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COVID-19 response in Colombia: Hits and misses

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ABSTRACT

Introduction: Colombia has been hit particularly hard by the COVID-19 pandemic, being ranked 22nd among 187 countries in deaths per 100,000 people by February 2022. The country has also experienced the worst economic recession in its history, with real GDP contracting 7% in 2020. This paper describes Colombia's pre-pandemic context and the overall effect of the pandemic on health and economic indicators and examines the government's response to COVID-19.

Methods: Descriptive chronologic policy analysis on the COVID-19 pandemic in Colombia and the measures and interventions implemented, using publicly available secondary data from Colombia's official agencies and international sources published from March 2020 to February 2022.

Results: The Colombian healthcare system increased its capacity in terms of infrastructure and human resources (from 8.6 ICU beds per 100,000 pre-pandemic to 21.9 in 2020, from 1.7 to 1.3 per 1000 doctors and nurses, respectively in 2019 to 1.8 and 1.5 per 1000 in 2020). The government commenced the National Vaccination Strategy on February 17, 2021, despite a slow start it managed to fully vaccinate 65.1% of its population, including Venezuelan immigrants, by February 2022.

Conclusions: Colombia's response to the pandemic combines hits and misses. The country organized an early and robust response; increased its healthcare system capacity; designed a risk-based, equitable, and inclusive national vaccination strategy; and introduced a flexible and responsive vaccine rollout. However, the government chose the wrong timing for reform, implemented a long and unpredictable lockdown, was late to procure COVID-19 vaccines and has not appropriately tackled vaccine hesitancy.

Public interest summary: Colombia has been hit particularly hard by the COVID-19 pandemic, with over 138,000 COVID-19 deaths and over 6 million cases by the end of February 2022. According to number of deaths per 100,000 people, Colombia ranks 22nd in the world, among 187 countries. The country has also experienced the worst economic recession in its history. The Colombian healthcare system has been able to cope with a high number of COVID-19 cases without collapsing, but some public health indicators deteriorated. Colombia's response to the pandemic combines hits and misses. The country organized an early and robust response; increased its healthcare system capacity; designed a risk-based, equitable, and inclusive national vaccination strategy; and introduced a flexible and responsive vaccine rollout. As of February 2022, Colombia has fully vaccinated 65.1% of its population. However, the government chose the wrong timing for a tax reform, implemented a long and unpredictable lockdown, was late to procure COVID-19 vaccines and has not appropriately tackled vaccine hesitancy, which certainly contributed to its undesirable position in the mortality world ranking.

Introduction

Colombia is an upper-middle-income country with a population of 51.2 million and a median age of 32.2 years old [1,2]. In 2019, disease burden was mainly from non-communicable diseases and leading causes

of mortality included diabetes and cerebrocardiovascular conditions [3]. The COVID-19 pandemic has had a substantial effect on the health of Colombians as well as the country's economy. Colombia's situation is not dissimilar from the situation in South America as a region; South America accounts for only 5.6% of the world's population [1,4] but had

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21.15% of the global deaths attributed to COVID-19 as of February 2022 [1,5]. The country has also experienced the worst recession in its history, with a partial recovery in 2021 [6].

Facing a pandemic has been challenging for every country on earth, after almost 2 years into the COVID-19 pandemic, Colombia continues to learn and adapt to new situations and with that defining its public policies. Colombia has not only encountered issues associated with the pandemic, but with internal social and governmental instability that has halted the country's recovery.

This policy paper chronologically describes Colombia's pre-pandemic context and the overall effect of the pandemic on health and economic indicators. It also examines the government's response to COVID-19, including what worked and what did not.

Understanding what happened in Colombia is of great interest since no other country in the world has its unique characteristics: a health system with universal coverage under a managed competition type, a country in the midst of a post-conflict era after 50 years of civil war, a massive influx of Venezuelan immigrants due to economic crisis, and an economy that depends on its natural resources to keep growing in the international context.

Methods

Descriptive chronologic policy analysis on the COVID-19 pandemic in Colombia and the measures and interventions implemented by its government, using publicly available secondary data from Colombia's official data agencies and from international sources published between March 2020 and February 2022.

Results

The overall effect of the pandemic

Colombia has been hit particularly hard by the COVID-19 pandemic, with over 138,000 COVID-19 deaths, and over 6 million cases confirmed by the end of February 2022 [1]. According to the global deaths per 100,000 people indicator, Colombia ranks in the 22th position among 187 countries with 276.8 deaths per hundred thousand people [7].

Before the pandemic, life expectancy at birth was 77.3 years old [1]. Pre-pandemic leading causes of mortality included diabetes and cerebrocardiovascular disease, with 27.7 deaths per 100,000 population and 285.4 deaths per 100,000 population, respectively [3]. From 2019 to 2020, the total number of non-COVID-19 related deaths decreased by 2.0%, but death from ischemic heart disease increased by 16.6% in males and 12.1% in females. Similarly, deaths from hypertensive diseases increased by 16.8% in males and 14.1% in females. The reduction in deaths is mainly explained by fewer deaths from traffic and road accidents; in women, for instance, deaths from traffic and road accidents fell by 52.2% [8]. However, all-cause mortality during 2020, and first semester of 2021 increased by 37.8% when compared to pre-pandemic levels [9]. In contrast, there was a 9.8% decrease in mortality in the third trimester of 2021 when compared to 2020, with an overall reduction of deaths due to natural causes by 11.5% in men and 0.25% in women [8]. COVID-19 was the leading cause of death in 2020 and 2021 [8].

Key public health indicators such as the proportion of mothers who did not attend any pre-natal control increased from 4.8% in 2019 to 5.6% in 2020, indicating access barriers during lockdowns [8].

Before the pandemic GDP per capita was USD 15,688, the monetary poverty rate was 29.4% and the unemployment rate was 10% [6,10]. During the pandemic the country experienced the worst recession in its history, with real GDP contracting by 7% in 2020, GDP per capita (PPP) dropped to USD 14,565, unemployment reached 20.8%, and monetary poverty increased to 42.5% [3,6,8,11] (see Table 1) [6].

These staggering figures reflect the sudden stop of economic activity, with a lockdown that started in late March 2020 and lasted for six months [12]. The year 2021 showed important signs of recovery, with

Table 1

Colombia and Latin America and Caribbean outlook before and during the first year of the pandemic [10–12].

	Latin America & Caribbean (2019)	Colombia (2019)	Colombia (2020)
Demographic			
Life expectancy at birth (years)	75.6	77.3	77.3
People over 65 years old (%)	8.7	9.0	9.0
Age dependency ratio, old (% of working age population)	13.0	12.8	13.0
Morbidity			
Diabetes I and II prevalence (%)	NA	7.4	NA
Obesity prevalence (%)	19	22.3	NA
Overweight prevalence (%)	57	58.6	NA
Economy			
Real GDP growth (%)	0.8	3.3	-7.0
GDP per capita PPP (USD)	16,612	15,688	14,565
Unemployment rate (%)	8.1	10.0	20.8
Informal labor (%)	NA	46.9	NA
Monetary Poverty (%)	22.5	29.4	42.5

an unemployment rate of 13.77% in December 2021 [3] and real GDP growing by 6.1% [11,13]. However, according to the Organization for Economic Co-operation and Development (OECD), and contrary to expectations for other countries, employment is expected to return to pre-crisis levels only by mid-2023 [13].

What worked in the Colombian government's response to COVID-19

The Colombian government's response to the COVID-19 pandemic was successful in four key domains:

Early and organised response

After the first COVID-19 case was confirmed in Colombia on March 6, 2020 [1], the government ramped up diagnostic capacity by engaging over 100 public and private providers—capacity went from zero to nearly 43,000 PCR tests per day in five months [1]—and including COVID diagnostic tests within the health benefits package [14,15]. The country reached a national maximum test capacity of 92,070 samples per day in 2022 [16].

The government also established a high-level decision-making structure—the Unified Command Post, or PMU—to respond to the pandemic at the highest levels within government. The PMU included representatives from key ministries, directors of national emergency entities, the Pan American Health Organization (PAHO/WHO), agencies of the United Nations system, and representatives of academia and the private sector.

Moreover, the government took several important measures to slow the pace of contagion and avoid deaths while buying time to strengthen the health system and increase intensive care unit (ICU) capacity. These measures included a national lockdown starting on March 25, 2020, which closed schools, workplaces and public transportation, canceled public events and international and domestic travel, shutting down borders [17]. During this first month of confirmed cases in Colombia there were 17.7 cases per million and 16 deaths [1].

On May 2020, in order to kick-start the economic recovery, the government allowed an opening plan in phases for the industrial sector, starting with the construction and manufacturing industries [17].

As the complete lockdown was lifted on September 1, 2020 with an evident country's reactivation, cases were dropping, travel was resumed, borders re-opened, however, stay-at-home restrictions, restriction on public gatherings, as well as mobility restrictions continued as control measures [1,17]. Given the instability of cases, with COVID-19 infection peaks and intensive care units (ICU) at their

maximum occupancy, these restrictions were constantly re-evaluated.

Strong and resilient health system

The Colombian healthcare system has been able to cope with a high number of COVID cases and has not collapsed. To February 2022, Colombia has been hit by four COVID-19 waves: August 2020, January 2021, June 2021, and January 2022. The total number of new cases per day, per million reached a maximum of 255, 411, 644 and 694 in each wave respectively [1].

The system increased its capacity, in terms of both infrastructure and human resources (see Table 2). For instance, by September 2020 Colombia acquired nearly 6000 new ventilators [15]. The number of ICU beds increased by 133.4% in just three months, from June 2020 to September 2020. Hospital beds also increased by 19.5% from 2021 to 2022 [16]. The number of ICU beds grew even further in 2021 and 2022, with an overall variation of 156.2% when compared 2022 to pre-pandemic ICU beds per 100,000 people figures, reaching an ICU capacity larger than other countries of the same income level [18] (see Table 2). This increase was achieved by shifting pediatric ICU beds to adult use, adapting standard hospital beds to ICU beds, and building new hospital facilities [19]. As of February 2022 Colombia has a total of 11,044 ICU beds and 47,640 hospital beds [16].

Expanding ICU infrastructure was key to the government's response to Colombia's first three COVID-19 waves, with ICU utilization and number of people under ventilatory support clearly increasing when all three waves occurred, as shown in Fig. 1 [20].

Furthermore, the government also took steps to increase the number of medical personnel (see Table 2). In April 2020, the government issued a decree whereby universities could graduate their medical students and residents in the last semester of their training [17]. Approximately 2,500 medical students were either enlisted in the mandatory social service scheme (recent graduates who are required to practice as general physicians in rural underserved areas for 12 months) or given the credential to practice medicine as a general practitioner everywhere in the country. Residents were considered essential personnel in the pandemic, and selected specialties, including anaesthesiology, critical care, and radiology, were also allowed to practice as specialists [21].

Risk-based, equitable, and inclusive national vaccination strategy

The National Vaccination Strategy (NVS) was established in January 2021. It followed international guidelines and prioritized vaccination groups based on risk of exposure/transmission and risk of suffering severe disease and death given age and comorbidities [22,23] (see Table 3). The program had two phases. The first phase was aimed at decreasing mortality and the incidence of severe cases and protecting health workers, while the second phase was aimed at decreasing transmission. Initially, Colombia's Health Ministry estimated that the eligible population—individuals over the age of 16 excluding pregnant women—was 34,234,649 people. The government also planned to vaccinate 20 million people, or 58.4% of the eligible population, by the beginning of phase 2 [23,24]. National Vaccination Strategy is explained in detail in Table 3 [15,25,26].

Table 2

Health system capacity in Colombia before and during the COVID-19 pandemic [3,9,17].

Healthcare system level	Pre-pandemic	2021*	Variation (%)
Hospitals, per million	211.1	214.1	1.4
Number of doctors, per 1000	1.7	1.8	8.4
Specialist doctors, per 1000	0.5	0.5	4.0
Nurses, per 1000	1.3	1.5	9.8
Ambulances, per 100,000	12.4	13.3	7.0
Hospital beds**, per 1000	0.8	0.9	17.9
ICU beds, per 100,000	8.6	21.9	156.2

* 2021 or nearest year available.

** Hospital beds for adults.

Colombia's inclusion in its NVS of all refugees and migrants from Venezuela sets it apart from other countries. The government issued 10-year temporary protection status to all Venezuelans living in Colombia, regular or irregular, in February 2021, giving them full access to the national health system [17,27]. This was a specially consequential decision given that Colombia is home to around 1.7 million Venezuelans or 37% of all Venezuelan refugees and migrants in Latin American and the Caribbean [27].

Colombia successfully leveraged its infrastructure and programmatic experience distributing routine immunizations to vaccinate against COVID-19. Before the pandemic, Colombia already had a wide network of authorized vaccination centers staffed by trained health professionals, built over many years, which reached all municipalities, including remote areas. This infrastructure was used to deploy COVID-19 vaccinations as described in Fig. 2.

Successful vaccination strategy due to an extensive and responsive network

Adaptive vaccination strategy: Colombia managed to effectively adjust its strategy to maximize health benefits after the vaccination campaign started (February 17, 2021) despite supply constraints—less than 300,000 doses arrived in the country during the first month of vaccination and approximately 8 million vaccines arrived in the following two months [28] (see section on Procurement of COVID-19 vaccines below).

Specifically, the Ministry of Health made four adjustments to its vaccination strategy to maximize the supply available and increase vaccination rate. First, it extended the dosing interval for the Pfizer-Biotech, Moderna, and AstraZeneca vaccines as part of its decision to accelerate population coverage with a single dose. The gap between doses was extended to 84 days. Second, it allocated different vaccines to specific age groups. The AstraZeneca, Sinovac, and Janssen vaccines were allocated to adults 18 years old and over, while Pfizer-Biotech was reserved for children between 12 and 17 years old. Third, it used the Janssen vaccine in remote areas that are difficult to outreach since it only required one dose. Finally, it added a booster dose to the vaccination plan [15].

According to vaccines rollout and vaccination scheme status, vaccines allocation (per biological type) to different age groups have been constantly re-evaluated.

Booster dose strategy plan: The first group prioritized to receive a booster dose were adults 70 years and older, and patients with history of organ transplants, starting October 1, 2021; followed by adults 50 years and older on November 19, 2021 [15]. After which a booster dose strategy plan was developed for population 18 years to 49 years old, divided in two phases and five stage. The first phase comprised 3 stages, the first two scheduled to initiate on November 24, 2021, which included health workers, followed by the third stage on December 21, 2021. Phase 2 included stage 4 scheduled to initiate on January 18, 2022 and stage 5 on February 16, 2022, this last stage including all non prioritized population 18 years and older [29].

Moreover, Booster doses intervals have been constantly modified, initially given 6 months after the second shot (or first if Janssen was provided), later modified to 4 months solely for people 50 years and older, and lastly changed to 3 months for people 50 years and older and 4 months to people 18 years and older. Booster doses have been delivered with homologues or heterologues vaccination scheme according to prioritized group [15,29,30].

COVID-19 vaccination in Colombia and epidemiological trends

Vaccination initiated in early 2021 (February 17) after the second COVID-19 wave hit the country. During this time cases were dropping, with an average of 109.2 new cases per million in February 2021 and a minimum of 65.2 new cases per million in one day [1]. Vaccination was progressing as an effort on tackling the virus and re-establishing the economy, and major legislative reforms were promoted by the

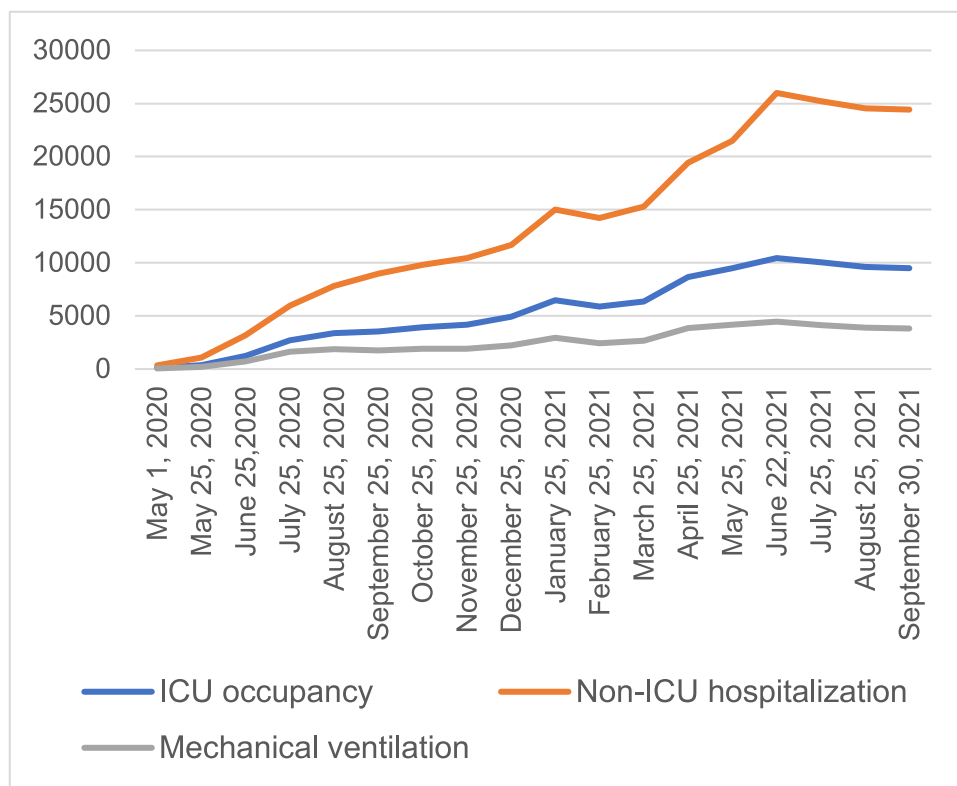


Fig. 1. ICU and non-ICU bed occupancy and invasive respiratory support requirement [21].

government in Congress. Approximately one year after the first COVID-19 case was confirmed in Colombia, total SARS-COV-2 cases per million were 46,939 with 1,237 total deaths per million, total ICU occupancy reached 60.8% and 3.82% of the total population had been vaccinated [1,16] (see Fig. 3).

In April 2021 a tax reform proposal was submitted to congress incidentally interfering with vaccination strategy as planned [31]. The draft reform triggered massive protests, vandalism, and riots, which continued for a month, blocking people's mobility, leading to gas and food shortages, and ultimately interrupting vaccination in some areas and forcing vaccination doses schemes to lengthen [1,32]. By this time, ICU occupancy increased to 82%, total new cases per million increased to 8,880, total new deaths per million reached 201.7 and percentage of people vaccinated increased only by 2.73 percentage points [1,16] (see Figs. 3 and 4).

Protesters were successful in having the tax reform proposal withdrawn, streets were cleared and the vaccination plan resumed as proposed. People vaccinated by May 2021 doubled as new SARS-COV-2 cases and deaths continued to increase [1] (see Fig. 4).

Then, the third COVID-19 wave arrived, total new cases per million increased to 16,347, total new deaths per million reached 348.1, with a maximum ICU occupancy of 86.3%, and vaccination rate of 22.47% [1,16] (see Figs. 3 and 4).

The vaccination strategy reached its last stage in July 2021 by including the last prioritized group, with less than half of the Colombian population vaccinated, failing the initial vaccination plan goal [23]. In addition, the first Delta variant case was confirmed by Colombia's Health and Social Protection Ministry at this time [15]. Although Delta has been considered highly contagious and more severe than other variants [33], and even though vaccination continued at a slow pace, ICU occupancy due to COVID-19, number of new cases and deaths started to decrease [1,16] (see Figs. 3 and 4).

After the Ministry's of Health adjustments to the vaccination strategy on September 2021, vaccination rate increased once again, with

approximately 60% of the Colombian population vaccinated by November 2021, ICU occupancy due to COVID-19 confirmed and suspected cases accounted for less than 20% of total ICU occupancy [1,16]. During this time share of SARS-COV-2 cases due to Delta were 96.54% [33], after which a new COVID-19 variant followed with the arrival of Omicron in mid-December 2021 [15].

As the number of new cases increased due to Omicron [34], and the national test capacity was approaching its maximum capacity [1], new preventive measures were imposed including no need of confirmatory diagnostic tests in symptomatic people under the age of 60, 7 day isolation for people with COVID-19 related symptoms regardless of vaccination status, and 7 day isolation for asymptomatic people with incomplete vaccination scheme [15,35].

Share of SARS-COV-2 cases due to Omicron peaked in January 10, 2022, accounting for 94.4% cases [15,34]. Further changes to the vaccination strategy were made in order to tackle Omicron, shortening booster dose interval by January 11, 2022 [15]. After which, a fourth COVID-19 wave hit Colombia in mid-January 2022 (see Fig. 3), with the highest new cases per million in a day (693.9) recorded since the start of the pandemic, a total ICU occupancy of 56.6% with COVID-19 confirmed and suspected cases accounting for 36.5% of occupancy, and a total of 14,296 and 85.3 new cases per million and total new deaths per million, respectively [1,16] (see Fig. 4). By the end of January 2022, 78.7% of the population had been vaccinated, of which 481,490 vaccines doses have been administered to migrants [15].

To February 2022, Colombia has accumulated 118,096 SARS-COV-2 cases per million, with 2,699 deaths per million [1]. Total ICU occupancy exceeds 50%, with 17.8% due to COVID-19 confirmed and suspected cases [16]. The country has vaccinated 80.5% of its entire population (see Fig. 4), of which 65.1% are fully vaccinated [1]. Additionally, 8.2 million booster doses have been administered, accounting for 19.9% of the vaccinated population [1].

Table 3
National vaccination strategy [15,25,26].

Phase	Stage	Original target population	Date of vaccination initiation (month, day, year)	Adjustments to original NVS*
1	1	-People 80 y/o and older -First-line health workers	2/17/21	NA
	2	-People between 60 and 79 y/o -2nd and 3rd line health workers (non-COVID areas)	3/8/21	
	3	-People between 50 and 59 y/o -People between 16 and 59 y/o with comorbidities -Military forces, police, indigenous guard	5/22/21	-Pregnant women (12 weeks of gestation and over) and up to 40 days postpartum** -Children 12 years and older with comorbidities -Public entity's personnel with ongoing fieldwork, strategic intelligence staff, National Direction of Taxes and Customs workers, Colombian representatives before international organisations, witness attention program personnel. -Athletes before traveling to international competitions.
		-Head of schools, teachers, and educative personnel		
		-People between 40 and 49 y/o -Institutional caretakers (geriatric homes, orphanages) -People at risk of outbreaks: firefighters, first responders, pilots, and flight attendants.		
	5	-People older than 16 y/o otherwise not prioritized	7/17/21	-Children between 12 and 16 y/o*** -Children between 3 and 11 y/o****

y/o=years old, NVS=National Vaccination Strategy, NA=not applicable.

* Target population added later on.

** Vaccination initiation=7/23/21.

*** Vaccination initiation=08/28/2021.

**** Vaccination initiation=11/01/2021.

What did not work in the Colombian government's response to COVID-19

The Colombian government's response was also marked by four important failures:

The government chose the wrong timing for reform

After the second COVID-19 wave hit the country and before vaccination ramped up, the Colombian government submitted a draft tax reform bill to Congress to partially finance the fiscal deficit due to increased government expenditure and decreased tax revenues [31]. Total general government expenditure as a percentage of GDP increased by 6.1 percentage points from 18.7 in 2019 to 24.8 in 2021 [6].

Government expenditure on health as a percentage of total public expenditure also increased by 1.11 percentage points from 11.39 in 2019 to 12.5 in 2021 [36].

The draft tax reform was unpopular for several reasons. First, it was set to increase the number of people paying income taxes from 4% to 12% of the population, as the income threshold was planned to be lowered. Second, an additional "solidarity tax" would be levied temporarily for two years on those already paying income taxes. And third, key inputs in the production of meat products including chicken and beef would be taxed, which in turn would increase final consumer prices [37].

The draft tax reform was withdrawn, and the Minister of Finance stepped down in May 2021. A few months later, in July 2021, the government introduced a new tax reform temporarily increasing levies on the private sector and the rich. This reform was approved by Congress on September 15, 2021. Changes to the tax code began in 2022 [31].

The lockdown was longer than the country was able to cope with

The early and well-organized national lockdown quickly turned into a series of smaller, locally led restrictions that were difficult to sustain, let alone explain. Colombian national and local authorities failed to provide a clear course of action to reopen and did not provide enough information about the different paths available depending on health indicators and the reasons behind their decisions.

The stringency index, a composite measure of a country's response to a pandemic that shows a higher score with stricter responses [38], was the highest in May 2020, reaching 90.74 (see Fig. 5). The government lifted several restrictions by the end of August 2020, including restrictions on national travel. The country moved into a period of selective isolation with responsible social distancing, while other restrictions remained in place, such as curfews. The stringency index decreased until early 2021 but increased again by April. As vaccination progressed, further restrictions were lifted and the stringency index decreased progressively to July, remaining steady until November 2021 and further increasing by Christmas to 59.26 and maintaining to February 2022 [1].

Procurement of COVID-19 vaccines started late

COVID-19 counteracting measures were followed by vaccines acquisition negotiations, with the global vaccine distribution project mechanism, known as COVAX, by late September 2020. Initially, the country over-relied on this mechanism to secure COVID-19 vaccine supply, however, it did not meet expectations as COVAX struggled with funding and vaccines acquisition per se due to competition with wealthy countries for supply, shifting its initial purpose of ensuring vaccination in less privileged countries [39]. Later, vaccines supply was ensured with the government purchasing directly to pharmaceutical laboratories in bilateral negotiations and donations in December 2020 [15].

Late procurement translated into a late and slow start of the vaccination program (compared to high-income countries), with the first COVID-19 vaccine administered on February 17, 2021, almost a year after the first case was diagnosed. Given the slow start of the vaccination program, in April 2021, the government also allowed the private sector to buy vaccines for their employees as long as it did not compete with the number of doses or the arrival time of those negotiated by the government [15,40]. Nonetheless, in the political realm, these measures were publicly contested. Bilateral agreements were heavily criticized on transparency issues because unitary prices at which vaccines were bought were not revealed due to confidentiality agreements. The private initiative was criticized as promoting inequality since employees and owners of wealthy private businesses would have faster access to then scarce vaccines.

Vaccines rollout: After vaccines negotiations started, Colombia's drug and food regulatory entity, INVIMA, granted vaccines approval to Pfizer-BioNTech on January 5, 2021, Astrazena-Vaxzevria on February 23, 2021, Johnson & Johnson-Janssen on March 25, 2021, Sinovac on June 16, 2021 and lastly, Moderna on June 24, 2021 [28].

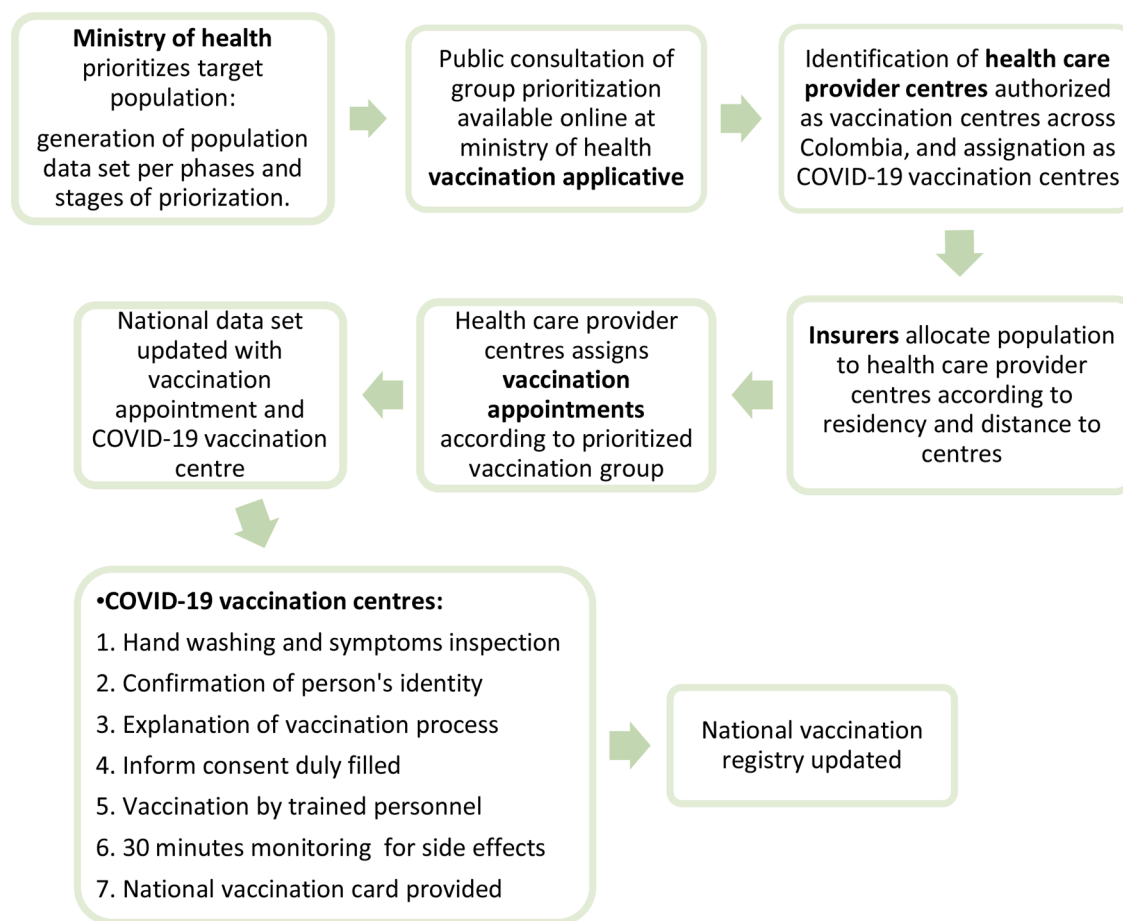


Fig. 2. System to deploy COVID-19 vaccinations in Colombia [23].

In 2021, Colombia secured a total of 83.4 million vaccines through bilateral agreements and COVAX, and an additional 7 million through donations; doses enough to reach 83.7% (42,722,460 people) of the total population. By December 2021, Colombia had received 91% of the doses secured through these mechanisms (see Table 4) [28].

By February 2022, secured vaccines increased to 99.7 million, of which 85.3 million were obtained through bilateral agreements and COVAX, and 14.4 million vaccines through donations (6.5 million Pfizer, 2.5 million Janssen, 3.5 million Moderna, and 1.9 million Astrazeneca doses). To the beginning of March 2022, only 11% (9.8 million Moderna-bilateral) of the total vaccines secured are still remaining [28].

Supply constraints: A number of factors contributed to the short supply of COVID-19 vaccines in Colombia and the slow initiation of the vaccine program:

- COVAX failed to deliver on its promise due to inadequate funding, unmet supply commitments from key manufacturers such as the Serum Institute of India, late registration of several vaccine candidates including Sinovac and Sinopharm, and general supply constraints. Even though Colombia was the first country in the region to receive vaccines through the COVAX mechanism, the volumes originally promised did not arrive to the country as initially envisioned [28].
- Colombia did not have the purchasing power to compete with wealthy countries for supply. It did not have big volumes to procure or a big budget to spend. Also, Colombia neither joined other countries in the region to pool demand nor led any continental effort to use regional procurement platforms like the PAHO revolving fund to procure COVID-19 vaccines. Colombia led conversations about

regional manufacturing under the newly created PROSUR (for its abbreviation in Spanish: foro para el progreso e integración de América del Sur), but these efforts did not materialize into an agreement. The PAHO revolving fund only started negotiating and procuring on behalf of the region in August 2021 [41].

- Colombia did not have adequate legal provisions in place to deal with the pandemic. The regulatory framework did not allow government officials to decide which vaccine to buy and determine the price at which to buy it without a public tender. Also, as the COVID-19 vaccine market was a seller's market, Colombia, like many other developing countries, was a price taker and had to accept multiple conditions demanded by manufacturers, including clauses on confidentiality and indemnity, and uncertainty regarding delivery schedules. The Colombian government had to introduce a new law in December 2020 to be able to negotiate and procure COVID-19 vaccines directly and accept the clauses required by the manufacturer [31].

Vaccine hesitancy has not been successfully tackled

A monthly poll carried out in 23 key cities in Colombia and their metropolitan areas by the National Administrative Department of Statistics (DANE, for its abbreviation in Spanish) estimated a vaccine hesitancy of 3.4% by January 2022 [8]. The most consistent reason for hesitancy throughout the vaccination strategy implementation and the most prevalent has been fear of vaccine un-safeness due to side effects. The least popular reasons for hesitancy have been anti-vaccine and history of COVID-19 previous infection [8]. Reasons for vaccination hesitancy from January 2021 to January 2022 are shown in Table 5.

Even though the percentage of Colombians who are hesitant to receive the COVID-19 vaccine has remained low since the vaccination

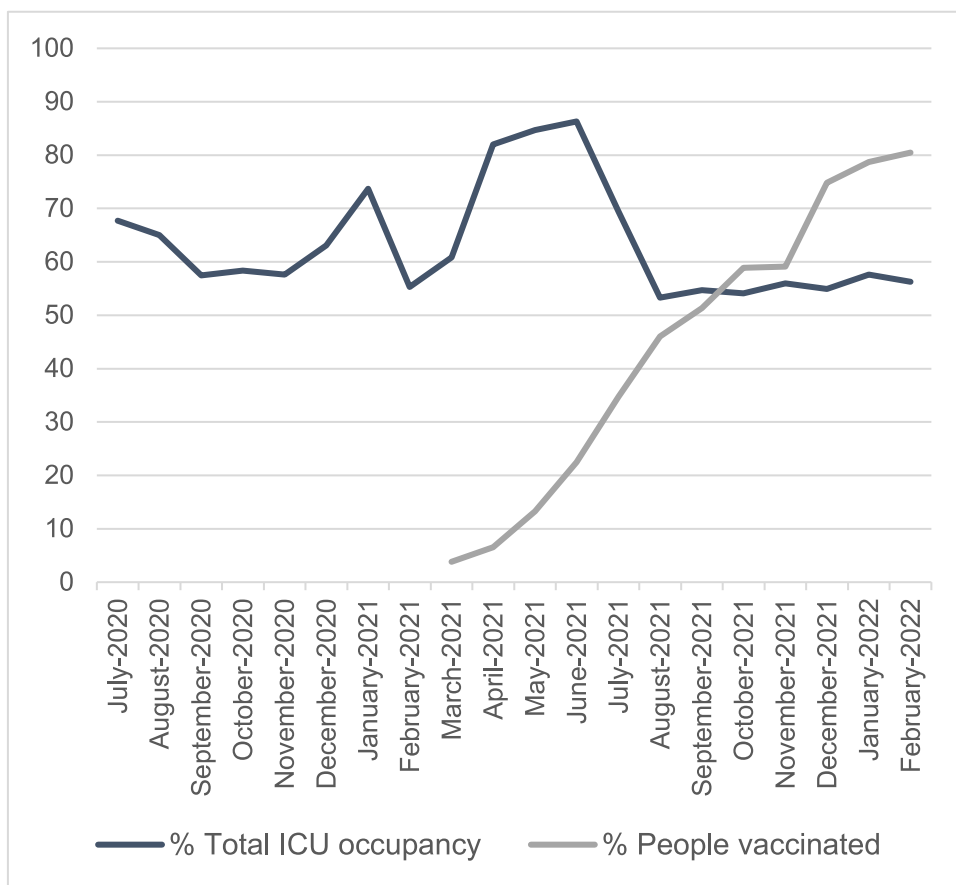


Fig. 3. Percentage of total ICU occupancy and percentage of people vaccinated (complete and incomplete vaccination scheme) [1,16].

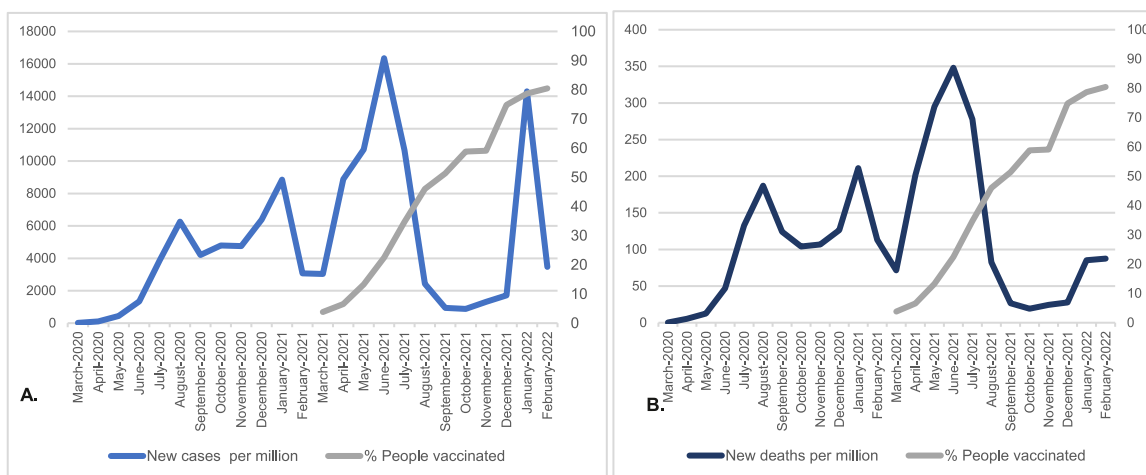


Fig. 4. (A) Monthly new cases per million and percentage of people vaccinated. (B) Monthly new deaths and percentage of people vaccinated [1].

start, the Colombian government did not explicitly introduce positive or negative incentives to address vaccine hesitancy until November 2021. Up to then, COVID-19 vaccination was voluntary, and no incentives were offered and no penalties were imposed. On November 3, 2021, the government issued a decree limiting access to massive public and private events, bars, restaurants, movie theaters, clubs, concerts, casinos, sports events, amusement parks, museums, and fairs for unvaccinated people [17]. However, in February 2022, Colombia’s president declare face masks use voluntary in open public spaces in municipalities where vaccination rate is equal to 70% [15].

Interestingly, a report from the Ministry of Health showed that around the fourth COVID-19 wave (November 28, 2021 to January 11, 2022) deaths per 100,000 people for the un-vaccinated population were 14, in contrast to the fully vaccinated population and those with a booster dose with 4 and 2 deaths per 100,000 people, respectively [42]. It is plausible that the figure for the unvaccinated was lower had measures been taken before.

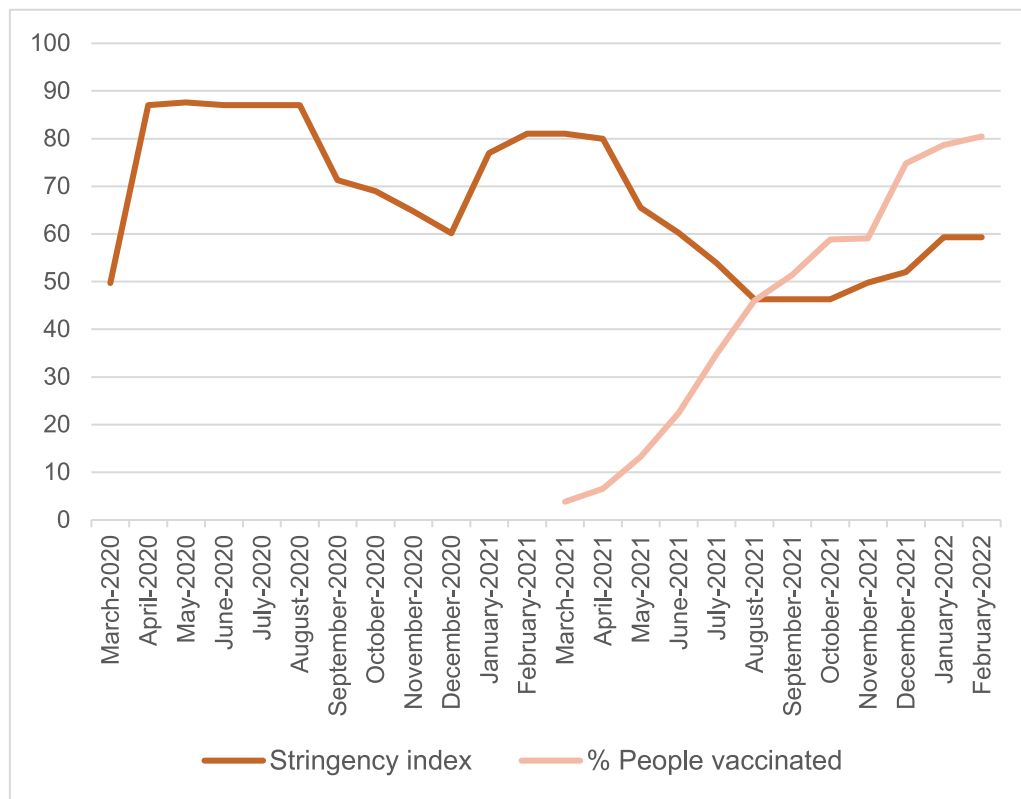


Fig. 5. Average stringency index per month before and after vaccination initiation[1].

Table 4

Total COVID-19 vaccines' arrival per month per vaccine brand [28].

Date	Pfizer-BioNTech	Sinovac	AstraZeneca	Moderna	Janssen	Total	Total People Vaccinated per month
February 2021	100,620	192,000	0	0	0	292,620	130,578
March 2021	617,760	2,307,964	244,800	0	0	3,170,524	1,605,990
April 2021	2,201,940	1,500,000	912,000	0	0	4,613,940	1,412,442
May 2021	2,662,920	3,500,040	0	0	0	6,162,960	2,129,100
June 2021	5,391,360	2,500,000	1,240,500	0	480,000	9,611,860	6,097,080
July 2021	988,650	2,000,000	874,200	3,500,000	2,500,000	9,862,850	5,419,463
August 2021	2,292,030	0	958,300	150,000	0	3,400,330	6,805,494
September 2021	1,356,030	2,097,600	4,460,360	2,105,460	2,834,700	12,854,150	3,262,491
October 2021	1,513,980	4,521,600	2,453,800	6,024,940	0	14,514,320	2,776,368
November 2021	92,430	0	1,977,600	0	0	2,070,030	533,176
December 2021	1,151,280	6,300,000	816,000	1,723,540	5,686,900	15,677,720	8,123,691
January 2022	0	0	0	0	0	0	1,653,546
February 2022	6,497,720	0	0	1,177,800	0	7,675,520	1,304,079
Total	24,866,720	24,919,204	13,937,560	14,681,740	11,501,600	89,906,824	41,253,498

Table 5

Vaccination hesitancy reasons among Colombians [8].

Date	Vaccine non-effectiveness,%	Vaccine unsafeness,%	Non- hazardous infection,%	Anti-vaccine,%	Manipulation tool,%	Previous COVID-19 infection,%	Other,%
January 2021	16.5	62.3	1.1	0.6	3	2.4	14
March 2021	23	52.1	2.2	2.8	2.6	3	14.3
June 2021	18.5	64.4	1.8	1.3	1.6	1.8	10.6
November 2021	24	52.6	2	1.9	8.4	1.4	9.7
January 2022	33.1	55.1	0.1	2.7	2	0.7	6.2

* Vaccine is not sufficiently effective, ** The vaccine might be unsafe due to side effects, *** COVID-19 is not hazardous, **** The vaccine is a manipulation tool.

Conclusions

Colombia has been severely affected by the COVID-19 pandemic, with an undesirable high position in the ranking of deaths

per 100,000 people [7]. Colombia also experienced its worst economic recession in history in 2020, increasing poverty, unemployment and social distress. In 2021, socioeconomic indicators started to recover, but still not to pre-pandemic levels.

This paper concludes that Colombia's response to the pandemic has been a combination of hits and misses. The country successfully organized an early and robust response, increasing the capacity of the healthcare system and designing a risk-based, equitable, and inclusive national vaccination strategy. Colombia has also mounted a flexible and responsive vaccine rollout, leveraging the pre-existing national vaccination network and managing to maximize health benefits associated with vaccination even given supply constraints.

However, the government chose the wrong timing for tax reform, detonating massive protests, which ultimately pushed the economic recovery into the second half of 2021 and interfered with the vaccination strategy. Lastly, the government implemented a long and unpredictable lockdown, was late to procure COVID-19 vaccines and to February 2022 it has not appropriately tackled vaccine hesitancy.

The emerging new COVID-19 variants have challenged the health's system response and infection control overall. Vaccination has been key in tackling emerging COVID-19 variants. Even though the Colombian government started vaccine procurement late, it managed to vaccinate the majority of its population with at least a single dose, with more than half of Colombians fully vaccinated by the beginning of 2022. Vaccination has been clearly associated with a fall in the number of new COVID cases, ICU occupancy and number of deaths. Colombia, in summary, paid a high price at the beginning of the pandemic but seems better prepared to cope with a pandemic that is not over.

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Patient consent

Not required.

Declaration of Competing Interest

None declared.

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References

- Our world in data. Colombia: coronavirus pandemic country profile [Internet]. [cited 2022 Mar 1]. Available from: <https://ourworldindata.org/coronavirus/country/colombia>.
- The World Bank. World Bank country and lending groups. [cited 2021 Oct 6]; Available from: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.
- Organisation for Economic Co-operation and Development. Health care resources. [Internet]. [cited 2022 Mar 1]. Available from: https://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_REAC.
- Population, total-world. The World Bank. [cited 2022 Feb 28]; Available from: <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=1W>.
- WHO Coronavirus (COVID-19) dashboard. World Health Organization. [cited 2022 Mar 1]; Available from: <https://covid19.who.int/>.
- GDP-Colombia. World Bank national accounts data, and OECD national accounts data files. The World Bank. [Internet]. [cited 2021 Sep 28]. Available from: <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=CO>.
- Johns Hopkins University. Coronavirus Resource Center. Cases and mortality by country. [cited 2022 Mar 1]; Available from: <https://coronavirus.jhu.edu/data/mortality>.
- DANE Información para todos. Estadísticas. [cited 2022 Mar 1]; Available from: <https://www.dane.gov.co/index.php>.
- Health at a Glance 2021: OECD indicators. Highlights for Colombia. OECD. [cited 2022 Mar 5]; Available from: <https://www.oecd.org/colombia/health-at-a-glance-Colombia-EN.pdf>.
- The World Bank in Latin America and the Caribbean. The World Bank; 2022 [cited Mar 1]; Available from, <https://www.worldbank.org/en/region/lac>.
- Colombia. The World Bank Data. IBRD IDA. [cited 2022 Mar 1]; Available from: <https://data.worldbank.org/country/CO>.
- OECD Policy responses to coronavirus (COVID-19). COVID-19 in Latin America and the Caribbean: an overview of government responses to the crisis. [cited 2022 Mar 1]; Available from: https://read.oecd-ilibrary.org/view/?ref=129_129907-ee84sciov&title=COVID-19-in-Latin-America-and-the-Caribbean_An-overview-of-government-responses-to-the-crisis&ga=2.14086911.93545503.1636143739-28839374.1631651443.
- Colombia economic snapshot. Economic forecast summary (December 2021). OECD Economic Outlook, Volume 2021 Issue 2. [cited 2022 Feb 26]; Available from: <https://www.oecd.org/economy/colombia-economic-snapshot/>.
- Ministerio de Salud y Protección Social. ABECE programa de Pruebas, rastreo y aislamiento selectivo sostenible-prass. [Internet]. [cited 2021 Sep 28]. Available from: <https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/ED/VSP/abece-prass.pdf>.
- Boletín diario de noticias de interés sanitario-Centro nacional de enlace. Ministerio de Salud y Protección Social. [cited 2022 Mar 1]; Available from: <https://www.minsalud.gov.co/salud/publica/CNE/Paginas/boletines.aspx>.
- Reportes de Situación COVID-19: Colombia. Listado de los reportes de situación del COVID-19 en Colombia de la Organización Panamericana de la Salud. [cited 2022 Mar 1]; Available from: <https://www.paho.org/es/reportes-situacion-covid-19-colombia>.
- Dapre. Decretos. Presidencia de la Republica. [cited 2022 Mar 1]; Available from: <https://dapre.presidencia.gov.co/normativa/layouts/15/viewlists.aspx>.
- Sen-Crowe B, Sutherland M, McKenney M, Elkbulli A. A closer look into global hospital beds capacity and resource shortages during the COVID-19 pandemic. J Surg Res 2021;260:56–63. <https://doi.org/10.1016/j.jss.2020.11.062>.
- Ministerio de Salud y Protección Social. Servicios y capacidad instalada de las ips por departamento o distrito y naturaleza jurídica. [Internet]. [cited 2021 Sep 30]. Available from: <https://www.sispro.gov.co/central-prestadores-de-servicios/Paginas/Servicios-y-capacidad-de-IPS-por-naturaleza-juridica.aspx>.
- Minsalud SISPRO. Comportamiento diario de uso de camas por servicio en el marco de la epidemia SARS Cov-2. [cited 2021 Nov 1]; Available from: <https://app.powerbi.com/view?r=eyJrJmJmZWQ0ZmU0UWUwMDE1MS00N2JmLWE2ZmYtMzE0ZWQxZjYzZDUwliwidCl6ImJmYjdmNTNhLDRmYjYjcTNDAXN04MzBjLWJkZmZlZzZlMzZDhiOCJ9&pageName=ReportSection>.
- Forbes Colombia. Adelantan grado a estudiantes de medicina por coronavirus. 2020 Apr 2; Available from: <https://forbes.co/2020/04/02/actualidad/adelantan-grado-a-estudiantes-de-medicina-por-coronavirus/>.
- World Health Organization. WHO SAGE values framework for the allocation and prioritization of COVID-19 vaccination. [cited 2021 Sep 28]; Available from: <https://www.who.int/publications/i/item/who-sage-values-framework-for-the-allocation-and-prioritization-of-covid-19-vaccination>.
- Ministerio de Salud y Protección Social. Plan nacional de vacunación contra el COVID-19. Enero 2021. [Internet]. [cited 2021 Sep 28]. Available from: <https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/ppt-pnv-pres-entacion-capacitacion-medios.pdf>.
- Minsalud. Información oficial sobre la vacunación contra el coronavirus en Colombia. [Internet]. [cited 2021 Sep 23]. Available from: <https://www.minsalud.gov.co/salud/publica/Vacunacion/Paginas/Vacunacion-covid-19.aspx>.
- Ministerio de Salud y Protección Social. Plan nacional de vacunación contra el COVID-19. Información oficial sobre la vacunación contra el coronavirus en Colombia. [Internet]. [cited 2021 Sep 28]. Available from: <https://www.minsalud.gov.co/salud/publica/Vacunacion/Paginas/MiVacuna.aspx>.
- Republica de Colombia. Ministerio de Salud y Protección Social. Decreto Numero 630 de 2021. 9 Jun 2021. Available from: https://dapre.presidencia.gov.co/normativa/normativa/DECRETO%20630%20DEL%209%20DE%20JUNIO%20DE%202021.pdf?TPD_101_R0=08394a21d4ab200004e6b64778b8878116bb2d056862bf6a8bb2e19cbeea833ba461415055f81270853698885145000238e5acf43a367088f79f62a9c91204179affbc2de90ce0e604bed701ca45d139f626e8d6deb195c2c1e06693717d9f715a12e80c3e7afbe356154b33275498ad1566c8fc92cd0714242ea6049bb1.
- UNHCR The UN Refugee Agency. UNHCR and IOM welcome Colombia's decision to regularize Venezuelan refugees and migrants. [Internet]. [cited 2021 Sep 30]. Available from: <https://www.unhcr.org/news/press/2021/2/60214cf74/unhcr-iom-welcome-colombias-decision-regularize-venezuelan-refugees-migrants.html>.
- Presidencia de la Republica. Plan nacional de vacunación. [Internet]. [cited 2022 Mar 2]. Available from: <https://app.powerbi.com/view?r=eyJrJmJmZWQ0ZmU0UWUwMDE1MS00N2JmLWE2ZmYtMzE0ZWQxZjYzZDUwliwidCl6ImJmYjdmNTNhLDRmYjYjcTNDAXN04MzBjLWJkZmZlZzZlMzZDhiOCJ9&pageName=ReportSection1290b0a3ca8200c59702>.
- Vacunación contra COVID-19. Plan Nacional de Vacunación contra el COVID-19. [cited 2022 Mar 1]; Available from: https://www.minsalud.gov.co/salud/publica/Vacunacion/Paginas/Vacunacion-covid-19.aspx?utm_source=Google.com&utm_medium=Search&utm_campaign=Presidencia&utm_content=presidencia&utm_term=Vacunacion_covid.
- Ministerio de Salud y Protección Social. Resolución número 00001887 de 2021. 23 Nov 2021. Available from: <https://www.minsalud.gov.co/Normatividad/Nuevo/Resoluci%C3%B3n%20No.%201887%20de%202021.pdf>.
- Dapre. Normativa, leyes. Presidencia de la Republica. [cited 2021 Sep 28]; Available from: <https://dapre.presidencia.gov.co/normativa/leyes>.
- OECD. "Colombia". OECD economic outlook. Paris: OECD Publishing; 2021. <https://doi.org/10.1787/33dca86b-en>. Volume 2021 Issue 1 December 2021.
- Centers for Disease Control and Prevention. What you need to know about variants. Centers for Disease Control and Prevention; 2022 [cited Feb 27]; Available from, https://www.cdc.gov/coronavirus/2019-ncov/variants/about-variants.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fvariants%2Fdelta-variant.html.
- Share of SARS-CoV-2 sequences that are the omicron variant. Our World in Data. [cited 2022 Feb 25]; Available from: <https://ourworldindata.org/explorers/corona>

- virus-data-explorer?zoomToSelection=true&facet=none&pickerSort=asc&pickerMetric=location&Interval=7-day+rolling+average&Relative+to+Population=true&Color+by+test+positivity=false&country=~COL&Metric=Omicron+variant+%28share%29.
- [35] En Colombia ya no se tomarán pruebas PCR para detectar covid-19 en personas de 3 a 60 años. *Revista Semana*. January 7, 2022. [cited 2022 Feb 28]; Available from: <https://www.semana.com/coronavirus/articulo/en-colombia-ya-no-se-tomaran-pruebas-pcr-para-detectar-covid-19-en-personas-de-3-a-60-anos/202252/>.
- [36] Leal Acosta A.C. El sector salud ha recibido 9% de los recursos del Presupuesto desde 2012, en promedio. *La Republica* [Internet]. [cited 2021 Sep 27]; Available from: <https://www.larepublica.co/economia/el-sector-salud-ha-recibido-9-de-los-recursos-del-presupuesto-desde-2012-en-promedio-2995092>.
- [37] Ley de Solidaridad Sostenible es el primer y mas importante paso en el camino a la equidad en pospandemia: minhacienda. Ministerio de Hacienda. Boletín n 11. April 15, 2020. Available from: https://www.irc.gov.co/webcenter/ShowProperty?nodeId=%2FConexionContent%2FWCC_CLUSTER-160333%2F%2FidPrimaryFile.&revision=latestreleased.
- [38] Hale T, Angrist N, Goldszmidt R, et al. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nat Hum Behav* 2021; 5:529–38. <https://doi.org/10.1038/s41562-021-01079-8>.
- [39] Ducharme J. COVAX was a great idea, but is now 500 million doses short of its vaccine distribution goals. What exactly went wrong?. September 9, 2021. Available at: https://time.com/6096172/covax-vaccines-what-went-wrong/?utm_med.
- [40] Rueda M. Colombia bets on privately funded Covid vaccinations. [Internet]. [cited 2021 Sep 17]. Available from: <https://www.bbc.com/news/world-latin-america-57819261>.
- [41] PAHO. PAHO will begin procuring COVID-19 vaccines to expand access in Latin America and the Caribbean. August 11, 2021. Available from: <https://www.paho.org/en/news/11-8-2021-paho-will-begin-procuring-covid-19-vaccines-expand-access-latin-america-and>.
- [42] Colombia: tasa de muertes por esquema de vacunación, todas las edades 28 de noviembre de 2021-11 de enero de 2022. Ministerio de Salud y Protección Social. [cited 2022 Mar 14]; Available from: <https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/ED/grafica-tasa-muertes-esquema-vacunacion-todas-edades-minsalud.pdf>.