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A Race Against Time: Deploying Vaccines and Addressing the Disproportionate Impacts of COVID-19 in Latin America and the Caribbean

In Latin America and the Caribbean, a region inhabited by 8.5% of the world's population, 29.9 million people have been diagnosed with COVID-19 (19% of world cases) and 951,710 have died of the disease (29% of world deaths) as of May 7, 2021.¹ Mortality among males has been greater than among females.² The number of deaths per population is higher than 100 per 100,000 in Brazil, Peru, Mexico, Colombia, Argentina, Panama, Chile, and Ecuador,¹ as shown in **Table 1**. With an average of 20 deaths per 100,000 population, Caribbean island countries and territories have experienced a smaller proportion of deaths than the rest of the region.¹ Not included in these statistics are the thousands more—including women of reproductive age, adolescents, and children—who are estimated to have died due to the disruption of essential health services, the decrease in the use of these services for fear of acquiring COVID-19, and other indirect effects of lockdown-related measures that affect women disproportionately.^{3,4}

The sharp increase in unemployment and loss of income caused by the pandemic has particularly affected informal workers, deepening social and economic inequalities and increasing poverty in Latin America and the Caribbean.^{5,6} These difficult conditions prevent people from attaining their best health potential and lead dignified lives,⁷ further increasing health equity gaps in the region.⁸ In a national antibody seroprevalence study conducted in Brazil in 2020 (before the availability of the COVID-19 vaccine), the researchers found the highest prevalence of COVID-19 infection among indigenous and Afro-Brazilian populations compared to other ethnicities and among those in the lower socioeconomic positions.⁹ Similar trends along the social gradient exist throughout the region.^{8,10}

In 2020, most hospitalizations and mortality in Latin America and the Caribbean occurred among those 60 years and older.¹¹ In 2021, however, data from Brazil, Chile, Paraguay, and Peru show that ICU and non-ICU hospitalizations and mortality rates have increased among all age groups, particularly among those younger than 60—whose hospital lengths of stay are longer than among older adults.¹¹ If severe COVID-19 cases are expanding to younger population groups, possible causes are the greater transmissibility and greater mortality of the new SARS-CoV-2 variants reported in Brazil, Peru, and elsewhere in the region.¹² The additional stress that the new variants can cause to already overstretched health systems is compounded by the direct effect on the health workforce: in 24 countries that report data, 7,449 health workers had died of COVID-19, as of May 7, 2021, among more than 1.3 million cases in Latin America and the Caribbean;¹³ on January 31, 2021, among those aged 40 to 59 in the Americas, 74% were women.²

Table 1: COVID-19 cases and deaths, in total population and per 100,000, as of May 7, 2021

Subregion and country or territory	Population 2021	COVID-19 cases	COVID-19 cases per 100,000 population	COVID-19 deaths	COVID-19 deaths per 100,000 population
Mexico and Central America					
Belize	404,915	12,686	3,133	323	80
Costa Rica	5,139,053	265,486	5,166	3,365	65
El Salvador	6,518,500	70,255	1,078	2,150	33
Guatemala	18,249,868	233,696	1,281	7,695	42
Honduras	10,062,994	218,330	2,170	5,585	56
Mexico	130,262,220	2,361,874	1,813	218,657	168
Nicaragua	6,702,379	5,575	83	183	3
Panama	4,381,583	366,762	8,371	6,258	143
Subtotal	181,721,512	3,534,664	1,945	244,216	134
South America					
Argentina	45,605,823	3,118,134	6,837	66,872	147
Bolivia	11,832,936	316,153	2,672	13,182	111
Brazil	213,993,441	15,082,449	7,048	419,114	196
Chile	19,212,362	1,235,778	6,432	27,021	141
Colombia	51,265,841	2,968,626	5,791	76,867	150
Ecuador	17,888,474	398,921	2,230	19,137	107
French Guiana	306,450	20,366	6,646	104	34
Guyana	790,329	14,037	1,776	314	40
Paraguay	7,219,641	294,233	4,075	6,974	97
Peru	33,359,416	1,839,465	5,514	63,519	190
Suriname	591,798	10,933	1,847	214	36
Uruguay	3,485,152	216,146	6,202	3,032	87
Venezuela	28,704,947	205,181	715	2,263	8
Subtotal	434,256,610	25,720,422	5,923	698,613	161
Caribbean					
Anguilla	18,424	99	537	-	-
Antigua & Barbuda	98,728	1,232	1,248	32	32
Aruba	107,195	10,737	10,016	100	93
Bahamas	396,914	10,773	2,714	212	53
Barbados	287,708	3,931	1,366	45	16
Bermuda	72,009	2,434	3,380	30	42
Bonaire	20,104	1,547	7,695	16	80
British Virgin Islands	38,172	219	574	1	3
Cayman Islands	63,103	548	868	2	3
Cuba	11,326,616	114,912	1,015	722	6
Curaçao	164,796	12,222	7,416	113	69
Dominica	74,321	175	235	-	-
Dominican Republic	10,953,714	270,600	2,470	3,523	32
Grenada	113,015	161	142	1	1
Guadeloupe	400,013	15,429	3,857	236	59
Haiti	11,402,528	13,164	115	263	2
Jamaica	2,973,462	46,588	1,567	803	27
Martinique	374,743	11,490	3,066	87	23
Montserrat	5,404	20	370	1	19
Puerto Rico	2,828,246	134,888	4,769	2,367	84
Saba	1,933	7	362	-	-
St Eustatius	3,138	20	637	-	-
St Kitts and Nevis	54,166	45	83	-	-
St Lucia	184,401	4,654	2,524	75	41
St Maarten	44,418	2,250	5,066	27	61
St Vincent & the Grenadines	111,269	1,912	1,718	12	11
Trinidad & Tobago	1,403,374	12,720	906	196	14
Turks & Caicos Islands	57,022	2,402	4,212	17	30
Subtotal	43,578,936	675,179	1,549	8,881	20
TOTAL	659,557,058	29,930,265	4,538	951,710	144

Source: World Health Organization, [Coronavirus Dashboard](#), 2021.¹

Access to the COVID-19 vaccines

The limited capacity to develop novel vaccines in the region is why most countries have negotiated access to COVID-19 vaccines through bilateral agreements with vaccine developers while participating in the COVID-19 Vaccines Global Access (COVAX) facility—the vaccine pillar of the Access to COVID-19 Tools Accelerator (ACT).^{14,15} Launched in April 2020, ACT was created to promote the equitable distribution of tests, treatments, and vaccines between and within countries by pooling public and private resources to invest in scientific discovery and strengthen health systems. COVAX is co-led by the Coalition for Epidemic Preparedness Innovations (CEPI), Gavi (The Vaccine Alliance), and the World Health Organization (WHO).

COVAX signs advanced purchase agreements with vaccine manufacturers, with either a flat or a tiered pricing mechanism, with the expectation that they will produce enough doses for low- and middle-income countries.¹⁶ Countries participate in COVAX as donor-dependents with advance market commitments (AMCs) or as self-financing participants (SFPs). The ten AMC countries in the region are Bolivia, Dominica, El Salvador, Guyana, Grenada, Haiti, Honduras, Nicaragua, Saint Lucia, and Saint Vincent and the Grenadines.¹⁴ SFP countries include: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Jamaica, Mexico, Panama, Paraguay, Peru, Saint Kitts and Nevis, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.¹⁴

Outside of the Americas, UNICEF's Supply Division is the procurement agent. The Pan American Health Organization (PAHO), which is the WHO Regional Office for the Americas, serves as the COVAX procurement agent for the region through its Revolving Fund for Vaccine Procurement,¹⁷ which operates in the region since 1979 as part of PAHO's technical cooperation.¹⁸ Thus far, all vaccines procured through COVAX are from vaccine developers AstraZeneca-Oxford (United Kingdom and Sweden) and Pfizer-BioNTech (United States and Germany); Moderna (United States) announced on May 3, 2021, an agreement with COVAX to supply 500 million doses to AMC countries.¹⁹ Since March 1, 2021, countries in the region have received 11.9 million vaccine doses through COVAX,¹⁴ and the goal is to distribute 280 million doses by the end of 2021.¹⁵

Argentina, Chile, Costa Rica, and Mexico started their COVID-19 vaccination programs through bilateral agreements at the end of December 2020, with other countries following suit.¹⁵ Many governments have negotiated these deals, in addition to participating in COVAX, to guarantee vaccine availability within their national borders. Brazil, Chile, Colombia, Ecuador, Mexico, Uruguay, and El Salvador have signed deals from both Pfizer-BioNTech and Sinovac (China), whereas Mexico has also reached agreements with CanSino (China) and Gamaleya (Russia). Honduras has signed with Moderna, Janssen (United States), and Gamaleya; Argentina with Sinopharm (China) and Gamaleya; Bolivia with Pfizer-BioNTech, Sinopharm, and Gamaleya; Paraguay with Bharat (India), Sinovac, Sinopharm, and Gamaleya; and Peru with Pfizer-BioNTech and Sinopharm. In addition to COVAX, Belize and Dominica have signed with Sinopharm; Nicaragua and Saint Vincent and the Grenadines with Gamaleya; Panama with BioNTech; and the Dominican Republic with Sinovac. The other AMC and SFP countries have not engaged in bilateral agreements.^{14,20}

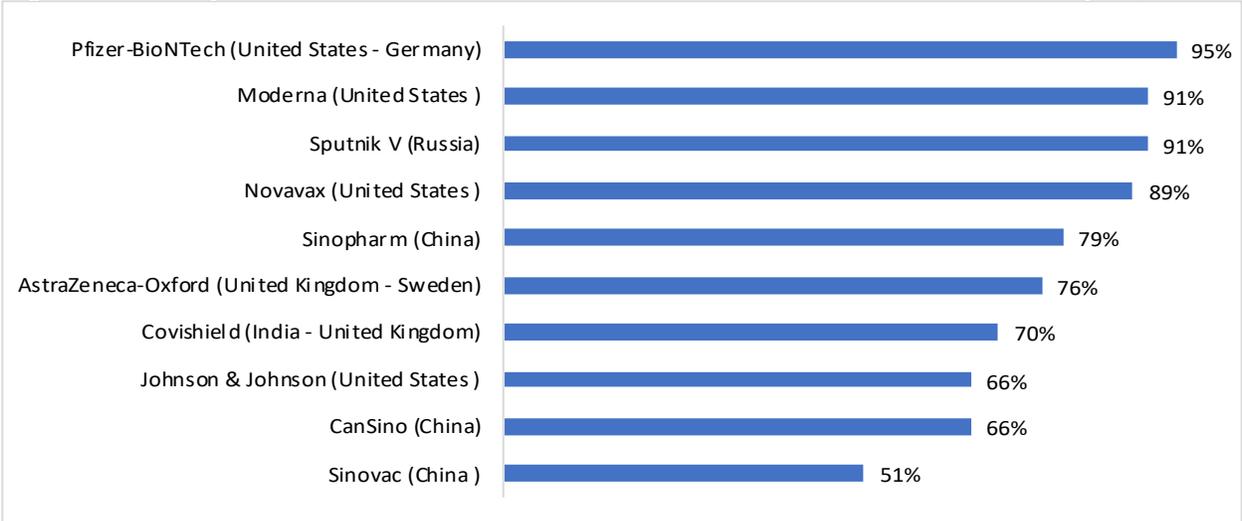
Despite the diversification of vaccine sources, access to COVID-19 vaccines is uneven throughout the region. As shown in **Table 2**, only 4.5% of the regional population is fully vaccinated and 12.2% is partially vaccinated as of May 7, 2021.²⁰ The sovereign nations with the highest coverage of vaccination are Chile (36.4% fully and 80.0% fully or partially), Uruguay (21.9% and 56.9%), and Dominica (13.8% and 39.1%).²⁰ In Mexico and Central America, 0.4% are fully vaccinated and 12.3% partially, whereas in South America it is 6.3% and 12.6%, respectively. In the Caribbean, the coverage is 4.3% and 7.6%, respectively.²⁰

Haiti and Venezuela have not yet started to vaccinate their populations—Haiti reportedly having turned away in April 2021 a shipment of vaccines procured through the COVAX facility²¹ and Venezuela due to lack of servicing its down payment.²² Cuba did not participate in COVAX due to limitations in currency exchange,²² instead deciding to invest in the development of their own vaccines. On May 7, 2021, Cuba authorized the emergency use of two local vaccines starting right away; by August, they plan to produce enough doses to vaccinate the entire population, which is expected to be completed by the end of December 2021.²³

Despite current efforts to procure vaccines through different mechanisms, the region is far from reaching its targets and overcoming the crisis. Effectively controlling the COVID-19 pandemic in the region and the rest of the world requires the deployment of a systematic vaccination strategy. That is, a plan that immunizes at least 67% of the population of every country—the estimated herd immunity threshold above which virus transmission is contained²⁴—before new variants that are more transmissible and more lethal reduce the efficacy of vaccination efforts.

Effective vaccination strategies also follow ethical and epidemiological principles that prioritize population groups more exposed to the coronavirus (such as health care workers), the elderly, and those with chronic health conditions.²⁵ Additionally, vaccines contracted in the region have different efficacy, shown in **Figure 1**. Countries and territories relying on the least efficacious vaccines may face challenges immunizing their populations and bringing transmission to an end.²⁶

Figure 1: Efficacy of vaccines contracted in Latin America and the Caribbean as of May 10, 2021



Source: Americas Society/Council of the Americas, [Timeline: Tracking Latin America's Road to Vaccination](#), 2021.¹⁵

Table 2: COVID-19 vaccination coverage, in total population and percentage, as of May 7, 2021

Subregion and country or territory	Population 2021	Fully vaccinated (number)	Fully vaccinated (%)	Partially vaccinated (number)	Partially vaccinated (%)	Not vaccinated (number)	Not vaccinated (%)
Mexico and Central America							
Belize	404,915	1,547	0.4%	46,067	11.4%	357,301	88.2%
Costa Rica	5,139,053	345,153	6.7%	605,099	11.8%	4,188,801	81.5%
El Salvador	6,518,500	124,073	1.9%	950,691	14.6%	5,443,736	83.5%
Guatemala	18,249,868	2,260	0.0%	180,072	1.0%	18,067,536	99.0%
Honduras	10,062,994	2,958	0.0%	66,345	0.7%	9,993,691	99.3%
Mexico	130,262,220	-	0.0%	19,951,121	15.3%	110,311,099	84.7%
Nicaragua	6,702,379	-	0.0%	146,698	2.2%	6,555,681	97.8%
Panama	4,381,583	263,974	6.0%	467,692	10.7%	3,649,917	83.3%
Subtotal	181,721,512	739,965	0.4%	22,413,785	12.3%	158,567,762	87.3%
South America							
Argentina	45,605,823	1,191,546	2.6%	7,399,515	16.2%	37,014,762	81.2%
Bolivia	11,832,936	257,840	2.2%	715,006	6.0%	10,860,090	91.8%
Brazil	213,993,441	15,032,654	7.0%	30,869,414	14.4%	168,091,373	78.5%
Chile	19,212,362	6,993,123	36.4%	8,374,316	43.6%	3,844,923	20.0%
Colombia	51,265,841	2,136,171	4.2%	3,769,535	7.4%	45,360,135	88.5%
Ecuador	17,888,474	256,328	1.4%	920,338	5.1%	16,711,808	93.4%
French Guiana	306,450	8,312	2.7%	19,867	6.5%	278,271	90.8%
Guyana	790,329	7,153	0.9%	153,295	19.4%	629,881	79.7%
Paraguay	7,219,641	14,621	0.2%	144,339	2.0%	7,060,681	97.8%
Peru	33,359,416	655,127	2.0%	1,285,791	3.9%	31,418,498	94.2%
Suriname	591,798	82	0.0%	41,205	7.0%	550,511	93.0%
Uruguay	3,485,152	762,532	21.9%	1,222,137	35.1%	1,500,483	43.1%
Venezuela	28,704,947	-	0.0%	-	0.0%	28,704,947	100.0%
Subtotal	434,256,610	27,315,489	6.3%	54,914,758	12.6%	352,026,363	81.1%
Caribbean							
Anguilla	18,424	2,992	16.2%	7,188	39.0%	8,244	44.7%
Antigua & Barbuda	98,728	66	0.1%	30,763	31.2%	67,899	68.8%
Aruba	107,195	23,787	22.2%	55,143	51.4%	28,265	26.4%
Bahamas	396,914	-	0.0%	36,314	9.1%	360,600	90.9%
Barbados	287,708	25,466	8.9%	75,148	26.1%	187,094	65.0%
Bermuda	72,009	25,033	34.8%	32,948	45.8%	14,028	19.5%
Bonaire	20,104	5,283	26.3%	12,398	61.7%	2,423	12.1%
British Virgin Islands	38,172	1,012	2.7%	10,007	26.2%	27,153	71.1%
Cayman Islands	63,103	32,237	51.1%	37,062	48.9%	(6,196)	0.0%
Cuba	11,326,616	-	-	-	-	11,326,616	100.0%
Curaçao	164,796	31,127	18.9%	76,122	46.2%	57,547	34.9%
Dominica	74,321	10,239	13.8%	18,801	25.3%	45,281	60.9%
Dominican Republic	10,953,714	807,263	7.4%	1,389,890	12.7%	8,756,561	79.9%
Grenada	113,015	4,494	4.0%	13,262	11.7%	95,259	84.3%
Guadeloupe	400,013	7,574	1.9%	16,639	4.2%	375,800	93.9%
Haiti	11,402,528	-	-	-	-	11,402,528	100.0%
Jamaica	2,973,462	1,602	0.1%	143,656	4.8%	2,828,204	95.1%
Martinique	374,743	9,821	2.6%	33,467	8.9%	331,455	88.4%
Montserrat	5,404	759	14.0%	1,302	24.1%	3,343	61.9%
Puerto Rico	2,828,246	852,386	30.1%	1,189,868	42.1%	785,992	27.8%
Saba	1,933	1,300	67.3%	-	0.0%	633	32.7%
St Eustatius	3,138	-	0.0%	-	0.0%	-	100.0%
St Kitts and Nevis	54,166	277	0.5%	13,281	24.5%	40,608	75.0%
St Lucia	184,401	6,690	3.6%	24,653	13.4%	153,058	83.0%
St Maarten	44,418	9,956	22.4%	14,678	33.0%	19,784	44.5%
St Vincent & the Grenadines	111,269	1,730	1.6%	12,657	11.4%	96,882	87.1%
Trinidad & Tobago	1,403,374	480	0.0%	58,897	4.2%	1,343,997	95.8%
Turks & Caicos Islands	57,022	12,083	21.2%	17,932	31.4%	27,007	47.4%
Subtotal	43,578,936	1,873,657	4.3%	3,322,076	7.6%	38,380,065	88.1%
TOTAL	659,557,058	29,929,111	4.5%	80,650,619	12.2%	548,974,190	83.2%

Source: Pan American Health Organization, [COVID-19 Vaccination in the Americas](#), 2021.²⁰

Expediting the delivery of COVID-19 vaccines

There are different mechanisms to increase the delivery of COVID-19 vaccines in Latin America and the Caribbean. In the short term, donating excess vaccines to COVAX and financing the logistics of vaccine rollout can immediately increase vaccine coverage. Engaging other countries to support the intellectual property waiver at the upcoming World Trade Organization meeting and to redesign intellectual property laws can help boost vaccine discovery and manufacturing in the mid- and long-terms.^{27,28}

The United States government can also undertake plans in collaboration with Latin American and Caribbean countries to increase the development and manufacturing of vaccines. These plans could start in Brazil and Mexico, the two largest countries in the region, both of which have existing manufacturing plants for vaccine production. The Oswaldo Cruz Foundation (Fiocruz)'s Institute of Drug Technology (Farmanguinhos)²⁹ and the Butantan Institute³⁰ are the largest pharmaceutical manufacturers in Brazil and are linked to its Ministry of Public Health. They have partnered with AstraZeneca-Oxford and Sinovac, respectively, to produce a total of 209 million COVID-19 vaccines³¹ with imported active pharmaceutical ingredients (APIs) from China; they expect to receive the technology to produce their own APIs later in 2021. The National Institute of Allergy and Infectious Diseases (NIAID) could also assist Fiocruz in developing mRNA vaccines and transferring technology for future vaccine needs, facilitated by the waiver of intellectual property rights. In Mexico, private laboratory Liomont has partnered with AstraZeneca-Oxford to produce vaccines with APIs manufactured in Argentina's mAbxience, another private manufacturer;³¹ however, issues with the certification process in Mexico have halted vaccine production.³² The United States' involvement through technology transfer agreements, human resource training, and leveraging regional supply chains could help increase production capacity in a region with a population of 660 million and insufficient vaccine development capacity.

Strengthening epidemiological surveillance and health systems

In most of Latin America and the Caribbean, the segmentation of health services, the concentration of human resources and medical technology in a few urban hospitals, the under-financing of primary health care and epidemiological surveillance, the limited use of digital health technologies, and the lack of coordination between the different levels of care have weakened the coordination of national response actions.⁴ Reengaging with the region to help improve epidemiological surveillance systems through the Centers for Disease Control and Prevention (CDC) and help strengthen health systems through the Pan American Health Organization are measures that can improve the lives of millions and the standing of the United States in the Latin American and Caribbean region.

References:

1. WHO. Coronavirus Dashboard. Available at: <https://covid19.who.int>. Geneva: World Health Organization; 2021.
2. PAHO. COVID-19 Health Outcomes by Sex in the Americas. From January 2020 to January 2021, <https://iris.paho.org/handle/10665.2/53372>. Washington, DC: Pan American Health Organization; 2021.
3. Castro A. Maternal and child mortality worsens in Latin America and the Caribbean. *Lancet* 2020; **396**(10262): e85.
4. Castro A. Challenges posed by the COVID-19 pandemic in the health of women, children, and adolescents in Latin America and the Caribbean. UNDP Latin American and the Caribbean, COVID-19 Policy Documents Series Number 19, September 2020. Available at: https://www.latinamerica.undp.org/content/rblac/en/home/library/crisis_prevention_and_recovery/de_safios-de-la-pandemia-de-covid-19-en-la-salud-de-la-mujer--de-.html. New York: United Nations Development Programme; 2020.
5. ECLAC, PAHO. Health and the economy: A convergence needed to address COVID-19 and retake the path of sustainable development in Latin America and the Caribbean. Available at: <https://www.cepal.org/en/publications/45841-health-and-economy-convergence-needed-address-covid-19-and-retake-path>. Santiago: Economic Commission for Latin America and the Caribbean and Pan American Health Organization.; 2020.
6. ECLAC. Employment Situation in Latin America and the Caribbean. Employment trends in an unprecedented crisis: policy challenges. Available at: <https://www.cepal.org/en/publications/46309-employment-situation-latin-america-and-caribbean-employment-trends-unprecedented>. Santiago, Chile: Economic Commission for Latin America and the Caribbean; 2020.
7. PAHO. Just Societies: Health Equity and Dignified Lives - Report of the Commission of the Pan American Health Organization on Equity and Health Inequalities in the Americas. Available at: <https://iris.paho.org/handle/10665.2/51571>. Washington DC: Pan American Health Organization; 2019.
8. Coates A, Castro A, Marmot M, Mujica OJ, Eijkemans G, Victora CG. Just societies: A new vision for health equity in the Americas after COVID-19. *Rev Panam Salud Publica* 2020; **44**: e137.
9. Horta BL, Silveira MF, Barros AJD, et al. Prevalence of antibodies against SARS-CoV-2 according to socioeconomic and ethnic status in a nationwide Brazilian survey. *Rev Panam Salud Publica* 2020; **44**: e135.
10. Castro MC, Gurzenda S, Macario EM, Franca GVA. Characteristics, outcomes and risk factors for mortality of 522 167 patients hospitalised with COVID-19 in Brazil: a retrospective cohort study. *BMJ Open* 2021; **11**(5): e049089.
11. PAHO. COVID-19 Epidemiological Alert: Increase in hospitalizations and deaths among patients under 60 years of age. Available at: <https://www.paho.org/en/documents/covid-19-epidemiological-alert-increase-hospitalizations-and-deaths-among-patients-under>. Washington, DC: Pan American Health Organization; 2021.
12. Phillips T, Collins D. Brazil's 'rapid and violent' Covid variant devastates Latin America, <https://www.theguardian.com/world/2021/apr/23/brazils-rapid-and-violent-covid-variant-devastates-latin-america>. *The Guardian*, April 23 2021.
13. Personal communication, May 10, 2021.
14. PAHO. COVAX vaccines COVID-19 deliveries in the Americas, <https://app.powerbi.com/view?r=eyJrIjoiMjA5ZDExMmEtYTljNC00M2I0LWE5MjUtYWQzZGQxNDc4OThhIiwidCI6ImU2MTBINzljLTJlYzAtNGUwZi04YTE0LTFINGIxMDElMTlmNyIsImMiOjR9>. Washington, DC: Pan American Health Organization; 2021.

15. Horwitz L, Zissis C. Timeline: Tracking Latin America's Road to Vaccination. Available at: <https://www.as-coa.org/articles/timeline-tracking-latin-americas-road-vaccination>. May 10. New York: Americas Society/Council of the Americas; 2021.
16. GAVI. GAVI approach creates tiered pricing for vaccines, <https://www.gavi.org/news/media-room/gavi-approach-creates-tiered-pricing-vaccines>: GAVI The Vaccine Alliance; 2020.
17. WHO. COVAX, <https://www.who.int/initiatives/act-accelerator/covax>. Geneva: World Health Organization, ; 2020.
18. PAHO. PAHO Revolving Fund, <https://www.paho.org/en/revolvingfund>. Washington, DC: Pan American Health Organization.
19. Gavi. Gavi signs agreement with Moderna to secure doses on behalf of COVAX Facility. Available at: <https://www.gavi.org/news/media-room/gavi-signs-agreement-moderna-secure-doses-behalf-covax-facility>, May 3. Geneva: Gavi The Vaccine Alliance; 2021.
20. PAHO. COVID-19 vaccinations in the Americas. Available at: https://ais.paho.org/imm/IM_DosisAdmin-Vacunacion.asp. Washington, DC: Pan American Health Organization; 2021.
21. Beaubien J. One Of The World's Poorest Countries Has One Of The World's Lowest COVID Death Rates, <https://www.npr.org/sections/goatsandsoda/2021/05/04/992544022/one-of-the-worlds-poorest-countries-has-one-of-the-worlds-lowest-covid-death-rat>. *NPR*, May 4 2021.
22. Personal communication, March 10, 2021.
23. Alonso Falcón R, Figueredo Reinaldo O, Sifonte Díaz YJ, et al. Prometedores resultados de candidatos vacunales cubanos: Comienza en mayo intervención con Abdala y Soberana 02 en grupos y territorios de riesgo [Promising results of Cuban vaccine candidates: Intervention with Abdala and Soberana 02 in risk groups and territories begins in May]. Available at: <http://www.cubadebate.cu/noticias/2021/05/10/ofrecen-detalles-sobre-fase-ii-de-ensayo-clinico-con-soberana-plus/>. *CubaDebate*, May 7 2021.
24. Sabino EC, Buss LF, Carvalho MPS, et al. Resurgence of COVID-19 in Manaus, Brazil, despite high seroprevalence. *The Lancet* 2021; **397**(10273): 452-5.
25. WHO. WHO SAGE Roadmap for Prioritizing Uses of COVID-19 Vaccines in the Context of Limited Supply. Available at: <https://www.who.int/publications/m/item/who-sage-roadmap-for-prioritizing-uses-of-covid-19-vaccines-in-the-context-of-limited-supply>. Geneva: World Health Organization; 2020.
26. In clinical and real world trials, China's Sinovac underperforms. Available at: <https://www.economist.com/graphic-detail/2021/04/15/in-clinical-and-real-world-trials-chinas-sinovac-underperforms>. *The Economist*, April 15 2021.
27. Garrett L. Stopping Drug Patents Has Stopped Pandemics Before. Available at: <https://foreignpolicy.com/2021/05/07/stopping-drug-patents-pandemics-coronavirus-hiv-aids/>. *Foreign Policy*, May 7 2021.
28. Okediji RL. With a Covid-19 vaccine patent waiver likely, time to rethink global intellectual property rules. Available at: <https://edition.cnn.com/2021/05/07/opinions/covid-vaccine-patent-waiver-as-equals-intl-cmd/index.html>. *CNN*, May 7 2021.
29. Institute of Drug Technology (Farmanguinhos), <https://portal.fiocruz.br/en/unidade/institute-drug-technology-farmanguinhos>.
30. Butantan Institute, <https://butantan.gov.br/instituto-butantan/about-us>.
31. Duke University. Launch and Scale Speedometer, Vaccine manufacturing, <https://launchandscalefaster.org/covid-19/vaccinemanufacturing>. 2021.
32. Smink V. Vacunas contra la covid-19: qué pasó con los millones de dosis de AstraZeneca que México y Argentina prometieron producir en América Latina [Vaccines against covid-19: what happened to the millions of doses of AstraZeneca that Mexico and Argentina promised to produce in Latin America]. Available at: <https://www.bbc.com/mundo/noticias-america-latina-56923216>. *BBC News Mundo*, April 29 2021.