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REVIEW

Advances and Challenges in COVID-19 Vaccination in Latin American: A public health perspective

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Abstract

The vaccination against SARS-CoV-2 has been recognized as a priority strategy to safeguard public health. However, disparities in productive, acquisitive and distributional capacity have led to delays in immunization, particularly in low- and middle-income countries. Consequently, global coverage is expected to achieve herd immunity against COVID-19 by 2023 or 2024, although with highly variable coverage percentages among countries. In Latin America, immunization against COVID-19 faces different challenges to achieve herd immunity. To date (February 6, 2022), the countries that had several doses needed to immunize their populations with at least two doses (number of doses between population) were Peru (520.7%), Chile (458.4%), Argentina (298.0%), Brazil (236.6%), Bolivia (206.0%) and Uruguay (unconfirmed doses). On the other hand, Uruguay (210.7%) and Chile (238.3%) have applied twice as many doses as their populations. Argentina (194.3%), Brazil (173.6%), Ecuador (170.3%), Peru (170.3%), Costa Rica (161.1%), and Panama (153.5%) are on the way to achieving this goal. In addition, Latin American countries also showed an insufficient distribution of vaccines and a storage capacity limited to only a few cities and multiple frequencies of vaccine hesitancy. Due to these scenarios, the production of more vaccine doses and equitable distribution to the rest of the population within the Latin American region should remain a public health priority to achieve collective immunity in the shortest time possible.

Keywords: Vaccines, Coronavirus infections, COVID-19, Latin America, Public Health (Source: MESH).

Avances y Retos en la Vacunación contra COVID-19 en América Latina: Una perspectiva desde la salud pública

Resumen

La vacunación contra el SARS-CoV-2 ha sido reconocida como una estrategia prioritaria para salvaguardar la salud pública. Sin embargo, las disparidades en la capacidad productiva, adquisitiva y de distribución han provocado retrasos en la inmunización, en particular en los países de ingresos bajos y medianos. En consecuencia, se espera que la cobertura mundial alcance la inmunidad colectiva contra la COVID-19 para 2023 o 2024, aunque con porcentajes de cobertura muy variables entre los países. En América Latina, la inmunización contra el COVID-19 enfrenta diferentes desafíos para lograr la inmunidad colectiva. A la fecha (6 de febrero de 2022), los países que tenían varias dosis necesarias para inmunizar a sus poblaciones con al menos dos dosis (número de dosis entre población) eran Perú (520,7%), Chile (458,4%), Argentina (298,0%), Brasil (236,6%), Bolivia (206,0%) y Uruguay (dosis no confirmadas). Por otro lado, Uruguay (210,7%) y Chile (238,3%) han aplicado el doble de dosis que sus poblaciones. Argentina (194,3%), Brasil (173,6%), Ecuador (170,3%), Perú (170,3%), Costa Rica (161,1%) y Panamá (153,5%) están en camino de lograr este objetivo. Además, los países latinoamericanos también mostraron una distribución insuficiente de vacunas y una capacidad de almacenamiento limitada a solo unas pocas ciudades y múltiples frecuencias de reticencia a la vacuna. Debido a estos escenarios, la producción de más dosis de vacuna y la distribución equitativa al resto de la población dentro de la región latinoamericana debe seguir siendo una prioridad de salud pública para lograr la inmunidad colectiva en el menor tiempo posible.

Palabras clave: Vacunas, Coronavirus, COVID-19, América Latina, Salud Pública

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Introduction

More than two years after the onset of the COVID-19 pandemic, the world continues to face challenges in overcoming the public health crisis caused by the high morbidity and mortality of SARS-CoV-2 infection[1,2]. Accordingly, the scientific community has unified efforts in developing and evaluating pharmacological agents to manage COVID-19[3]. In the same sense, the development of different vaccine candidates against COVID-19 seeks to guarantee a safe immunization with good effectiveness to reduce the virus's transmission, infection, and severity[4,5].

Development of COVID-19 vaccines

At the time of writing (February 6, 2021), the World Health Organization (WHO) has registered 335 candidate vaccines against COVID-19, of which 141 are in the clinical phase, 31 (21.1%) in phase 3 and 10 (7.8%) in phase 4 clinical trials[6]. Although decades ago, this vaccine development process required years of work and research, today, thanks to technological advances and knowledge about vaccine development[7], the accelerated manufacture of several candidates has been achieved[8,9], with sufficient evidence of short-term safety and efficacy to be approved early and administered to the general population[10].

Developed countries have led the development of vaccine candidates against COVID-19 and have been the first to participate in clinical trials to ensure safety and efficacy[11]. The first vaccines were developed from different components and novel active ingredients[12], such as those based on DNA and RNA (Table 1)[6]. The first to reach phase 3 clinical trials (in July 2020) were messenger RNA-based vaccines (Moderna and BioNTech/Pfizer)[13,14], preliminarily showing superior efficacy to other vaccine types such as Sinopharm's vaccine containing inactivated virus (classical structure for vaccine manufacture)[15]. Despite this, regardless of the active principle of the different vaccines that reached phase 4, the efficacy shown both in the studies and in the current context has been very encouraging, since they generated a high degree of protection against infection, as well as a significant impact on the reduction of severe cases[10].

Vaccine acquisition

All countries faced the challenge of acquiring sufficient doses as soon as possible to vaccinate their populations against COVID-19[16]. However, low- and middle-income countries faced more significant difficulties in the procurement, distribution, and delivery of vaccines[17]. These countries, due to their scarce resources to invest in the massive and anticipated purchase of the different vaccines, could have gone through a complex process of evaluation as to which candidate vaccine would have optimal safety margins and which would also have proven efficacy since a lousy investment could put populations at risk of receiving a vaccine without the desired safety or efficacy, or that not all the population would be vaccinated due to distrust in vaccines without adequate support for their application[18].

Vaccine procurement has been a cornerstone for controlling the pandemic[8]. Unfortunately, however, the countries of Europe, the United States, Australia and parts of Asia, in addition to having been the countries that had been developing several of the candidate vaccines, had also prepaid for the reservation of millions of doses of vaccines against COVID-19, in order to guarantee prompt vaccination. That led to an inequality in the acquisition of vaccines, since by August 24, 2020, before the reports on vaccines safety and effectiveness, these countries had already purchased 2000 million doses of vaccine[16]. Meanwhile, middle and low-income countries, such as those in Latin America, had to make a competitive purchase, where the first million doses were already destined for richer countries[16,19].

In this context, while low-risk individuals in developed countries received some vaccine against COVID-19, health care workers in many low- and middle-income countries had no vaccine and no reasonable date for immunization[12]. Faced with this inequity, the Vaccine Alliance (GAVI), the Coalition for Epidemic Preparedness Innovation (CEPI5), and WHO created the Global Access to Vaccines mechanism (COVAX)[12], which aimed to accelerate vaccine development and ensure fair, transparent, and equitable access, pledging 2 billion doses of vaccines to protect vulnerable and high-risk people and frontline health workers in less wealthy countries[20].

Table 1. Structure of COVID-19 vaccine candidates in the clinical phase.

Description of the structure of the COVID-19 vaccine candidates	Candidates in clinical phase n=141 (100%)	In Phase 3 n=31 (100%)	In Phase 4 n=10 (100%)
Protein subunit	47 (33.3)	15 (48.4)	1 (10)
RNA based vaccine	23 (16.3)	3 (9.7)	3 (30.0)
Viral Vector (non-replicating)	19 (13.5)	2 (6.5)	3 (30.0)
Inactivated Virus	20 (14.2)	6 (19.4)	3 (30.0)
DNA based vaccine	16 (11.3)	2 (6.5)	0 (0.0)
Virus Like Particle	6 (4.3)	1 (3.2)	0 (0.0)
Viral Vector (replicating)	4 (2.8)	1 (3.2)	0 (0.0)
Live Attenuated Virus	2 (1.4)	1 (3.2)	0 (0.0)
Viral Vector (replicating) + Antigen Presenting Cell	2 (1.4)	0 (0.0)	0 (0.0)
Viral Vector (non-replicating) + Antigen Presenting Cell	1 (0.7)	0 (0.0)	0 (0.0)
Bacterial antigen-spore expression vector	1 (0.7)	0 (0.0)	0 (0.0)

DNA Deoxyribonucleic Acid, RNA Ribonucleic Acid. Last updated on February 6, 2022. Source: Modified from World Health Organization (WHO). Draft landscape and tracker of COVID-19 candidate vaccines. 2020. Available at: https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines

However, after the first year since the creation of COVAX, the goals set were not met, distributing, by June 2021, less than 4% of the vaccines administered worldwide[21]. As a result, low- and middle-income countries, including Latin American countries, which relied heavily on the promise of equitable and timely distribution by COVAX, had the insufficient acquisition of doses to immunize their populations[21].

A final point concerning vaccine procurement in Latin American countries is that countries such as Mexico, Cuba, and Brazil have advanced avidly developing their vaccine despite limited local vaccine production capacity[19]. Likewise, Argentina, Chile, Ecuador, and Peru are also facing the challenge of manufacturing their vaccine with limited progress[22]. However, the possibility of initiating the industrial manufacture of vaccines by their means in most Latin American countries is still a distant scenario. Consequently, the acquisition of doses will depend for the time being on the market in other countries, as well as on multinational donations[23,24]. On the other hand, Argentina and Mexico have joined efforts to boost local productivity by sharing the manufacturing functions of approved vaccines (vaccine production in Argentina and packaging in Mexico). However, there have been delays in obtaining the number of vaccines proposed by this initiative[25].

Vaccine distribution

Another cornerstone for pandemic control with COVID-19 vaccines is their equitable and timely distribution. However, its realization represents a major logistical challenge for many developing countries[24]. Therefore, pre-arrangements are required for vaccine distribution[26]. In addition, it is necessary to generate an environment conducive to safety and trust in vaccines since the population may have doubts and false perceptions that could lead to the misuse of resources to conserve and distribute vaccines[27]. Therefore, it is necessary to combat misinformation and propose active surveillance during vaccination to provide more excellent safety to the population[28].

In each country, health authorities have prepared strategic prioritization plans[29], offering the vaccines first to healthcare workers and persons at high risk of severe COVID-19, and finally concluding with immunization of the rest of the population[30]. However, in the middle- and low-income countries, for vaccines distribution, the logistics needed to stockpile different types of COVID-19 vaccines had to be anticipated[6], since, as with other vaccines, adequate local transport capacity will be required for different communities, ensuring adequate storage until the dose is administered, the availability of associated and necessary materials for vaccination (needles, syringes and diluents), equipment in local facilities to preserve the efficacy and safety of the biological product, as well as comprehensive training for immunizers and workers in the vaccination centers[31]. In addition, due to the different specifications for the conservation of each type of vaccine against COVID-19, countries with limited equipment or resources to meet these requirements in all their cities had to evaluate the type of vaccine they wanted to acquire since some of them require temperatures as low as -80°C[32]. Unfortunately, these conditions are not all cities, limiting equitable distribution.

Number of doses of the SARS-CoV-2 vaccines

Another point that low-income countries had to consider before acquiring any of the vaccines against COVID-19 was the number of doses that would need to be administered to their population to achieve immunity since the number of doses required varied among the different vaccines[6]. Therefore, when a vaccine entered the vaccination schedule of the countries, a continuous effort was needed to comply with the scheduled dates for administering the biologic and to guarantee adequate immunogenicity in the population (24). In low- and middle-income countries, where the acquisition of doses is limited, scientific evidence indicated that it was more advisable to immunize the most significant number of people with one or two doses than to offer many more administrations to only some groups; this is because some of the vaccines (Oxford/AstraZeneca and BioNTech/Pfizer), demonstrated that a single dose developed sufficient levels of antibodies to neutralize SARS-CoV-2, and thus reduce the risk of developing severe COVID-19[33]. Nevertheless, applying the complete scheme (usually two doses) was of utmost importance to significantly reduce the incidence and mortality from COVID-19.

On the other hand, applying a booster (third or fourth dose) seems to increase and enhance immunogenicity against COVID-19 infection[34]. Therefore, an attempt should be made to reach a higher proportion of vaccinated persons with the two or three doses and subsequently guarantee the administration of a booster, prioritizing those groups with a higher risk of severe disease. Furthermore, although, for the time being, more solid studies are needed on the average time in which the doses administered should be spaced apart from the booster, countries should guarantee a more significant number of doses in case it is necessary to include the COVID-19 vaccine in the annual immunization schedule. Unfortunately, although this strategy could be a viable option for those countries that have sufficient vaccines, for many Latin American countries, this scenario does not seem possible in the short term, since many of these countries have barely managed to acquire enough doses to vaccinate one or two rounds of their total population.

SARS-CoV-2 strains and vaccine efficacy

Multiple variants of SARS-CoV-2 have circulated worldwide (Table 2)[35]. Each variant was characterized by mutations in its structure, mainly in the Spike protein, which favours virus binding to human cells[36]. In addition, the epidemiological consequences of the appearance of new SARS-CoV-2 variants were recorded based on the transmission potential, infectivity, pathogenicity and lethality of the virus[37].

Table 2. SARS-CoV-2 Variants and attributes towards vaccination.

WHO label	PANGO lineage	Earliest documented samples	Variant classifications	Attributes of transmissibility	Attributes towards vaccination
Latin American variants					
Gamma	P.1	Brazil, November-2020	Variant of Concern	Not assessed	Reduced neutralization by convalescent and post-vaccination sera.
Zeta	P.2	Brazil, April-2020	Formerly monitored variants	Not assessed	Reduced neutralization by post-vaccination sera.
Lambda	C.37	Peru, December-2020	Variant of Interest	Not assessed	Not assessed
Mu	B.1.621	Colombia, January-2021	Variant of Interest	Not assessed	Not assessed
Other variants					
Alpha	B.1.1.7	United Kingdom, September-2020	Variant of Concern	Around 50% increased transmission. Potential increased severity based on hospitalizations and case-fatality rates.	Minimal impact on neutralization by convalescent and post-vaccination sera.
Beta	B.1.351	South Africa, May-2020	Variant of Concern	Around 50% increased transmission. Potential increased severity based on hospitalizations and case-fatality rates.	Reduced neutralization by convalescent and post-vaccination sera.
Delta	B.1.617.2	India, October-2020	Variant of Concern	Increased transmissibility.	Reduced neutralization by convalescent and post-vaccination sera.
Epsilon	B.1.427 / B.1.429	United States-(California), March-2020	Formerly monitored variants	Around 20% increased transmission.	Reduced neutralization by convalescent and post-vaccination sera.
Eta	B.1.525	United Kingdom/ Nigeria, December-2020	Formerly monitored variants	Not assessed	Potential reduction in neutralization by convalescent and post-vaccination sera.
Iota	B.1.526	United States (New York), November-2020	Formerly monitored variants	Not assessed	Reduced neutralization by convalescent and post-vaccination sera.
Kappa	B.1.617.1	India, October-2020	Formerly monitored variants	Not assessed	Reduced neutralization by convalescent and post-vaccination sera.
Omicron	B.1.1.529	Multiple countries, November-2021	Variants of concern	Increase in transmissibility.	Reduced neutralization post-vaccination sera.
Theta	P.3	Philippines, January-2021	Formerly monitored variants	Not assessed	Not assessed

Last updated on February 6, 2022. PANGO: Phylogenetic Assignment of Named Global Outbreak. Variant of Interest: A variant with specific genetic markers that have been associated with changes to receptor binding, reduced neutralization by antibodies generated against previous infection or vaccination, reduced efficacy of treatments, potential diagnostic impact, or predicted increase in transmissibility or disease severity. Variant of Concern: A variant with evidence of an increase in transmissibility, more severe disease (e.g., increased hospitalizations or deaths), a significant reduction in neutralization by antibodies generated during previous infection or vaccination, reduced effectiveness of treatments or vaccines, or diagnostic detection failures. Formerly monitored variants: The variant is no longer circulating at global public health significance levels. However, the variant has been circulating for a long time without impacting the overall epidemiological situation, or scientific evidence demonstrates that the variant is not associated with any concerning properties. Source: Health Organization (WHO) extracted and modified data regarding SARS-CoV-2 variants, and their attributes were extracted and modified from Health Organization (WHO). Tracking SARS-CoV-2 variants [Internet]. 2021 [cited 2022 February 6]. Available from: https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/ and Centers for Disease Control and Prevention. SARS-CoV-2 Variant Classifications and Definitions [Internet]. 2021 [cited 2022 February 6]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/variants/variant-info.html.

In Latin America, several strains (Gamma, Zeta, Lambda, Mu) were identified as variants of interest or concern due to their potential risk of transmissibility and evasion of vaccine neutralization[35]. However, Latin countries were mainly confronted with variants initially identified in other regions. For example, the Delta variant (B.1.617.2) identified in India[35] was possibly responsible for a wave during the end of 2021, in which there was an accelerated increase in COVID-19 cases[38] because the variant had higher transmissibility (about 60% higher than the alpha variant) and was moderately resistant to vaccines, especially in people who had received a single dose[39]. Similarly, the Omicron variant, identified in multiple countries, has been responsible for a new wave in Latin American countries, significantly impacting public health due to its high transmissibility and ability to infect immunized persons[40]. In addition, this variant presented little or no neutralization capacity after a series of 2 doses of messenger RNA vaccines[41]. However, with the application of a booster dose, increased protection against symptomatic or asymptomatic infections, transmission and severe forms were observed[42].

Antigen mutation in SARS-CoV-2 variants was a due process since it was previously observed in other coronaviruses[43]. This ability to mutate puts the efficacy of vaccines at risk because they may become less neutralizable in the future[37]. Despite this, to date, messenger RNA-based vaccines appear to maintain efficacy against coronavirus variants[44]. However, it will still be necessary to re-evaluate the efficacy of each vaccine against the emergence of new variants[45], taking into consideration that populations where vaccination is not massive, could generate an environment with conditions to favour new variants. Therefore, strains should be monitored in all regions, and vaccine efficacy should be evaluated periodically[43].

Impact of vaccines on the pandemic

By November 2, 2021, 49.6% of the world's population had received at least one dose of a COVID-19 vaccine, with most doses administered in China, the United States, and India[46]. February 6, 2022, this figure has increased to 61.5%, with 10.240 billion doses administered globally[46]. Following the application of COVID-19 vaccines, it has been shown to reduce mortality in all age groups that received it[47]. However, even the efforts to achieve herd immunity are insufficient since massive and simultaneous vaccination of all world regions is required[16].

Vaccination against COVID-19 has shown that socioeconomic inequalities play an essential role in guaranteeing the population's health, being responsible for the fact that many regions have not been adequately covered in the present pandemic. That could delay the goal of achieving herd immunity at the global level, according to estimates for 2023 or 2024[9,48]. Despite this bleak scenario, it must be recognized that the natural immunity achieved after COVID-19 infection and the advancement of vaccination has contributed to the acquisition of herd immunity in populations. Therefore, protecting vulnerable individuals from severe outcomes remains crucial as the virus mutates and becomes endemic[49].

Current status of acquisition and coverage in Latin America

Currently, Latin American countries are still in negotiations to acquire a vaccine against COVID-19 since, due to their limited capacity to produce their vaccine in a short time, the acquisition of doses depends on the market[19,24], a situation that leads to inequity in achieving vaccine coverage in comparison with richer countries[11].

By February 6, 2022, the total number of doses acquired in Latin America was sufficient to immunize at least twice the entire Latin American population (1,483,932,255 vaccines acquired for a population of approximately 611,289,000); however, inequities within this region give rise to a scenario in which not all countries have sufficient doses. Two-thirds of the doses were distributed in Brazil (40.8%), Mexico (14.7%), Argentina (13.2%) and Peru (11.7%)[16]. Three of the 21 countries (Honduras, Nicaragua and Venezuela) did not have enough doses to cover 100% of their population with the first dose of vaccine (Table 3).

Regarding the application of COVID-19 vaccines in Latin American countries, it is observed that by the date (February 6, 2022), Uruguay (210.7%) and Chile (238.3%) have administered double the number of doses concerning their population. Meanwhile, Argentina (194.3%), Brazil (173.6%), Ecuador (170.3%), Peru (170.3%), Costa Rica (161.1%), and Panama (153.5%) are on track to achieve this goal. However, this leaves the rest of the countries (13 countries) with the need to intensify their vaccination strategies (Table 3).

Another factor that limited immediate distribution to all cities in Latin American countries was the limited logistics for the proper conservation of vaccines. Some vaccines required special storage conditions to break the cold chain[49]. For example, the ChAdOx1 nCoV-19 vaccine from Oxford University/AstraZeneca (United Kingdom) was the most widely distributed in Latin America[16]. That could have been because this vaccine did not require very rigorous logistics, remaining viable at a temperature of 2 and 8 °C. On the other hand, the vaccine from Moderna (United States) and Pfizer in collaboration with BioNTech (United States), requiring temperatures below freezing (-80°C) for long-term storage, was purchased in smaller quantities, since it would limit equitable distribution to all cities[23,50].

Despite all these barriers and limitations to achieving immunization of the Latino population, vaccination is progressing. In the first groups that received some new vaccines, a decrease in the mortality rate is recorded[51]. In addition, when waiting for a more significant number of doses to complete the vaccination schedule (two doses plus booster), the application of a heterologous dose (dose of a vaccine different from the one applied in the first dose) has been integrated as a mitigation measure against the delay in the acquisition of more vaccines[52]. Although there is evidence (CombiVacs study) on the efficacy of applying the Oxford-AstraZeneca vaccine with the Pfizer-BioNTech vaccine[53], there is no certainty as to whether this regimen is superior to vaccination with the same type of biologic in the long term or future safety (54), so their combination should be carried out with caution and long-term surveillance[55].

COVID-19 vaccine acceptance and hesitancy

Acceptance of vaccination against COVID-19 in Latin American countries has been variable (80% among Latin American citizens)[56], ranging from 72 to 85.4% in Brazil (57,58), 74.9% in Peru[59], 76.3% in Mexico[58], and 97% in Ecuador[60]. However, the persistence of indecision on the part of a percentage of the

Table 3. Acquisition and Vaccine Coverage against COVID-19 in Latin America

Country	Number of confirmed purchased doses by vaccine type	Total confirmed purchased doses	Number of doses of vaccine from donations	Total doses acquired	Total population	Potential coverage of a first dose (%)	COVID-19 vaccine doses administered	Potential people who could have received a first dose (%)
North America								
Mexico	Pfizer BNT162 (34 400 000), Oxford University AZD1222 (79 430 000), Gamaleya Research Institute Sputnik V (24 000 000), Sinovac Coronavac (20 000 000), Sinopharm (12 000 000), CanSino Biologics Ad5-nCoV (35 000 000).	204 830 000	13 110 900	217 940 900	127 950 000	170.3	169 630 000	132.6
Central America								
El Salvador	Pfizer BNT162 (4 400 000), Oxford University AZD1222 (2 000 000), Sinovac Coronavac (2 000 000).	8 400 000	6 439 370	14 839 370	6 826 000	217.4	9 980 000	146.2
Panama*	Pfizer BNT162 (5 000 000).	5 000 000	1 503 450	6 503 450	4 339 000	149.9	6 660 000	153.5
Costa Rica*	Pfizer BNT162 (4 000 075), Oxford University AZD1222 (1 000 000).	5 000 075	2 029 820	7 029 895	5 163 000	136.2	8 320 000	161.1
Guatemala	Gamaleya Research Institute Sputnik V (8 000 000).	8 000 000	13 835 780	21 835 780	17 110 000	127.6	13 720 000	80.2
Honduras*	Pfizer BNT162 (2 700 000), Oxford University AZD1222 (1 400 000), Gamaleya Research Institute Sputnik V (70 000).	4 170 000	4 695 780	8 865 780	9 451 000	93.8	10 570 000	111.8
Belize	Unknown	Unknown	723 150	723 150	430 000	168.2	445 691	103.6
Nicaragua*	Unknown	Unknown	5 641 130	5 641 130	6 665 000	84.6	8 880 000	133.2
South America								
Chile	Pfizer BNT162 (10 000 000), Oxford University AZD1222 (14 400 000), Janssen (J&J) Ad26,CoV2,S (4 000 000), Sinovac Coronavac (60 000 000), CanSino Biologics Ad5-nCoV (1 800 000).	90 200 000	Unknown	90 200 000	19 679 000	458.4	46 890 000	238.3
Argentina	Pfizer BNT162 (20 000 000), Oxford University AZD1222 (23 600 000), Gamaleya Research Institute Sputnik V (30 000 000), Moderna mRNA-1273 (20 000 000), Sinopharm (34 000 000), CanSino Biologics ad5-nCoV (5 400 000).	133 000 000	6 2530 920	195 530 920	45 809 000	426.8	89 020 000	194.3
Brazil	Pfizer BNT162 (300 000 000), Oxford University AZD1222 (102 000 000), Janssen (J&J) Ad26. COV2.S (38 000 000), Sinovac Coronavac (100 000 000), CanSino Biologics ad5-nCoV (60 000 000).	600 000 000	5 216 600	605 216 600	212 897 000	284.3	369 520 000	173.6
Peru	Pfizer BNT162 (67 000 000), Oxford University AZD1222 (14 000 000), Gamaleya Research Institute Sputnik V (20 000 000), Moderna (20 000 000), Sinopharm (49 000 000).	170 000 000	3 416 130	173 416 130	33 035 000	524.9	56 250 000	170.3
Bolivia	Oxford University AZD1222 (5 000 000), Gamaleya Research Institute sputnik V (2 600 000), Sinopharm (1 400 000).	9 000 000	12 188 190	21 188 190	11 797 000	179.6	12 020 000	101.9

Country	Number of confirmed purchased doses by vaccine type	Total confirmed purchased doses	Number of doses of vaccine from donations	Total doses acquired	Total population	Potential coverage of a first dose (%)	COVID-19 vaccine doses administered	Potential people who could have received a first dose (%)
Ecuador*	Pfizer BNT162 (6 000 000), Oxford University AZD1222 (5 000 000), COVAXX -United Biomedical-UB-162 (2 000 000), Sinovac Coronavac (2 000 000), CanSino Biologics ad5-nCoV (6 000 000).	21 000 000	4 248 350	25 248 350	17 794 000	141.9	30 310 000	170.3
Guyana	Gamaleya Research Institute Sputnik V (800 000), Sinopharm (100 000).	900 000	572 790	1 472 790	790 000	186.4	779 882	98.7
Uruguay*	Pfizer BNT162 (2 000 000), Sinovac Coronavac (1 700 000)	3 700 000	500 000	4 200 000	3 555 000	118.1	7 490 000	210.7
Colombia*	Pfizer BNT162 (10 000 000), Oxford University AZD1222 (10 000 000), Moderna mRNA-1273 (10 000 000), Janssen (J&J) Ad26,CoV2,S (9 000 000), Sinovac Coronavac (2 000 000)	49 000 000	15 561 270	64 561 270	51 049 000	126.5	72 930 000	142.9
Venezuela*	Gamaleya Research Institute Sputnik V (10 000 000)	10 000 000	500 000	10 500 000	28 705 000	36.6	35 350 000	123.1
Paraguay	Pfizer BNT162 (1 000 000), Moderna mRNA-1273 (2 000 000), Bharat Biotech – COVAXIN (600 000), Sinopharm (250 000).	3 850 000	4 212 350	8 062 350	7 353 000	109.6	7 670 000	104.3
Suriname	Unknown	Unknown	956 200	956 200	592 000	161.5	498 165	84.1
French Guiana	Unknown	Unknown	Unknown	Unknown	300 000	Unknown	Unknown	Unknown
Total (Latin America)		1 326 050 075	157 882 180	1 483 932 255	611 289 000	242.8	956 933 738	156.5

Last updated on February 6, 2022.

* In Countries with underreporting in the number of doses acquired, the proportion of vaccination is higher than the number of doses.

The estimated potential vaccination coverage for the first dose was determined by the percentage of a country's total population vaccinated with the total doses acquired to date. Therefore, the doses administered represent the number of doses administered to the population without considering that a person could have received more than one dose.

Source: Data underlying total country doses purchased of COVID-19 vaccines were extracted and modified from Duke Global Health Innovation Center. Tracking COVID-19 Vaccine Purchases Across the Globe | Launch and Scale Speedometer [Internet]. 2021 [cited 2022 February 6]. Available from: https://launchandscalefaster.org/covid-19/vaccinepurchases; data on the number of COVID-19 vaccine doses administered were extracted and modified from Our World in Data. COVID-19 vaccine doses administered [Internet]. 2021 [cited 2022 February 6]. Available from: https://ourworldindata.org/grapher/cumulative-covid-vaccinations

population could generate gaps that would limit the achievement of collective immunity. Therefore, the dissemination of information about vaccines should be considered an additional point within national vaccination strategies to favour greater acceptance of the vaccine among those who have not yet decided to be vaccinated[61]. Therefore, we recommend that vaccination campaigns be accompanied by adequate information on the need for immunization against COVID-19.

Conclusions

The speed at which different SARS-CoV-2 vaccines were developed was impressive. In less than a year, a new disease has been characterized, a new viral genome has been sequenced, and the efficacy of different vaccines has been established in clinical trials. In addition, vaccine procurement, distribution, and delivery have accelerated in developed countries. Meanwhile, in low- and middle-income countries such as those in Latin America, insufficient acquisition of doses, unequal distribution of vaccines due to lack of logistic resources, and the presence of reluctance to vaccines in the population have generated slow progress in immunization in this region. Given this, strategies should be promoted to intensify local production and guarantee the acquisition of more doses, providing vaccination centres with the necessary resources to conserve the biological product and thus favour equitable distribution to the rest of the region. In addition, it is necessary to formulate measures to reduce the population's doubts and maximize the acceptance of vaccine doses and their timely boosters.

Authorship criteria

- Daniel Fernandez-Guzman: Conceptualization and methodology; research, data curation and visualization, formal analysis, writing - original draft and writing - revision and editing.
- Edward Chavez-Cruzado: data curation, formal analysis and writing - proofreading and editing.
- Cristian Diaz-Velez: data curation, formal analysis and writing - proofreading and editing.

- Tomas Galvez-Olortegui: writing - proofreading and editing.
- Esteban Vergara-de la Rosa: writing - proofreading and editing.
- Alfonso Rodríguez-Morales: writing - proofreading and editing.
- Jose Galvez-Olortegui: conceptualization and methodology; project management and supervision; writing - original draft and writing - revising and editing.

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Conflict of interest. Edward Chavez-Cruzado declares that he works in a Contract Research Organization, executing different clinical trials, including vaccines. AJ Rodriguez-Morales is speaker/consultant for Amgen, AstraZeneca, and Valneva, in relation with COVID-19 vaccines. The rest of the authors declare that they have no conflict of interest.

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