
Covid-19 Vaccines, Countries around the World, and the Vaccines they are Currently Administering: A Practical Insight and Narrative Review

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Abstract

The push for vaccine approval during the heat of the Covid-19 Pandemic was unusual, in the world of vaccines.

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Countries also had to ensure the various vaccines that have been approved for use were safe and acceptable by the populace. This review aimed to provide the most recent insight into the current vaccines that have been approved for use and what countries over the world are using to vaccinate their teeming population. A search was done on 5 August 2021 on peer-reviewed English literature, indexed in PubMed, Medline, and other relevant sources, online. Results from 23 peer-reviewed English surveyed studies formed the basis of the final Covid-19 vaccines and what countries around the world are currently using. The Pfizer-BioNTech vaccine had the highest number of reviews (74%) followed by Moderna (60%), while Covaxin and CasinoBio had the smallest published studies at 10% each. A total number of 11 vaccines were found to have been approved for use, from studies. The kingdom of Bahrain had the highest number of vaccines approved for use (6/11, 54%) while China had 5, (5/11, 45%) followed by the UK, with 4 vaccines currently approved for use (4/11, 36%). Countries like Puerto Rico, have no vaccine approved for use, others such as Tanzania, Burundi, and Eritrea are yet to receive vaccines. South Africa is the only country in Africa that is currently participating in vaccine trials. This could act as a harbinger to vaccine approval and use in many African countries. More vaccine-based trials and studies are needed mostly in Sub-Saharan African countries, North and South America.

Keywords: Approved vaccines; Vaccines currently in use; countries and the vaccine they are using; vaccines for emergency use; covid-19; coronavirus; SARS-COV-2.

1. Introduction

As part of pharmacological measures to tackle the COVID-19 pandemic, neutralizing antibodies and vaccines were seen as the realistic and promising candidates that can be deployed successfully in the fight against the SARS-CoV-2 virus [1]. The race to identify a potential vaccine against the SARS-CoV-2 virus is however riding on improved vaccine development processes emanating from technical improvements over time, which has substantially shortened timeframes for developing vaccines [2]. The norm in terms of timeframe for developing a vaccine used to be about 10 years to 15 years [3, 4]. This contrasts with the time spent in developing the current COVID-19 vaccines. As a result of tremendous scientific and technological progress in the field of clinical trials, the duration for developing vaccines has significantly shortened [4]. The quick transition of COVID-19 vaccine participants into human trials highlights this position, that vaccine development duration appears to be reduced from what was obtainable in the past [5]. A vaccine candidate that triggers the production of S protein neutralizing antibodies in the vaccinated subjects is the primary aim of all the programs for COVID-19 vaccines. Research has shown that there is a limited to no cross-neutralization between the sera of SARS-CoV and SARS-CoV-2, postulating that recovery from one infection may not shield against the others [6]. To buttress further, a database of approximately 5500 full-length genomes of SARS-CoV-2 taken from various countries is now available at NCBI which facilitates ascertaining the polymorphisms in S protein and other important proteins of the virus concerning vaccine development. This review aims to gather all the information about the COVID-19 vaccine candidates currently in use, even as trials and not necessarily the vaccines that are in pipeline of production like other studies have done, and to list the countries in which these various vaccines have been accepted and are being used. It is desired to give researchers and learners the most recent knowledge of the vaccines being used by countries, worldwide.

2. Method

This review was conducted by strictly following and adhering to the PRISMA guidelines [7]. Published papers in PubMed/Medline and other relevant information from the internet, that aimed at evaluating COVID-19 vaccine update and vaccines currently approved for use and the various countries of the world and the vaccines they are using were eligible for inclusion in this review.

The studies considered for this review were those done in the English language, only. The inclusion criteria were:

- Peer-reviewed published articles indexed in PubMed.
- Most recent updates on Covid-19 vaccine approval and usage, from relevant online sources, such as the WHO).
- The major aim of the study was to evaluate the COVID-19 vaccines currently approved for use, their trial phase, notwithstanding, and to take a major view of most countries of the world and the vaccine approved for use in those countries; and
- The language of publication was English.

The exclusion criteria were:

- (1) unpublished manuscript, unworthy and untrusted online source of information.
- (2) Articles not aiming to evaluate COVID-19 vaccine usage and approval and what countries are currently using; and
- (3) publication language was not English.

A search was done as of 5 August 2021, using the following technique: (COVID * vaccine * currently in use [Title/Abstract]) OR (COVID * countries and the vaccine they are using[Title/Abstract])) OR (COVID * vaccine * approved *[Title/Abstract])) OR (COVID * what vaccines are countries using * [Title/Abstract]) OR (COVID* vaccine * emergency usage *[Title/Abstract]) AND (2021:2021[pdat] Screening of titles and abstracts was conducted, followed by data extraction for the following items: date of survey, country/countries in which the survey was conducted, COVID-19 vaccine currently being used (which included the number of vaccines that are currently in use, those approved for emergency use and those currently undergoing human trials).

3. Results

A total of 92 records were identified, and following the screening process, a total of 23 articles were included in this review. These studies comprised surveys on the COVID-19 vaccine being used, from a total of 21 different countries and also, studies regarding vaccine approvals. Surveys were done mostly in the UK/US ($n = 7$), followed by China ($n = 4$) South Africa, India and Russia had 3 studies each ($n=3$). The majority of the countries had 2 surveys ($n=2$), these include Bahrain, Zimbabwe, Seychelles, Poland, and Turkey. Dates of survey distribution ranged from December 2020 to August 2021. A few studies were conducted in more than

one country.

Table 1: The table below summarizes the vaccines currently approved for use out of several vaccine candidates at different stages of development

Study	Date of publication	Name(s) of vaccine [8]	Manufacturer	Type/Category
Shresta S and his colleagues [9]	August 2021	BNT162b	Pfizer BioNTech	Messenger vaccine RNA
		AZD1222	AstraZeneca/Oxford	Adenovirus vaccine
		Ad26.COV2. S	Janssen	Recombinant human-adenovirus type 26 vector vaccine
		EpiVacCorona	FBRI	Peptide antigen
	July 2021	ChAdOx1_nCoV-19	Serum Institute of India	Adenovirus based vaccine
Prüß. B [10]	January 2021	CoronaVac	Sinovac Biotech	Inactivated SARS CoV-2 vaccine
		Sputnik V	The Gamaleya National Centre of Epidemiology and Microbiology	Adenovirus Vector-based vaccine
		Ad5-nCoV	CanSinoBio	Adenovirus based vaccine
		mRNA-1273	Moderna	mRNA-based vaccine
		BBIPB-CorV	Sinopharm	Inactivated
Massinga LM, Nkengasong JN [11]	July 2021	BBIPB-CorV/ Vero Cell	Sinopharm	Inactivated vaccine
		Covaxin	Bharat Biotech	Inactivated

The study by Rzymiski P. and his colleagues was conducted in 11 countries and closely followed by that of Forni G. and his colleagues which was conducted in 9 countries. Out of the 23 published studies that were reviewed, most were specifically focused on the vaccines that have been approved for use, worldwide. While some

vaccines have been reviewed more times, with more publications to this regard, others had less reviews, with lesser publications. As per vaccine studies and publications, Pfizer-Bio/Ntech had the highest number, with 17 reviews and studies (17/23, 74%), closely followed by Moderna with 13 studies, (13/23, 60%). Covaxin and CasinoBio were among the smallest vaccine with published studies, having 3 each. (3/23, 10%). Note that these were the number of various studies and publications that have been done, on individual vaccines.

3.1. Countries and the Vaccines Approved for Use

Table 2: Studies based on vaccines approved for use by individual countries. Most of the studies were published in July 2021

Study	Date of publication	Countries	Vaccines
Oliver SE. and his colleagues [12]	January 2021	UNITED STATES OF AMERICA	PfizerBioNTech : BNT162b2 Moderna: mRNA-1273
Rzymiski P. and his colleagues [13]	February 2021	UNITED KINGDOM	Pfizer/BioNTech: BNT162b2 Moderna: mRNA-1273
Rzymiski P. and his colleagues [14]	February 2021	CANADA	Pfizer/BioNTech: BNT162b2 Moderna: mRNA-1273
Polack FP. and his colleagues [15]	December 2020	BRAZIL	Pfizer/BioNTech: BNT162b2
Rzymiski P. and his colleagues [13]	April 2021	GERMANY	Pfizer/BioNTech: BNT162b2
Pageaud S. and his colleagues [16]	January 2021	FRANCE	Pfizer/BioNTech: BNT162b2
Rzymiski. and his colleagues [13]	February 2021	INDIA	Moderna: mRNA-1273

Rzymski P. and his colleagues [14]	April 2021	CHINA	Sinopharm (Beijing): BBIBP-CorV
Polack and his colleagues [15]	December 2020	SOUTH AFRICA	Pfizer/BioNTech: BNT162b2
Dzinamarir a T. and his colleagues [17]	March 2021	ZIMBABWE	Sinopharm (Beijing): BBIBP-CorV

In Table 1, the total number of currently approved vaccines by studies was 11. Most of the publications were in August (n=7), followed by July (n=4) and January with 3. The table also described the generic name of the vaccines which is not quite popular and then the type of vaccine which was mostly mRNA-based vaccines. As at December 2020, studies by PruB and his colleagues showed that out of the nine vaccines that were in stage III clinical trial, only two approved, had been published on [10]. The table below further shows the worldwide view of countries and the type of vaccine each country has approved for use. The table further explains the number of vaccines, each country has approved for use, out of the total number of 11 vaccines, with published studies. As per country-based studies for vaccine usage, the kingdom of Bahrain has the highest number of vaccines currently approved for use, about 6, (6/11, 54%) closely followed by China with 5 approved vaccines for use, (5/11, 45%). The UK currently has 4 approved vaccines for use, from published studies (36%). Most countries have 2 vaccines currently approved for their use. In another vein, countries like Puerto Rico currently have no approved vaccines for use but have the Novavax vaccine in clinical trials in the country. Countries like Tanzania, Burundi, and Eritrea are also yet to receive vaccines. In terms of vaccines in trials, the US has the highest number of ongoing trials; 27, followed by China at 19, India at 13, Germany at 12, Japan at 11, and the UK at 9. Canada, Argentina, Australia, and Brazil follow all with 8 ongoing clinical trials. South Africa is the only African country participating in clinical trials in the COVID-19 vaccine. It has 6 ongoing. The US, the UK, Australia, Austria, and Belgium have so far abandoned certain vaccines due to non-progression.

Rzymski and his colleagues [13], had the highest number of vaccines review, per country with about 11 countries around the world and the vaccines they are currently administering, among the currently approved 11 vaccines with different studies and publications. Oliver S E and his colleagues [12], had did only published on the vaccine approved for use, in the United States of America.

3.2. Variations in Approval of Vaccines by Countries

Some countries had multiple studies over time, on vaccine approval. For instance, in the UK, Pfizer/BioNTech mRNA vaccine was first approved for emergency use on 2nd December 2020. This was followed by AstraZeneca/Oxford adenovirus vaccine, which was approved for use, on 30th December 2020. The Moderna vaccine was the third to be approved in January 2020 and finally the Jansen single-dose vaccine which was

approved in May 2021. In Canada, the Pfizer-Bio/Ntech vaccine was authorized for use from the ages of 16 upwards on 9th December 2020. This was followed by the Moderna vaccine, which was approved for use on 23rd December 2020. The AstraZeneca Covid19 vaccine was approved for use in February 2021 and finally, the Jansen, which was approved in March 2021. In the USA, initial vaccine approval was that of Pfizer-BioNTech, which was approved for use on December 12, 2020, for ages >16. This was after the advisory committee on immunization practices (ACIP), issued an interim recommendation for its use. On December 18, 2020, the Food and Drug Administration (FDA) issued an emergency use authorization (EUA) for the Moderna Covid19 (mRNA-1273). This was the second vaccine authorized under the EUA for use in the United States. On February 28, 2021, the Advisory Committee on Immunization Practices (ACIP) issued an interim recommendation for the use of the Janssen COVID19 vaccine in a person age >18 years. This was the third vaccine authorized for use in the prevention of COVID19 in the United States.

4. Discussion

Vaccine approval for emergency use by a "stringent regulatory authority" or the World Health Organisation (WHO) is a top priority when being considered for use.¹⁸ The mRNA vaccines from Pfizer-BioNTech and Moderna were the first vaccines approved for emergency use in the US. Both vaccines achieved greater than 90% efficacy against symptomatic infection in clinical trials with good safety profile [19, 20, 21, 22]. From the total 23 studies/publications used in this review, the Pfizer-Bio/Ntech vaccine was seen to be involved in about 17 studies(74%), while the Moderna vaccine was involved in 13(56%). The Johnson & Johnson vaccine was the first non-mRNA vaccine for COVID-19 approved in the U.S. for emergency use. It is the first single-dose vaccine and provides protection levels almost as high as the two-dose mRNA vaccines [22]. Over half of the U.S. population has now received at least one dose, and states are flush with supply. That is enough to cover everyone ages 12 and older-the entire population for which vaccines are currently approved [23]. In the U.S., an average of 1.12 million doses per day are administered [23]. After focusing first on hospitals and other institutional healthcare settings, states expanded the number of places that offer the shots. Sports stadiums, theme parks, convention halls, and racetracks doubled as mass vaccination centers. Now those sites are beginning to close, as local pharmacies directly receive millions of doses each week [23]. In the European Union, the first vaccine, BNT162b2 by BioNTech/Pfizer was authorized on 21st December 2020, followed by mRNA-1273 by Moderna and AZD1222 by Oxford/AstraZeneca approved on the 7th and 29th January 2021, respectively [24]. Corminaty and Moderna were the two mRNA vaccines authorized in the EU, while AstraZeneca and Janssen were also the two adenovirus-vectored vaccines approved in the EU and other countries in the interest of public health because the benefit of immediate availability outweighs the risk from less comprehensive data than normally required [25]. In a study carried out in Poland, it was also discovered that both BNT162b2 (BioNTech/Pfizer) and mRNA-1273 (Moderna) vaccines gained a high level of usage, in contrast to the AZD1222(Oxford/AstraZeneca) vaccine, which had a significantly lower level of usage [24]. The potential reasons included the reported higher efficacy of BNT162b2 and mRNA-1273 vaccines during the third phase of clinical trials as compared to the studies conducted for the AZD1222 vaccine. Although the direct comparison of these vaccines' efficacy values is unproven as researchers studied them separately and they differed in timing, geographical regions, and dominating SARS-Cov-2 variant in circulation. Moreover, the mRNA vaccines received more coverage from media and expert groups regarding their mechanism of action,

likely resulting in a higher level of understanding and approval. Thirdly, the difference may be due to varying awareness levels on adverse events following the vaccination between different groups of individuals. In Poland, teachers received AZD1222 while the elderly and healthcare workers who are most informed on vaccines and the associated effects related to their administration received mostly mRNA vaccines. According to the UK Medicines and Healthcare Products Regulatory Agency, three COVID-19 vaccines; Pfizer/BioNTech, AstraZeneca, and Moderna, are currently being used in the UK. When compared with the number of vaccine-based studies for the total number of approved vaccines for use, from our review [26], this is found to be 27% vaccine usage. An estimated 18 million first doses of the Pfizer/BioNTech vaccine and 24.5 million first doses of the COVID-19 Vaccine AstraZeneca had been administered, and around 11 million and 20.7 million second doses of the Pfizer/BioNTech vaccine and COVID-19 Vaccine AstraZeneca respectively by 23rd June 2021. An approximate 880,000 first doses of the COVID-19 Vaccine Moderna had also been administered [26]. For the Pfizer/BioNTech vaccine, COVID-19 Vaccine AstraZeneca vaccines, and COVID-19 Vaccine Moderna the overall reporting rate is around 3 to 7 Yellow Cards per 1,000 doses administered [26]. Reports from the 4th Pharmacovigilance Report on COVID-19 Vaccines of the Spanish Agency for Medicines and Health Products (AEMPS) as of 21st March 2021, showed that a total of 6,125,119 doses of COVID-19 vaccines had been administered in Spain since the beginning of the vaccination campaign (December 27th, 2020). Sixty-seven percent of 4,136,963 people vaccinated were women. Vaccines administered corresponded to 79% Comirnaty (Pfizer/BioNTech), 16% Vaxzevria (Oxford/AstraZeneca) and 5% Moderna vaccine. In December 2020, Israel initiated a national campaign to vaccinate its population with Pfizer–BioNTech's mRNA COVID-19 vaccine BNT162b2. Israel's Ministry of Health recommended a two-dose schedule with a 21-day interval between doses. Israel delivered more than 10 million doses within 4 months. Fifty-four percent of the 9.1 million people, and 88% of people aged 50 years or older, had received two doses by April 19, 2021 [27]. The factors contributing to Israel's rapid roll-out include its small geographical and population sizes, advanced information technology that allowed prioritization, allocation, and documentation of vaccines for eligible individuals; effective cooperation between government and community-based health funds, which were charged with providing vaccines to those they insured; and experience in rapid large-scale emergency responses [28]. Israel was the first to show that vaccinations were having a nationwide effect. The country has led the world in vaccinations, and by February more than 84% of people ages 70 and older had received two doses. Severe covid cases and deaths declined rapidly [28]. Most African countries obtained the COVID-19 vaccine through the COVAX facility. COVAX was launched in April 2020 by the World Health Organisation, the European Commission, and France as a global response strategy to the COVID-19 pandemic. COVAX was established as a global initiative to maximize chances of successfully developing COVID-19 vaccines and producing them in quantities needed to end the crisis, and in doing so ensure that the ability to pay does not become a barrier to accessing them [29]. Seychelles is the African country with the highest coronavirus (COVID-19) vaccination rate, around 140 doses per 100 individuals have been administered [30]. Especially compared to other African countries, the population of Seychelles is extremely small, estimated to be 98,500 inhabitants [31]. This explains why the country managed to vaccinate a large part of the population in a limited period. In Africa, Morocco had a vaccination rate of approximately 51 doses per 100 people, registering the highest number of inoculations [30]. The majority of vaccinated people have received China's Sinopharm vaccine as well as the AstraZeneca shot (known as Covishield locally, a version produced in India). In total, Seychelles with an

estimated population of over 97,000 recorded just under 8,200 cases and 28 deaths during the pandemic [31]. To date, among those who have received two doses, 57% have received Sinopharm and 43% Covishield, Seychelles' health ministry said. It is unclear which vaccine had been given to individuals who had been fully immunized but then tested positive for Covid [32]. On 1st February 2021, South Africa became one of the first African countries to receive a COVID-19 vaccine. From our study, South Africa is the only country from Africa, where a country-based study for the vaccine was being carried out, out of the 23 published studies used in the review. The country received a million doses of the AstraZeneca/Oxford COVID-19 vaccine, produced by AstraZeneca-SK Bioscience (AZ-SKBio) and the Serum Institute of India (AZ-SII) [33]. The roll-out of the AstraZeneca/Oxford COVID-19 vaccine was suspended on the 8th of February 2021 following the release of results that showed the vaccine had low efficacy against the 501Y.V2 variant of this coronavirus, the variant most common in the South African population [34]. On the 17th of February 2021, South Africa began a roll-out of the Johnson and Johnson COVID-19 vaccine with an initial 80,000 doses [35]. In addition to being effective against the 501Y.V2 variant, this vaccine, compared to AstraZeneca/Oxford and other currently available ones, is cheaper and requires only regular refrigeration for storage. The country was able to secure a total of 9 million doses of the Johnson and Johnson COVID-19 vaccine and 20 million doses of the Pfizer/BioNTech [36]. Zimbabwe received its first delivery of a COVID-19 vaccine on the 15th of February 2021 with the roll-out of the vaccination program beginning 18th February 2021 [37]. The BBIBP-CorV vaccine, produced by the Beijing Institute of Biological Products and Sinopharm, is approved for use in Bahrain, China, Egypt, and UAE. Zimbabwe received 200,000 doses as a donation from the Chinese government with a further 600,000 doses bought by the Zimbabwean government. The doses received were prioritized for frontline workers, especially medical personnel, the elderly, and those with underlying conditions. Zimbabwe expects to receive a donation of 75,000 doses of the COVID-19 vaccine from the Indian government. The country aims to inoculate at least 10 million of its 16 million citizens to achieve herd immunity [36]. As of 2 March 2021, two weeks into the vaccination program roll-out, only 25,000 doses had been administered to healthcare and other frontline workers [38]. Several communities in Africa have always resisted vaccines, irrespective of the type and form of vaccination. For instance, in Zimbabwe, the Apostolic Faith community religious group, which makes up a third of the population, is well known to have poor health-seeking behavior, including vaccine uptake [39]. Recent studies on health-seeking behavior of the apostolic groups in Zimbabwe suggest attribution of the causation of disease to spiritual factors negatively shapes healthcare-seeking behavior [40]. There is an urgent need for the government to effectively overcome theological rigidity on health-related issues among the apostolic sector as it negatively affects any vaccination program. Targeted information, education and communication materials, and promotional events can address misinformation, myths, and lack of understanding on vaccination in general and more specifically for COVID-19 [36]. Nigeria received 3.92 million doses of the AstraZeneca vaccine on 2nd March [41]. The National Primary Health Care Development Agency (NPHCDA) initiated a nationwide vaccination campaign on 12th March. Frontline health workers were prioritized for the first phase of vaccination, followed by elderly and vulnerable people as identified by their doctors, pregnant women, and people under the age of 18 are exempted from vaccination until the vaccines are certified as fit for them [42]. By the 23rd of March, 122,410 vaccinations have been carried out, accounting for 3.1% of the total dosage received [43]. The major limitations of this review include our sole dependence on published studies on vaccines that have been approved and also, country based studies on the vaccines they are using. This has led to

some restrictions, as some recent online data which could be as recent as the day this review was concluded, were not included. Another limitation owed from the fact that, getting studies that were strictly based on countries vaccine usage, was tedious, as most studies were focused on vaccines that have been approved. It was difficult filtering studies separately and achieving different results, both on the vaccine approved and what countries are using. Hence, interpretation of results should be done with extreme care as it cannot predict the future outcome of events as regards what vaccines countries would be using. However, the results of this study can be used as an initial pointer for future studies for vaccine approval processes and what countries will accept to administer to their populace.

5. Conclusion

A lot of countries have commenced covid19 vaccination for their population. Also, many studies reported most countries have approved at least, one vaccine for their citizens, for use. While many countries in Europe and UK are already administering more than one vaccine, most countries in Africa are currently administering only one vaccine. This has caused limitations in vaccine adherence. Vaccine-based studies showed that many vaccines have been approved for use, despite the initial scare that was the case with some vaccines. However, some vaccines are still in their trial phase, others have been outrightly abandoned. The major challenges that could face the successful approval and usage of vaccines by countries will principally be due to lack of access to vaccines, vaccine hesitancy, and long-term efficacy and side effects of vaccines. The widespread unapproved vaccine and lack of vaccine use by countries demand a collective effort by the government, policymakers, and even health workers. This will enable more access to vaccine-based studies and subsequent administration of vaccines on the populace.

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7. Conflicts of interests

There are no conflicts of interests.

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