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A Comparative Study on Different Approaches of COVID-19 Vaccines

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ABSTRACT

Worldwide recorded 324 million human infected coronavirus patients and a mortality rate of over 5.53 million till now. In this situation coronavirus type-2 has suddenly arisen as a global problem. It impacts all humans directly via disease and death and indirectly by isolation creates a tremendous financial and psychological barrier. It remains the most feasible method so far but is untenable beyond a lengthy period. At this time vaccine development is the most helpful strategy for controlling emerging virus strains. Pfizer/BioNTech (Ribonucleic acid vaccine), Johnson and Johnson, Novavax (UK), AstraZeneca, Sinovac (China), Moderna (Ribonucleic acid), CanSinoBio, and Covishield (India) etc. are among the firms involved in the continuing vaccination program, which is taking place all over the world. This assessment covers all aspects of COVID-19 and concentrates on the following approaches. Besides AI systems, advanced drug delivery systems (nanotechnology) and a trained immunity vaccination method are being used to advance the COVID-19 vaccine development cycle. We give a glimpse of a comparative evaluation of global vaccination approaches, efficacy, adverse effects, worldwide reached vaccination, a general review of clinical trials coronavirus disease-2019 vaccines also vaccine effectiveness against novel coronavirus variants based on real-world data. Also, variants considered is the influence of disquieting variants and under of interest.

Keywords: COVID-19, nanotechnology, vaccine approaches, variants.

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I. Introduction

Coronavirus is a non-segmented, enclosed virus of the Nidovirales family containing positive-sense RNA as genetic material, it is a member of the Coronaviridae family. A coronavirus-related viral respiratory illness caused by a SARS-associated coronavirus [1].

However, the first coronavirus incidence was identified in 1960. It was discovered during an epidemic in late February 2003 for the first time. It started in China's Guangdong province in late 2002 and swiftly expanded worldwide along aviation channels, eventuating in8,450 incidents and 810 deaths in 33 nations and territories across five continents [2].

First cases of original viral pneumonia were linked epidemiologically [3], [4]. Against Coronavirus produce vaccines were created pre-clinically after the 2002-2004 SARS outbreak, and two were tried in phase I trials. This coronavirus was eliminated from human society in 2004, but no evidence of it has been found since then, at this moment there had been a stop in development. Different non-aquatic species including bats, pangolins, and rabbits were available for purchase fish marketplace in Wuhan city, in advance of an epidemic. The disease has been identified there for the first time in December 2019 [5].

After the arrival of COVID-19, many effective Vaccines are frontline. Various approaches will be developed they can prevent morbidity and mortality for COVID-19 disease [6]. Such as Nanoparticle-based strategies, Ayurveda, Lockdown, Artificial Intelligence, Trained immunity vaccine strategies. Many nations, even the wealthiest with the strongest healthcare system announced a state of emergency as a result of the corona pandemic. Inactivated or weakened virus vaccines, protein-based vaccinations, RNA and DNA vaccines, and viral vector vaccines are all being developed as potential vaccines.

Whenever patients went from a community transmission region or engaged with a COVID-19 patient in the previous 14 days, they were considered suspected cases. Because of

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lockdown applied, it was nearly possible to control SARS COV-2 transmission [7]. Advanced drug delivery system based such as nanoparticle which is primarily used to identify the virus inside the human body but seems to be effective in asymptomatic individuals. Artificial intelligence evaluated the SARS-CoV-2 genome for epitope possibilities in recent times, using learning algorithms that can autonomously make corrections or learn methods. According to research antigenic determinants might lead to more effective vaccines and neutralizing antibodies [8]-[10].

In 2020 the coronavirus pattern was discovered on 11 January [11], [12]. On the eleventh of March, after it was discovered that Coronavirus disease-2019 followed the coronavirus pattern, the WHO officially designated it a pandemic [13]. The first clinical study of a coronavirus vaccine began in March 2020, following the introduction of the fatal illness Coronavirus (NCT04283461).

24 June, China approved the CanSino (Viral vector non-replicating) vaccine, and two inactivated viral vaccines that can be used in high-risk fields in the case of emergencies. In Russia, the (Sputnik-V) vaccination was approved on an emergency basis on the 11th of August. The Pfizer–BioNTech collaboration presented a (BNT162b2) messenger ribonucleic acid (mRNA) vaccine EUA proposal to the organization that controlled the administration of food and drug (US) on November 20, 2020[14].

In addition, on 11th December the vaccine was authorized by the organization that controlled the administration of food and drug (US) for emergency use authorization. Since about 21 December, several nations, including the EU officially authorized and approved the vaccine. After a week emergency use was issued for the (Moderna: Spikevax) vaccines (Ribonucleic acid type) (mRNA-1273). An inactivated vaccine is Carnivac-Cov for large predators, most particularly pets. According to the Government of Russia, Carnivac-Cov, the first COVID-19 vaccination for animals, was issued thirty-first March 2021. In addition, the research work published in June 2021 has been created the UB-612 vaccination by COVAX in the United States. [19]

Now 9.8 billion COVID-19 vaccine dosages were administered through January 22, 2022 [11], [15]. According to the Norwegian Medicines Agency, 33 probable adverse medication effects have been discovered in Norway, including several fatal incidents following BioNTech & Pfizer vaccines [16]. The global report of vaccination process and comparison with different country situations: Dose administered worldwide 9,819,660,020 people. Fully vaccinated population 4,070,565,084 like almost 53.60%. China is the most dose administered country, with almost 2,956,218,000 and a fully vaccinated ratio of 86.69%. The vaccine being used in this country is Sinovac, Sinopharm/Beijing/Wuhan, CanSino. Globally after China also India was most drug administered their people which is 1,600,333,779[17]-[19].

The pandemic is now in various phases in many nations worldwide. It became clearer over these six months which tactics are more effective. In the meantime, there are high hopes for a definitive answer in the form of a successful vaccine. Many contenders are now being evaluated, including a handful in the phase 4trial [20].

A. Different Approaches in COVID-19Vaccine

Mainly COVID-19 outbreak start in Wuhan, which is situated in China in 2019 and it gradually spread over the whole earth. So, we need an effective vaccine as a frontliner. Different researchers work together to develop an efficient vaccine that can confine morbidity and mortality from this disease [21].

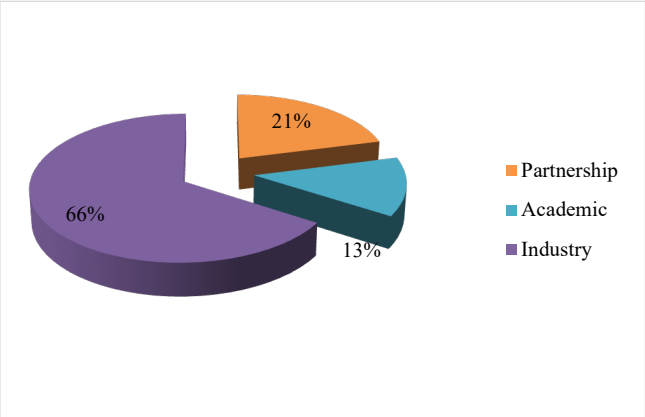
Researchers work with different strategies like- Artificial intelligence, Nanotechnology, and trained immunity strategies. To design a proper vaccine, we need to study different terms such as Antigen, adjuvant, manufacturing system, and delivery strategy.

Antigen: Antigen is a foreign component that may incline an immune response in our body. The vaccine can be categorized based on how the antigen is presented. These are live attenuated vaccine, inactivated vaccine, Subunit vaccine, and Peptide-based vaccine.

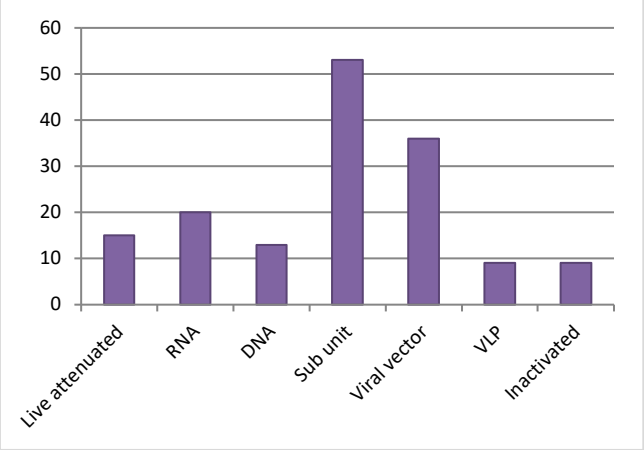
Adjuvant: It is a stimulatory agent that is planned to promote an immune response to an antigen (Co-delivered). Then Nano-carrier and device part come [22].

The main concern of vaccine design is- Antigen selection, Vaccine platforms, and finally vaccination routes and regimen [23].

B. Candidates Who Contribute to Developing COVID-19 Vaccine and Also Vaccine Types



(a)



(b)

Fig. 1. DifferentCOVID-19 vaccine developer (a) and their types (b) [22].

Here the pie chart elucidates the vaccine developer percentage as we see 66% of vaccines are developed

industrially some of them are also developed by the partnership. There is also some vaccine developed academically the percentage is 13%. The right-handed column explained the developed vaccine type here the major vaccine are subunit vaccines.

C. The strategy of COVID-19 Vaccine development

1) Artificial Intelligence

COVID-19 pandemic situation is getting worst day by day. So, scientists and researchers all around the world work with a different kind of vaccine development strategy. Artificial intelligence strategy is one of them. Mainly, large databases are processed by Artificial intelligence strategy in a more modified way. Diverse possible targets, repurposing, and vaccine applicants are easily identified faster by this technology. There are several vaccines are in late-stage clinical trials which may effective against COVID-19. Still, the screening program which is Artificial intelligence-based is in a formative state. Proper screening and research may turn it into useful against this life-threatening disease [24].

2) Nanotechnology

Nanotechnology strategy is an effective vaccine development strategy that helped catalyze novel candidate vaccines for clinical testing. It is also a faster procedure. Nowadays there is a lot of vaccines developer already working with nanotechnology like the inactivated vaccine, MRNA, Viral vector vaccine. As mRNA vaccines released by lipid nanoparticles and viral vector vaccine also work with this technology and some of them also reached in phase II & III clinical trials.

3) Trained Immunity Vaccine strategy

It is also acquainted as innate immune memory [25]-[28]. Recently it involved with vaccine development strategy as BCG Vaccine offers a level of protection againstCOVID-19 and it is also developed by trained immunity [29]. We can see these types of strategies in live attenuated COVID-19 vaccines. Here, trained immunity inclines for mediated non-specific conservative responses, which work on heterogonous infection [25], [27], [30].

Here, the column chart interprets the difference in the time duration between the COVID-19 vaccine and the classical vaccine. COVID-19 vaccine doesn't take any time in pre-clinical stage and phase III stage while the general vaccine takes 48 to 60 months.

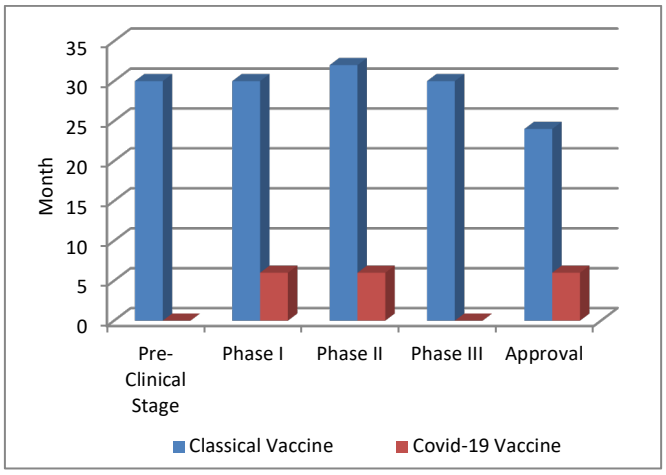
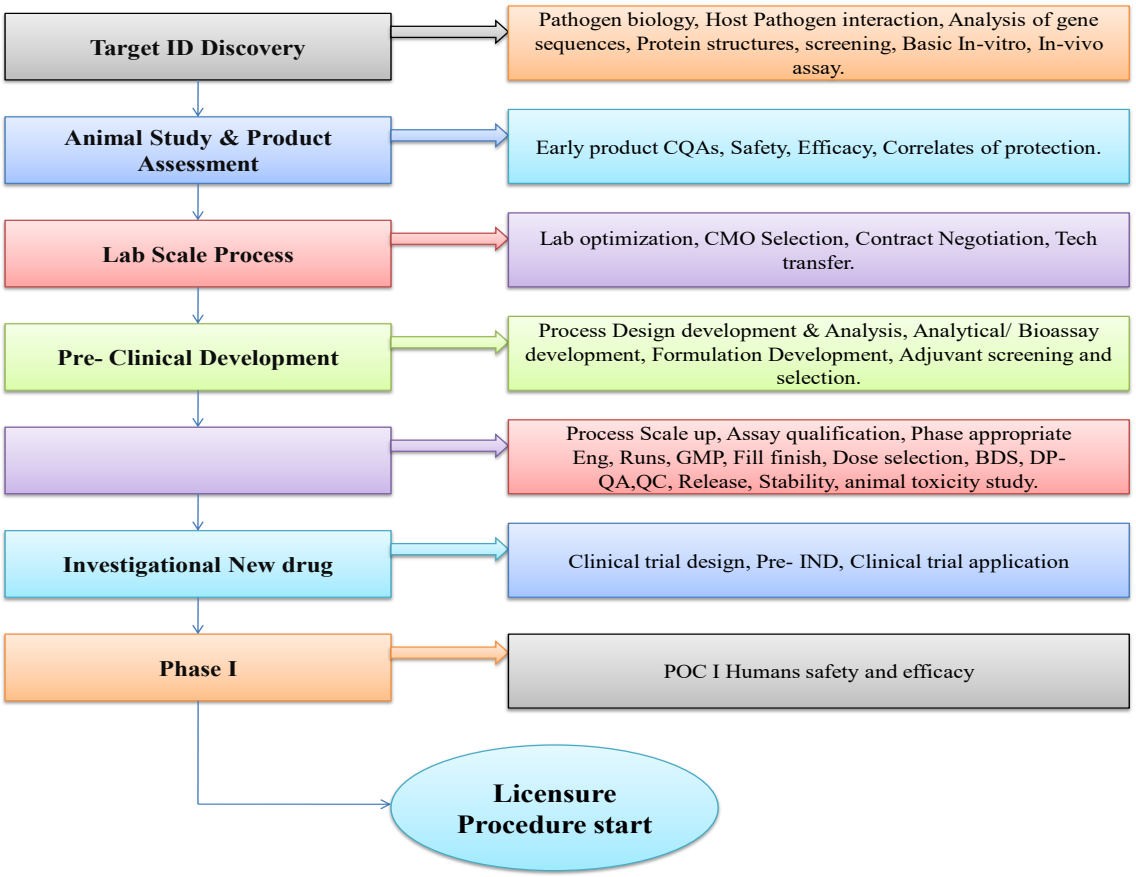


Fig. 2. Time duration ofCOVID-19 vaccine compared to the classical vaccine [32].

4) General Vaccine Development Pathway vs COVID-19 Vaccine Development Pathway



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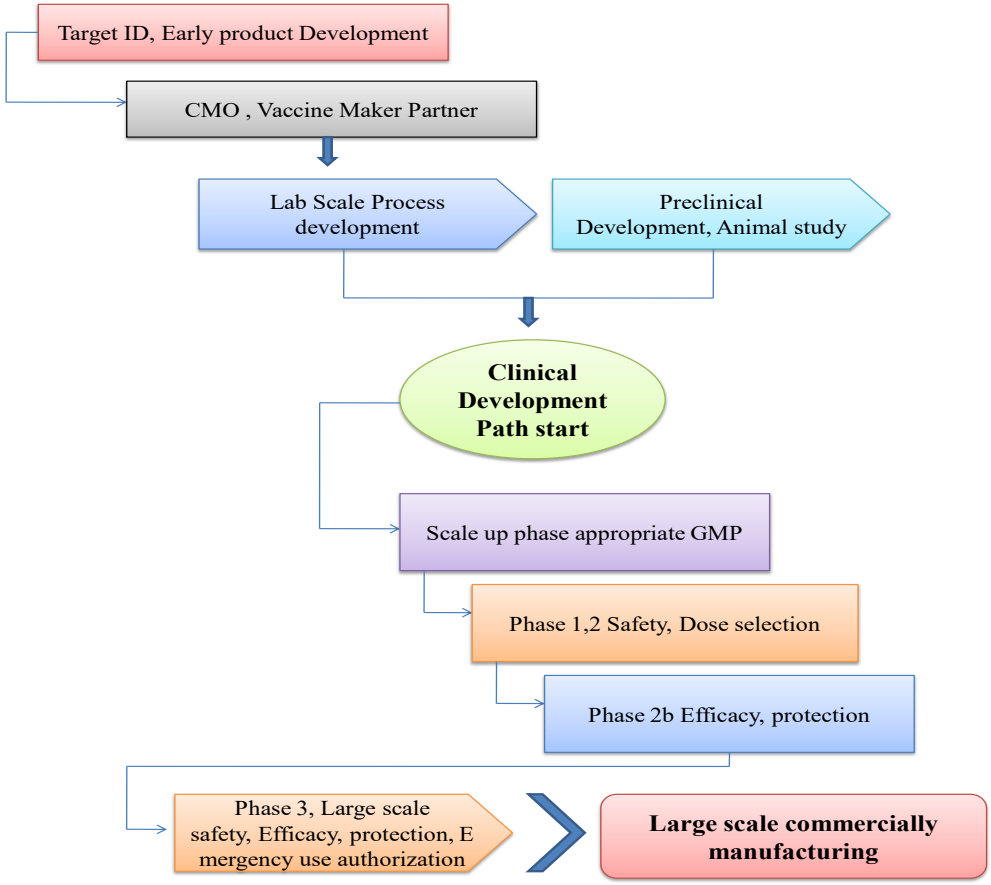

Fig. 3. Difference between general vaccine development pathway and COVID-19 vaccine development pathway [31].

5) Common Strategy forCOVID-19Vaccine

TABLE I: SOME COMMON COVID-19 VACCINE STRATEGIES AND THEIR TYPES [22]

Vaccine	Strategy	Vaccine Type
Sinovac	Here, inactivate virus particles combined with an adjuvant.	Inactive Vaccine
NVX-CoV2373	Pre-fusion S Protein which is stable is given with adjuvant (Saponin based)	Subunit Vaccine
AstraZeneca	Chimpanzee adenovirus vaccine vector (ChAdOx1)	Non- replicating viral vector vaccine
Shenzhen Geno-Immune Medical Institution	First of all, dendrite cells need to be modified and its expressing SARS-CoV-2 minigenes. Secondly, SARS-CoV-2 minigenes are expressed by synthetic antigen-presenting cells.	Non- replicating viral vector vaccine
COVID-19 mRNA vaccine Moderna	It is an mRNA vaccine which is works by prefusion ballast S protein.	Ribonucleic acid (RNA) Vaccine
Pfizer, BioNTech	It is an mRNA vaccine where lipid nanoparticle takes on.	Ribonucleic acid (RNA) Vaccine
Inovio Pharmaceutical company	This vaccine is work by optimizing the DNA vaccine which is given by electroporation.	Deoxyribonucleic acid (DNA) Vaccine

D. Comparative Studies on DifferentCOVID-19 Vaccine Strategies

DifferentCOVID-19 Vaccines work with different strategies. Nanotechnology, Artificial Intelligence, Trained immunity Vaccine strategy are common them.

The main feature of nanotechnology is that it is highly relevant to counter nano particle-like viruses. It also helps to design Nanocarriers for vaccine development and these carriers are used to make drug release profile, helps to increase surface area, and also gives protection from degradations. Moderna and Pfizer/ BioNTech first use Nanotechnology for developing the mRNA-based vaccine [33]. While by using machine learning leverage the learning of pre-existing data could be made by combined effort. A mainly Broad-ranging collection of peptides, epitopes, and small molecules are needed for the development of vaccines, and these are easily done by AI-based model and screening intelligently [34]. Then, the Trained immunity vaccine strategy work by inducing trained immunity in the human body.

This Bar chart illustrates the percentage of vaccinated people. Here we select a highly populated country and also the highly affected country. Though China is a highly populated country they are doing great in vaccination. Their 85% population is fully vaccinated. We also show The African countries do not have a good position here as only 27% population is fully vaccinated in South Africa while 37% of Bangladeshi people are fully vaccinated.

This line diagram illustrates the worldwide reached vaccine. Here Oxford- AstraZeneca vaccine is reached the highest number of countries. Though Pfizer-BioNTech vaccine reached 146 countries. we also show a less reached vaccine that is Novavax which is reached only in 2 countries. Researches still try to develop different types of vaccines for COVID-19 disease we think day by day these vaccines get reach globally and help Human beings.

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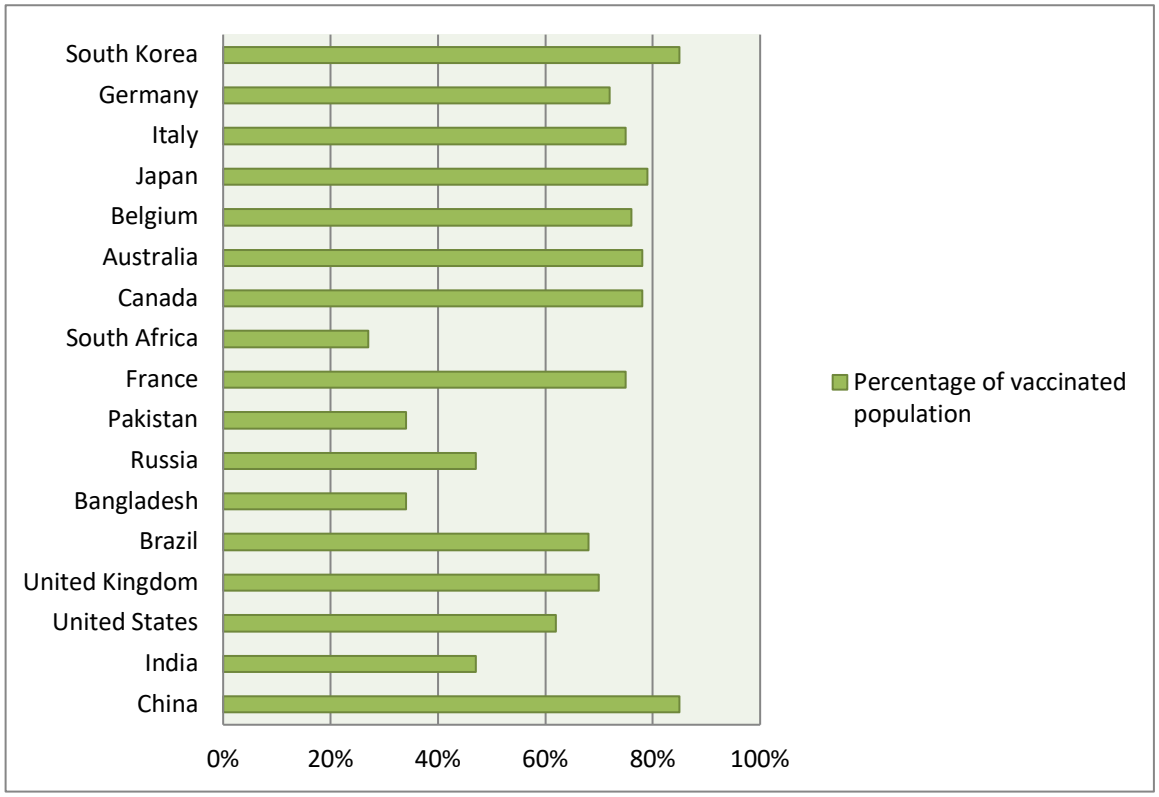

Fig. 4. The percentage of the fully vaccinated population according to highly affected and highly populated country (Till 17 January 21, 2022) [35].

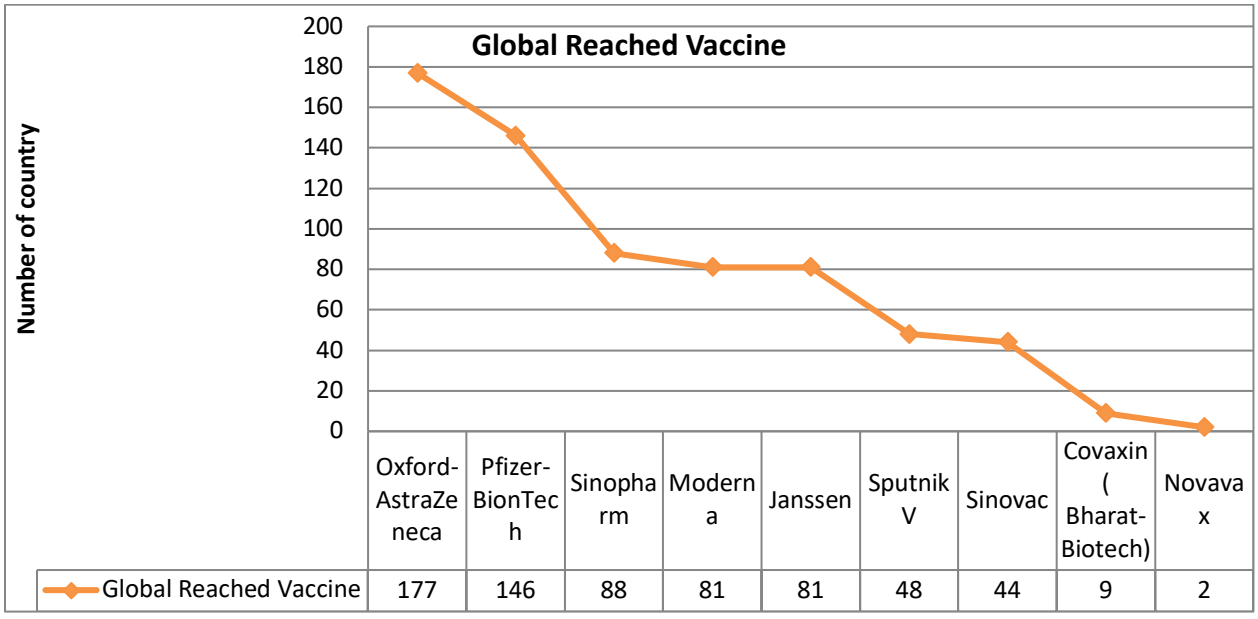

Fig. 5. Worldwide reached Vaccine (Till 6 December 2021) [35].

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E. Overview Of Authorized or Official ApprovalCOVID-19 Vaccines Worldwide

TABLE II: AMONG THE INFORMATION INCLUDED ARE THE SERIAL NUMBER, NAME OF THE VACCINE, TYPE IN ONE WORD, DOSAGE FORM, NAME OF THE MANUFACTURER, FIRST PUBLISHED DATE AND REFERENCE[19]

SI No.	Vaccine Name	Vaccine platform description	Administration			Approval information			(Developer/manufacturer)
			Storage	Route	Dosage	Date	Age Range	Approval Countries	
1.	Sinovac: CoronaVac	Inactivated virus (IV)	Stable Conditions: 2 to 8°C	IM	Two does	11-01-2021	≥18 y old	51	Sinovac Biotech Ltd
2.	Covilo	Inactivated virus (IV)	Stable Conditions: 2 to 8°C	IM	Two does	21-08-2020	≥18 y old	85	China National BioNTech Group Company
3.	Covaxin, BBV152	Inactivated virus (IV)	Stable Conditions: 2 to8°C	IM	Two does	03-11-2021	≥18 years	13	Bharat Biotech
4.	mRNA-1273	Ribonucleic acid (RNA)	Stable Conditions: −50 ~ −15°C; 2 to 8°C (30 d); 8 to 25°C (24 hours)	IM	Two does	18-12-2020	≥18 y old	85	Moderna/NIAID
5.	Tozinamera, BNT162b2	Ribonucleic acid (RNA)	Stable Conditions: −80 ~ −60°C; 2 to 8°C for a month	IM	Two does	20-11-2020	≥16 y old	132	BioNTech/ Pfizer/ Fosun Pharma
6.	Vaxzevria, ChAdOx1 nCoV-19.	VVNR	Stable Conditions: 2 to 8°C	IM	Two does	30-12-2020	≥18 y old	134	AstraZeneca/ Oxford University
7.	Covishield (Oxford/ AstraZeneca formulation)	VVNR	Stable Conditions: 2 to 8°C	IM	Two does	30-12-2020	≥18 y old	47	Serum Institute of India
8.	Ad26.COV2. S	Non-replicating Viral vector (VVNR)	Stable Conditions: 2 to 8°C (3 months)	IM	one dose	1-03-2021	≥18 y old	101	Janssen (Johnson & Johnson)
9.	Novavax: Nuvaxovid, NVX-CoV2373	PS	Stable Conditions: 2 to 8°C	IM	Two does	17-12- 2021	≥18 y old	31	Serum Institute of India (COVOVAX)
10.	COVOVAX (Novavax formulation)	PS	Stable Conditions: 2 to 8°C	IM	Two does	17-12- 2021	≥18 y old	3	Serum Institute of India

TABLE III: CURRENT SCENARIO OF CLINICAL TRIALS FOR COVID-19 VACCINES [19], [36]

SI. No.	Names of candidate vaccine	Vaccine platform description	Number of Dosage	Clinical trials (Phase)	Route	Manufacturer Country
1.	CoronaVac	Inactivated vaccine	2	IV	IM	China
2.	Verocell	Inactivated vaccine	2	IV	IM	China
3.	BBIBP-CorV, Covilo.	Inactivated vaccine	2	IV	IM	China
4.	AZD1222,Vaxzevria.	Non-replicating Viral vector	1-2	IV	IM	United Kingdom
5.	Ad5-nCoV.	Non-replicating Viral vector	1	IV	IM	China
6.	Ad5-nCoV-IH.	Non-replicating Viral vector	1	III	IH	China
7.	Gam-COVID-Vac, SputnikV	Non-replicating Viral vector	2	III	IM	Russia
8.	Ad26.COV2. S.	Non-replicating Viral vector	1-2	IV	IM	China
9.	SARS-CoV-2rS	PS	2	III	IM	USA
10.	mRNA-1273, Spikevax.	RNA based vaccine	2	IV	IM	USA
11.	BNT162b2(3LNP-mRNAs), Comirnaty.	RNA based vaccine	2	IV	IM	China
12.	Zifivax	PS	2-3	III	IM	China
13.	CVnCoV	RNA based vaccine	2	III	IM	
14.	Inactivated (verocells)	Inactivated vaccine	2	III	IM	China
15.	QazVac	Inactivated vaccine	2	III	IM	Kazakhstan
16.	INO-4800	DNA	2	III	ID	China
17.	AG0301-COVID19	DNA	2	II/ III	IM	Japan
18.	ZyCoV-D	DNA	3	III	ID	India

TABLE III: CURRENT SCENARIO OF CLINICAL TRIALS FOR COVID-19 VACCINES [19], [36] *(CONT)*

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SI. No.	Names of candidate vaccine	Vaccine platform description	Number of Dosage	Clinical trials (Phase)	Route	Manufacturer Country
19.	GX-19N,GX-19	DNA	2	II/ III	IM	South Korea
20.	BBV152, covaxin.	Inactivated vaccine	2	III	IM	India
21.	KBP-201	PS	2	I/II	IM	USA
22.	CoV2 preSdTM adjuvanted vaccine (B.1.351)	PS	2	III	IM	France & USA
23.	ARCT-021.	RNA	NR	II	IM	USA
24.	RBDSARS-CoV-2HBsAgVLP	Virus like particle	2	I/II	IM	India
25.	InactivatedSARS-CoV-2vaccine (Verocell)	Inactivated vaccine	2	III	IM	China
26.	GRAd-COV2	Non-replicating Viral vector	1	II/ III	IM	Italy
27.	VXA-CoV2-1.1-S	Non-replicating Viral vector	2	II	Oral	USA
28.	MVA-SARS-2-S	Non-replicating Viral vector	2	I	IM	Germany
29.	SCB-2019	PS	2	III	IM	China
30.	COVAX-19	PS	2	III	IM	Australia
31.	MVC-COV1901	PS	2	IV	IM	Germany
32.	FINLAY-FR-1A	PS	2	II	IM	Cuba
33.	FINLAY-FR-2, PastuCovac	PS	2	III	IM	Cuba
34.	EpiVacCorona	PS	2	III	IM	Russia
35.	Recombinant (Sf9 cell)	PS	2	III	IM	China
36.	CoVac-1	PS	1	I/II	SC	Germany
37.	UB-612	Protein subunit	2	II/ III	IM	USA
38.	DelNS1-2019-nCoV-RBD-OPT	Replicating Viral vector	2	III	IN	China
39.	LNP-nCoVsaRNA	RNA	2	I	IM	US
40.	ARCoV	RNA	2	III	IM	China
41.	CoVLP, MT-2766	Virus like particle	2	III	IM	Canada
42.	COVID-19/aAPCvaccine	Replicating Viral vector +APC	3	I	SC	China
43.	LV-SMENP-DC	Non-replicating Viral vector+APC	1	I/II	SC&IV	China
44.	AdimrSC-2f	PS	NR	I	NR	Taiwan
45.	CovigenixVAX-001	DNA	2	I	IM	Canada
46.	CORVax12	DNA	2	I	ID	Washington, US
47.	ChulaCov19mRNA	RNA	2	I	IM	Thailand
48.	bacTRL-Spike	DNA	1	I	Oral	Canada
49.	hAd5-COVID-19	Non-replicating Viral vector	1-2	I/II	SCorOralorSL	United States
50.	COH04S1	Non-replicating Viral vector	1-2	I	IM	California, US
51.	IIBR-100, Brilife	Replicating Viral vector	1	II/ III	IM	Israel
52.	AV-COVID-19.	Replicating Viral vector +APC	1	II	IM	United States
53.	COVI-VAC	Live attenuated virus	1-2	III	IN	New York
54.	CIGB-669	PS	3	I/II	IN	Cuba
55.	CIGB-66	PS	3	III	IM	Cuba
56.	VLA2001	Inactivated vaccine	2	III	IM	UK
57.	BECOV2B	PS	2	III	IM	India
58.	AdCLD-CoV19	Non-replicating Viral vector	1	I/II	IM	South Korea
59.	GLS-5310	DNA	2	I/II	ID	South Korea
60.	Nanocovax	PS	2	III	IM	Vietnam
61.	S-268019	PS	2	I/II	IM	Japan
62.	AKS-452X	PS	1-2	II	SCorIM	Netherlands
63.	TURKOVAC,ERUCOV-VAC	Inactivated Virus	2	III	IM	Turkey
64.	COVAC 1and 2	PS	2	I/II	IM	Canada

TABLE III: CURRENT SCENARIO OF CLINICAL TRIALS FOR COVID-19 VACCINES [19], [36] *(CONT)*

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SI. No.	Names of candidate vaccine	Vaccine platform description	Number of Dosage	Clinical trials (Phase)	Route	Manufacturer Country
65.	GBP510	PS	2	III	IM	South Korea
66.	RaziCovPars	PS	3	III	IMandIN	Iran
67.	CovIran-Barkat	Inactivated Virus	2	II/ III	IM	Iran
68.	MF59.	PS	2	I	IM	Australia
69.	COVIGEN	DNA	2	I	IDorIM	Australia
70.	COVID-eVax	DNA	2	I/II	IMor IM+electroporation	Italy
71.	BBV154	Non-replicating Viral vector	1	I	IN	Italy
72.	PTX-COVID19-B	RNA	2	II	IM	Canada
73.	CpG 1018	Inactivated vaccine	2	I/II	IM	Thailand
74.	CoV2SAM(LNP)vaccine	RNA	2	I	IM	England
75.	VBI-2902a	Virus like particle	2	I/II	IM	Canada
76.	SKSARS-CoV-2	PS	2	I	IM	South Korea
77.	ChimpanzeeAdenovirusserotype68(ChAd)	Non-replicating Viral vector	2-3	I	IM	California, US
78.	mRNA-1273.351	RNA	3	IV	IM	Maryland, US
79.	SpFN Vaccine	PS	2-3	I	IM	United States
80.	EuCorVac-19	PS	2	I/II	IM	South Korea
81.	FAKHRAVAC(MIVAC)	Inactivated vaccine	2	I	IM	Iran
82.	MV-014-212	Live attenuated virus (LAV)	1	I	IN	United States of America
83.	MRT5500	RNA	2	II	IM	United States of America
84.	SARS-CoV-2VLP	Virus like particle	2	II	SC	Turkey
85.	ReCOV(CHOcell)	PS	2	II/ III	IM	New Zealand
86.	DS-5670a	RNA	2	II/ III	IM	Japan
87.	Koçak-19	Inactivated Virus	2	I	IM	Turkey
88.	COVIVAC	Replicating Viral vector	2	I/II	IM	Russian Federation
89.	SC-Ad6-1	Non-replicating Viral vector	1-2	II	IM	Australia
90.	ABNCoV2	Virus like particle	2	I	IM	Germany
91.	V-01	PS	2	III	IM	China
92.	HDT-301	Inactivated vaccine	2	I	IM	Brazil
93.	AdjuvantedinactivatedvaccineagainstSARS-CoV-2.	RNA	2	I	SC	Turkey
94.	mRNA-1283	RNA	2	I	IM	United States of America
95.	RecombinantSARS-CoV-2Vaccine (CHO cell)	PS	2	I/II	IM	China
96.	EXG-5003	RNA	1	I/II	ID	Japan
97.	KD-414	Inactivated Virus	2	II/ III	IM	Japan
98.	rNDV vector vaccine	Inactivated vaccine	2	I	IMorIN	Mexico
99.	mRNACOVID-19	RNA	2	I	IM	China
100.	CoVepiTvaccine	PS	1-2	I	SC	Belgium
101.	Modified Vaccinia Virus Ankara(MVA)vector	Non-replicating Viral vector	2	I/II	IM	Germany
102.	CoV2-OGEN1	PS	1-2	I	Oral	New Zealand
103.	QazCoVac-P	PS	2	I/II	IM	Kazakhstan
104.	LNP-nCOVsaRNA-02	RNA	2	I	IM	Northern Ireland (Uganda)
105.	mRNA-1273.211	RNA	1	II/ III	IM	America
106.	Noora vaccine	PS	3	III	IM	Iran
107.	BaiyaSARS-CoV-2	PS	2	I	IM	Thailand
108.	SCB-2020S	PS	2	II	IM	Australia
109.	PIV5	Non-replicating Viral vector	1	I	IN	America

TABLE III: CURRENT SCENARIO OF CLINICAL TRIALS FOR COVID-19 VACCINES [19], [36] *(CONT)*

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SI. No.	Names of candidate vaccine	Vaccine platform description	Number of Dosage	Clinical trials (Phase)	Route	Manufacturer Country
110.	AZD2816	Non-replicating Viral vector	2	II/ III	IM	UK
111.	202-CoV	PS	2	I	IM	China
112.	AG0302-COVID19	DNA	2-3	I/II	IM	Japan
113.	HIPRA SARS-CoV-2	PS	2	II	IM	Spain
114.	Versamune-CoV-2FCvaccine, recombinantS1antigen	PS	2	I/II	NR	Brazil
115.	ARCT-154	RNA	2	III	IM	Viet Nam
116.	ARCT-165	RNA	2	I/II	IM	United States of America
117.	ARCT-021	RNA	2	I/II	IM	Singapore, United States of America
118.	SIIB.1.351	PS	2	I/II	IM	Australia
119.	SIIBivalent	PS	1	I/II	IM	Australia
120.	SIIB.1.617.2	PS	1-2	I/II	IM	Australia
121.	AAV5-RBD-S, BCD-250	Non-replicating Viral vector	1	I/II	IM	Russian Federation
122.	SCTV01C	PS	1	II/ III	IM	China
123.	KoviVac	Inactivated Virus	2	I/II	IM	Russia
124.	COVIDITY	DNA	2	I	ID/IM	South Africa
125.	COVID19OralVaccineConsistingofBacillusSubtilisSpores	Bacterial antigen-spore expression vector (BacAg-SpV)	3	NA	Oral	China
126.	VB10.2129	DNA	1-2	I/II	IM	Norway
127.	VB10.2210	PS	1-2	I/II	IM	Norway
128.	SARS-CoV-2ProteinSubunit Recombinant Vaccine	PS	2	I/II	IM	Indonesia
129.	PIKA COVID-19 Vaccine	PS	2	I	IM	New Zealand
130.	SARS-CoV-2DNAvaccine	DNA	2	I	IM	Hong Kong
131.	Ad5-triCoV/Mac	Non-replicating Viral vector	1	I	IE	Canada
132.	PepGNP-SARSCoV2	PS	2	I	ID	Switzerland
133.	IN-B009	PS	2	I	IM	Republic of Korea
134.	LYB001	Virus like particle	3	I	IM	China
135.	CoviVax	Inactivated vaccine	2	I	IM	Egypt
136.	HDT-301	RNA	1-2	I	IM	United States
137.	VLPCOV-01	RNA	2	I	IM	Japan
138.	Osvid-19	Inactivated vaccine	2	I	IM	Iran
139.	Almansour-001	DNA	3	I	IM	Saudi Arab
140.	NDV-HXP-S	Replicating Viral vector	1	I	IN/IM	United States

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F. Different Variants of COVID-19

WHO identified 5 strains of COVID-19 as disquieting variants which are α, β, γ, O. Here is a short information about COVID-19 variants.

TABLE IV: DIFFERENT VARIANTS OF SARS-COV-2 [37], [38]

WHO entitle	CoV- Lineage	Initial reported specimen	Designation date
VOC			
α	B.1.1.7	09/2020 (UK)	18.12.2020
β	B.1.351	05/2020 (South Africa)	18.12.2020
γ	P.1	11/ 2020 (Brazil)	11.01.2021
δ	B.1.617.2	10/2020 (India)	VOI: 04.04.2021 VOC: 11.05.2021
O	B.1.1.529	02.11.2021 (Botswana) 14.11.2021 (South Africa)	31.11. 2021
VOI			
ε	B.1.427/B.1.429	03/2020 (USA)	05.03. 2021
ζ	P.2	04/2020 (Brazil)	17.03.2021
η	B.1.525	12/2020 Various countries	17.03.2021
θ	P.3	01/2021 (Philippines)	24.03.2021
ι	B.1.526	11/ 2020 (UK)	24.03.2021
κ	B.1.617.1	11/2020 (India)	04.04.2021

G. Vaccine Efficacy and Effectiveness against Variants of Coronavirus

At present COVID-19 variant Omicron spreading Worldwide day by day. It has become a cause of concern for us. But the good news is that divers' number of the vaccine may effective against this variant. According to Health line news, 2 doses Pfizer- BioNTech vaccine may be 70-75% effective against this variant, and with booster dose, it may be 85.9% effective.

The bar chart illustrates the vaccine efficacy and effectiveness against variants of Coronavirus.

First of all, in this bar chart we can see, vaccine efficacy of AstraZeneca (AZD1222) against Wuhan reference strain is 55-81% [39], Pfizer-BioNTech is 95% [40], Moderna is 94.1% [41], Johnson & Johnson is 66% [42], [43], Novavax(NVX-CoV2373) is 89% [44] and Sinovac (Coronavac) is 50-90% [45]. Compared with AstraZeneca, Moderna, Johnson & Johnson, Novavax and Sinovac, Pfizer-BioNTech shows highest efficacy against Wuhan reference strain.

Secondly, vaccine efficacy of AstraZeneca contrary Alpha (B.1.1.7) variant is 75%[46], Pfizer-BioNTech is 90% [47], Johnson & Johnson is 70%[48] and Novavax is 86% [49]. Here, Pfizer-BioNTech shows greatest efficacy in opposition to Alpha variant.

Thirdly, vaccine efficacy of AstraZeneca against Beta (B.1.3.51) variant is 10% [50], Pfizer-BioNTech is 75% [48] and Novavax is 60% [49]. Moderna lessened levels of neutralizing immunoglobulin52 and Johnson & Johnson shows 72% potency in the United State of America. It shows 66% and 57% efficacy respectively Latin America and South Africa[49]. Compared with other vaccines Pfizer-BioNTech shows highest efficacy against Beta variant.

Fourthly, vaccine efficacy of Johnson & Johnson is 68% [48] against Gamma (B.1.1.28.1) variant and Sinovac is 51 [52]. Moderna lessened levels of neutralizing immunoglobulin [51]. Compared with Sinovac, Johnson & Johnson shows greatest efficacy.

Finally, AstraZeneca shows 92% effectiveness in opposition to people who were hospitalized [53] and one dose effectiveness estimated at 60-71% [54] against Delta (B.1.617.2) variant. Pfizer-BioNTech shows lower average plaque reduction neutralization concentration of at least 40 [54], one dose of vaccine is 88% effective [55] against Delta variant. Moderna shows minor serum neutralization concentration (6.8-fold) but still neutralized by recuperating sera from most vaccinated individual [53].

Overall, Pfizer-BioNTech shows better efficacy against COVID-19 variants than other vaccines.

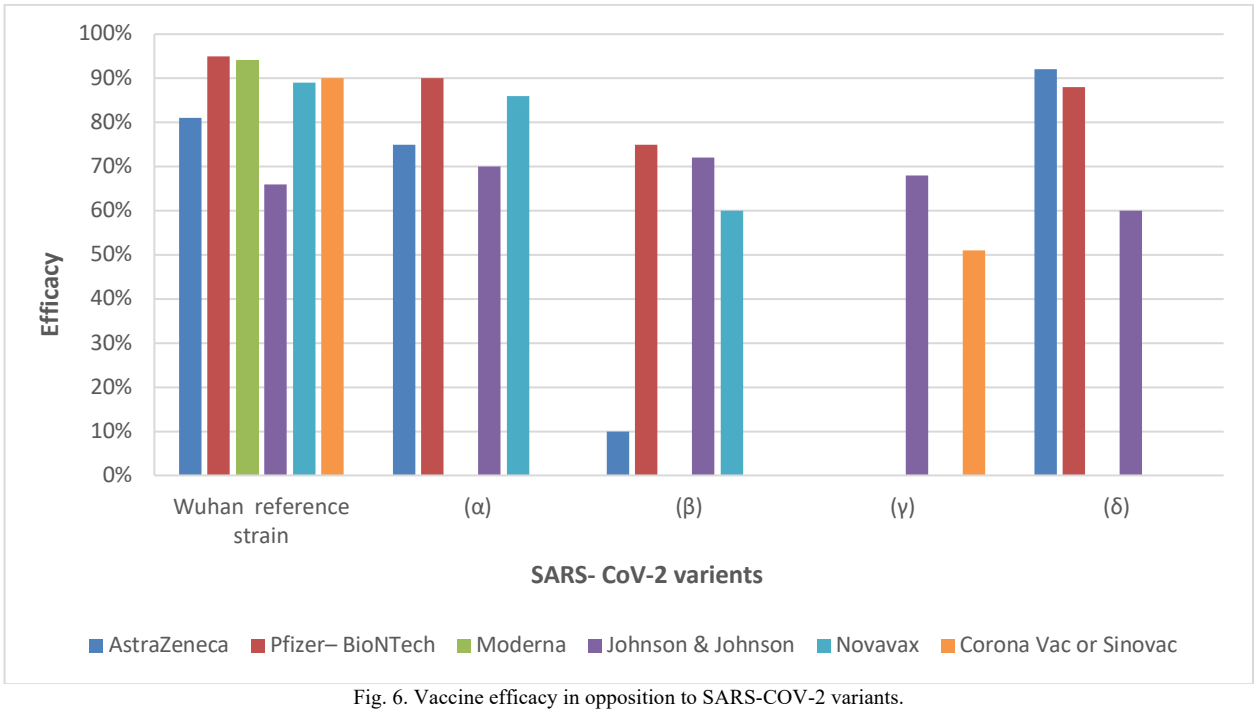

Fig. 6. Vaccine efficacy in opposition to SARS-COV-2 variants.

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H. Frequencies of Adverse effects of Pfizer-BioNTech and Moderna Vaccine

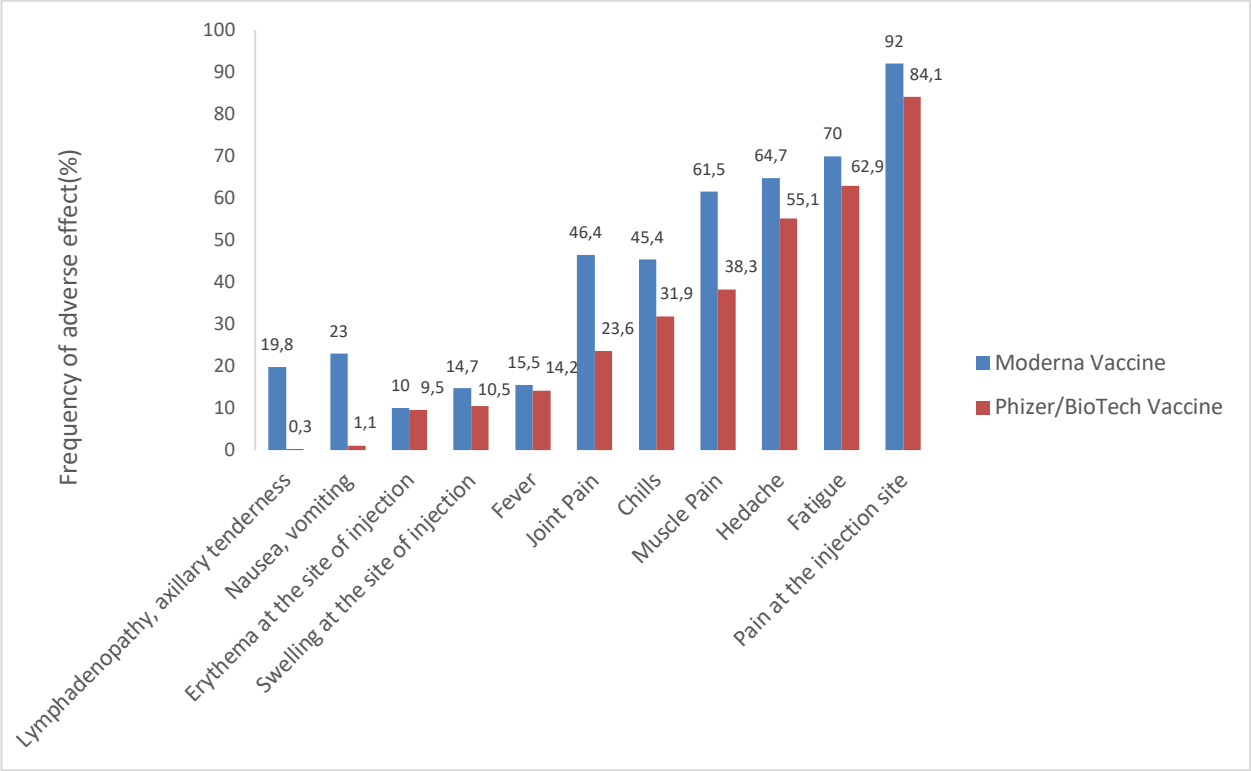

Fig. 7. Comparison between frequencies of unfavorable impacts of Pfizer and Moderna Vaccines [56]-[59].

The bar chart gives information about the comparison between frequencies of unfavorable impacts of Pfizer and Moderna vaccines.

Considering the adverse effects of BNT162b2 and mRNA-1273 both have some unfavorable impacts such as lymphadenopathy, axillary tenderness, nausea, vomiting, erythema (injection site), lump (injection site), pyrexia, arthralgia, chills, myalgia, headache, tiredness, pain (injection site).

Overall, Pfizer vaccine shows comparatively less adverse effects than Moderna vaccine but if we compared with their transport and storage system then Moderna vaccine is easier than Pfizer vaccine.

II. Method

We conducted a panorama review of the vaccine development for COVID-19 disease. Here we collect data from various reviews or raw work and analyze them. We also provide some data from World Health Organization's database.

III. Discussion

Our world facing big trouble with a virus Called SARS COV-2. We need an effective vaccine against this virus that could mobilize our immune response. An effective vaccine may protect our world from this life-threatening disease.

Different companies, academies, and researchers work together to develop an effective vaccine. Through, 66% of vaccines are industrially developed. However, we already have various types of vaccines with different strategies like live attenuated, RNA, DNA, Subunit, viral vector, VLP, and many more. These vaccines are also developed by some approaches such as the Trained Immunity vaccine strategy, Artificial intelligence technology, Nanotechnology. Here in this article, we comprised these approaches and also discuss common Vaccine strategies. By comparison, we found Inactive and viral vector-type vaccines follow the Nanotechnology study, where live attenuated Vaccines follow the trained immunity vaccine strategy.

We also discuss here the pathway of COVID-19 Vaccine development. Generally, it takes a huge time and also funds to develop a vaccine, but the pathway of COVID-19 vaccine development is slightly different from general. For urgent global demand, the researcher goes on faster to develop a vaccine that works against theCOVID-19 disease. In the later part of our article, we try to focus on the Information of existing and clinical and preclinical trialed vaccines. Finally, in the last part of our article, we review the vaccine efficacy against variousCOVID-19 variants. Here five strains were identified as variants of concern including Omicron. There are also some variants of interest identified such as Epsilon, Zeta, Eta, Theta, Iota, Kappa. Vaccine efficacy and effectiveness are also discussed here by a bar chart. Then we try to compare the adverse effect of the two most common Vaccines. Overall, the prevalence of unfavorable effects is indicated to be lower with the Pfizer-BioNTech vaccine than the Moderna vaccine but if we compared with their transport and storage system then the Moderna vaccine is easier than Pfizer-BioNTech.

IV. Conclusion

In conclusion, in order to develop the COVID-19 vaccine, we explored different strategies and approaches. As well, we compare the COVID-19 vaccine development pathway to the general vaccine development pathway since we know it takes less time and why it is quicker. This article also focuses on authorized and official approval COVID-19 vaccine worldwide as well as the clinical and pre-clinical trial of the COVID-19 vaccine. Lastly, we discuss the variant of SARS-COV-2. Alfa variant is the first discovered variant, and it is first discovered on 18 December 2020. Recently Omicron variant was found on 30 November 2021this variant became dangerous day by day. There are also some variants of interest were found such as Epsilon, Eta, Zeta, etc. The effectiveness of vaccine against COVID-19varients also recapitulates here. We found Pfizer- BioNTech vaccine is very much effective on all variants except the Gama variant. Finally, we discuss some common side effects of some common or local uses vaccines.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

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