publications, respectively.

The highest documents are published by Dormitzer, P.R. (n=6), Swanson, K.A. (n=6), Klimek, L. (n=5), Shi, P.Y. (n=5) and Tureci, O. (n=4). Institutionally, based on the Scopus data, the highest documents were published by Tel Aviv University (n=7), followed by Pfizer Inc. (n=6), UT Medical Branch at Galveston (n=5), Imperial College London (n=5), Universita degli Studi di Milano (n=5) and BioNTech SE (n=5). While, Harvard Medical School, Tel Aviv University, Sackler Faculty of Medicine, University of Toronto, Technical University of Munich, Klinikum rechts der Isar der Technischen Universitat Munchen and Zentrum Allergie und Umwelt all published four (n-4) documents.

Total 46 countries were directly involved in all publications. The highest documents were published by United States (n=48), Germany (n=22), United Kingdom (n=17), Italy (n=16) and Canada (n=13). Other countries in the list includes Israel (N=12), India (n=8), South Africa (n=6), Spain (n=6), Brazil (n=5), Australia (n=4) and Netherlands (n=4).

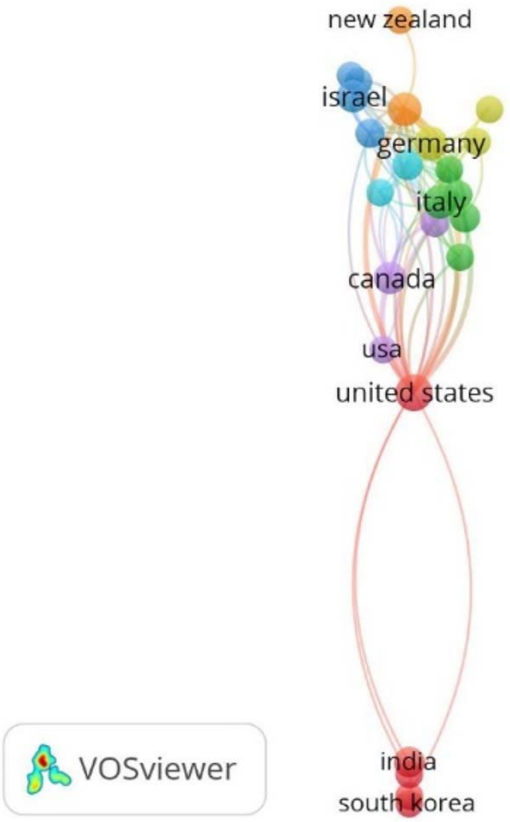


Fig. 4. The co-authorship network for countries.

The collaboration among authors, institutes, and countries could be explained by the fact that;

1. 28 authors (Polack F.P., Thomas S.J., Kitchin N., Absalon J., Gurtman A., Lockhart S., Perez J.L., Marc G.P., Moreira E.D., Zerbini C., Bailey R., Swanson K.A., Roychoudhury S., Koury K., Li P., Kalina W.V., Cooper D., Frenck R.W., Hammitt L.L., Tureci O., Nell H., Schaefer A., Ünal S., Tresnan D.B., Mather S., Dormitzer P.R., Sahin U., Jansen K.U., Gruber W.C., C4591001 Clinical Trial Group;
2. From 17 departments or hospitals (Fundacion INFANT, Buenos Aires, Argentina; ITrials-Hospital Militar Central, Buenos Aires, Argentina; State University of New York, Upstate Medical University, Syracuse, NY, United States; Vaccine Research and Development, Pfizer, Pearl River, NY, United States; Vaccine Research and Development, Pfizer, Hurley, United Kingdom; Vaccine Research and Development, Pfizer, Collegeville, PA, United States; Worldwide Safety, Safety Surveillance and Risk Management, Pfizer, Collegeville, PA, United States; Associacao Obras Sociais Irma Dulce and Oswaldo Cruz Foundation, Bahia, Brazil; Centro Paulista de Investigacao Clinica, Sao Paulo, Brazil; Global Product Development, Pfizer, Peapack, NJ, United States; Cincinnati Children's Hospital, Cincinnati, United States; Johns

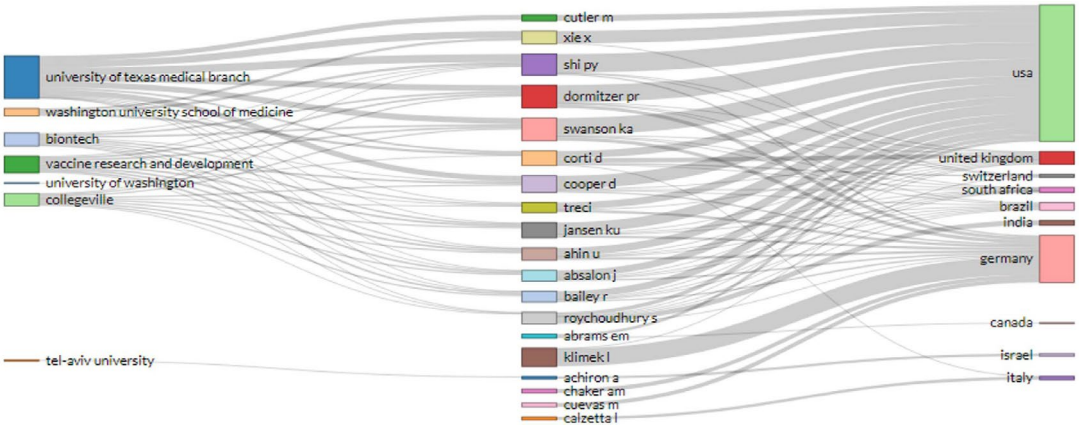
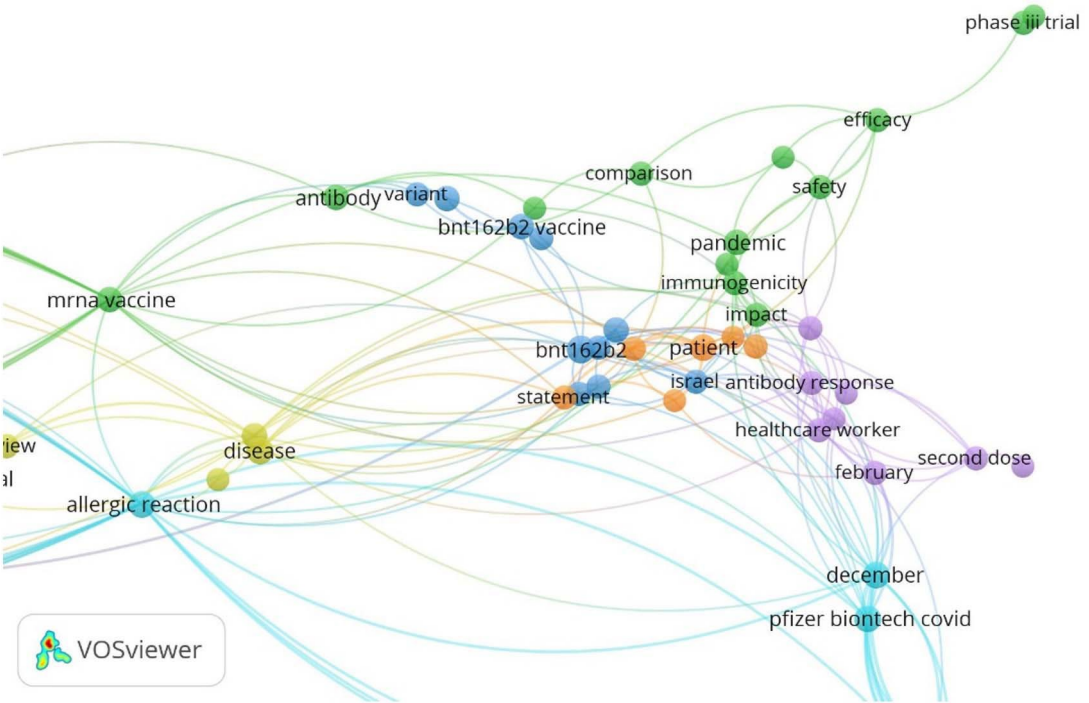
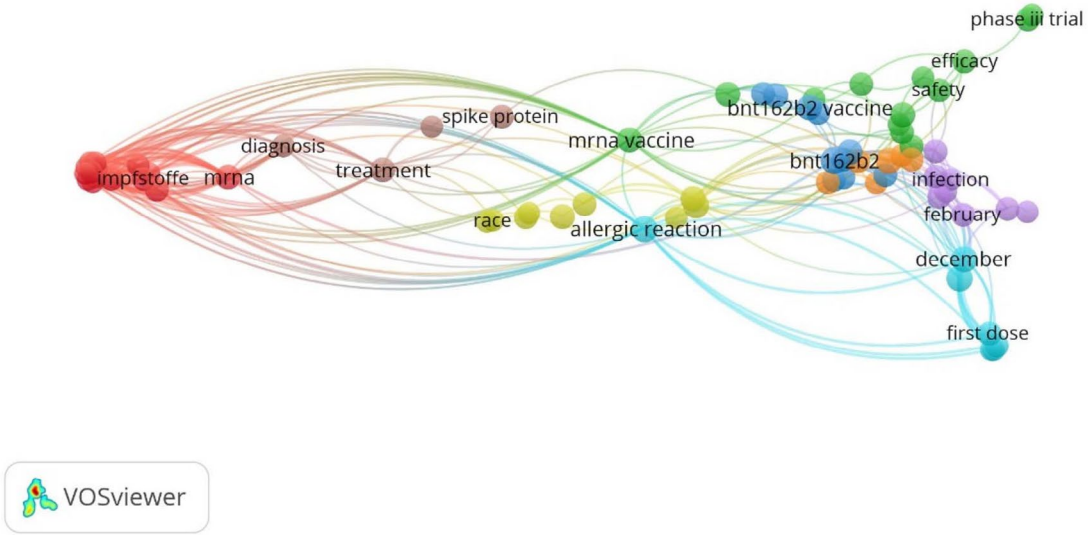


Fig. 5. The co-authorship network for authors, institutes and countries (three fields plot).

Hopkins Bloomberg School of Public Health, Baltimore, United States; BioNTech, Mainz, Germany; Medizentrum Essen Borbeck, Essen, Germany; Tiervlei Trial Centre, Karl Bremer Hospital, Cape Town, South Africa; Hacettepe University, Ankara, Turkey; Worldwide Safety, Safety Surveillance and Risk Management, Pfizer, Groton, CT, United States)



6A



6B

Fig. 6. The co-words analysis of publications.

3. From 7 countries (Argentina, Brazil, USA, UK, Germany, South Africa and Turkey) collectively contributed to a single article published in New England Journal of Medicine.

By Vosviewer we also presented the collaboration between those authors who have published atleast two documents. The data is depicted in Fig. 2. For example, in red cluster there are total eight authors. They collectively contributed to the following research documents.

1. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine
2. Safety and immunogenicity of two RNA-based covid-19 vaccine candidates
3. Neutralization of SARS-CoV-2 lineage B.1.1.7 pseudovirus by BNT162b2 vaccine–elicited human sera
4. Neutralization of SARS-CoV-2 spike 69/70 deletion, E484K and N501Y variants by BNT162b2 vaccine-elicited sera
5. Resistance of SARS-CoV-2 variants to neutralization by monoclonal and serum-derived polyclonal antibodies
6. BNT162b vaccines protect rhesus macaques from SARS-CoV-2

Interestingly these authors were from different institutes as shown in Fig. 3 A and B. Furthermore, twenty-six countries have published atleast two research documents. Their interconnectivity is described in Fig. 4.

While, by three fields plot we also represented authors, institutes, and countries in the same diagram (Fig. 5).

Sources

The documents are published in 102 sources. The highest documents are published in Vaccines (n=8) and Nature Medicine (n=5). However, the highest citations were noted for New England Journal Of Medicine (n=838), followed by Morbidity And Mortality Weekly Report (n=66) and Nature (n=46). The list of top 20 sources with H-index, g-index and m-index details are described in table 2.

Co-words Analysis

Based on the co-words analysis it was noted that the publications focused on clinical trials (Phase 1, 2 and 3 Clinical Trial). Different subject groups were included (young to aged) in reports. The drug designing, safety, administration, dosage, side effects of bnt162b1 and bnt162b2 was explored for the possible treatment of COVID-19. The authors also analyzed various symptoms associated with COVID i.e. fatigue, fever, headache, inflammation, infection, injection site pain, and mortality (caused by). The genetic & immune response and epidemiology was also studied in detail. The co-words are described in Fig. 6 A &B.

Limitations

One of the major limitations of the present study is that we only explored Scopus. Other common databases, such as PubMed, Embase, and WoS, were not searched. Thus, some influential papers may have been missed. Therefore, future bibliometric studies with other databases are recommended which may complement the present findings. We also did not analyze letters, notes, editorials, conference papers etc. Most of the articles are recently published. Ample time is required to get proper citations. Consequently, it may affect the rankings of the manuscript (based on citations). Citation analysis may have spelling, names changes, homonyms, clerical errors, addition of post codes, language biases and problem with journal impact factors. However we did not consider it in the present report. Furthermore, we did not analyze self-citations, which may affect the total citation count.

CONCLUSION

There are various bibliometric reports about the COVID-19. To the best of our knowledge, this is the first study in which we summarized the publication histroy of the Pfizer-BioNTech vaccine. Initially, we discussed the advantages and disadvantage of bibliometric studies. Later some information about the novel therapeutics and vaccine development for COVID-19 is added. Based on the Scopus record, one hundred and seventy three (n=173) research documents (91 articles & 42 reviews) are published about Pfizer vaccine. Based on biblioshiny analysis, the local and global citation record is provided. We also briefly discussed the top five cited documents. 1160 authors have significantly contributed to all publications. The collaborative index (CI) was found to be 9.47. By Lotka's Law, we provided breif informaqtion about the frequency of publication of authors. For example, 1097 authors contributed

to only one publication. Based on the number of publication, details about the top authors, university and country is provided. By Vosviewer analysis we presented the collaboration between authors, institutes, and countries. The documents are published in 102 sources. The citations details (h-index, g-index and m-index) of the top 20 sources are also provided. Last but not the least, the trend and focus of publication is depicted by co-words analysis.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

Both the authors have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

FUNDING

None.

DATA AVAILABILITY

The data is retrieved from the Scopus database.

ETHICS STATEMENT

Not applicable.

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