Impact of the COVID-19 pandemic on routine childhood immunisation in Colombia

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► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/archdischild-2021-321792).

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Received 4 February 2021
Accepted 28 June 2021

Check for updates

To cite: Moreno-Montoya J, Ballesteros SM, Rojas Sotelo JC, *et al*. *Arch Dis Child* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/archdischild-2021-321792

ABSTRACT

Objective To assess the impact of the COVID-19 pandemic on routine childhood vaccination coverage in Colombia by age group, rural/urban residence, state and vaccine type.

Design Ecological study of official monthly vaccination records.

Setting Vaccination records from the Colombian Ministry of Health (March–October 2019 and 2020).

Participants Aggregated data for Colombian children (<12 months, n=676 153; 12–23 months, n=700 319; and 5 years, n=734 295) participating in the Expanded Program on Immunization.

Main outcome measures Proportion of eligible population receiving vaccination.

Results Vaccination coverage showed an overall decline of approximately 14.4% from 2019 to 2020 (2019 coverage=76.0, 2020 coverage=61.6%). The greatest reduction in proportion vaccinated was observed in children <12 months of age for pneumococcal vaccine (second dose) (2019 coverage=81.4%; 2020 coverage=62.2%; 2019–2020 absolute difference, 19.2%; 95% CI 14.8% to 23.7%). For children aged 12–23 months, the proportion vaccinated for yellow fever declined by 16.4% (12.4% to 20.9%) from 78.3% in 2019 to 61.8% in 2020. Among children 5 years of age, the biggest decrease occurred for the oral polio vaccine (second dose), with a difference of 11.4% (7.1% to 15.7%) between 2019 and 2020 (73.1% and 61.7% for 2019 and 2020). We observed a statistically significant effect on vaccine coverage in rural versus urban areas for children <12 months and 5 years of age.

Conclusions Reduced uptake of immunisations during the COVID-19 pandemic poses a serious risk of vaccine-preventable disease outbreaks. Colombia and other middle-income countries need to continue to monitor immunisation programme coverage and disease outbreaks at the national and subnational levels and undertake catch-up vaccination activities.

What is already known on this topic?

- ► Inequalities in access to healthcare services between socioeconomic groups might be intensified by the COVID-19 pandemic.
- ► To effectively control and reduce the risk of outbreaks of vaccine-preventable diseases, countries must maintain high immunisation rates as a public health priority.
- ► Low-income to middle-income nations face greater difficulties in achieving optimal vaccination coverage.

What this study adds?

- ► The finding of lower vaccine uptake indicates the need for urgent immunisation catch-up programmes in Colombia.
- ► Rural areas are disproportionately affected, with greater differences in vaccine coverage between 2019 and 2020 and must be a focus of vaccination efforts.

INTRODUCTION

The WHO and the Pan-American Health Organization adopted a strategic immunisation plan for 2014–2020 aimed at improving vaccination coverage in all countries of the Americas. The strategy was designed to completely interrupt poliovirus transmission and ensure virus containment; eliminate measles, rubella and neonatal tetanus; and control other vaccine-preventable diseases guided by the principle that 'the entire population must have access'.[1] In response, Colombia developed yearly programmes and a comprehensive multiyear national immunisation plan to achieve those objectives, including a 95% vaccination coverage goal for each vaccine. Periodic monitoring of vaccination coverage, disease trend surveillance, and other programmatic indicators have been implemented at the national and state levels to continuously evaluate vaccination plans.[2] However, the 2020 COVID-19 pandemic created barriers for the national health system to maintain scheduled mass immunisations; thus, lags were expected in the provision of and access to health services.[3] For low-income and middle-income countries, the effects of these disruption may be even more detrimental to achieving optimal immunisation coverage for poor households and remote or rural areas.[4 5] Although inequities are decreasing in Latin America,[6] infectious outbreaks such as COVID-19 have the potential to affect what has been achieved by diverting health resources from preventive healthcare and through lockdown measures that contribute to reducing normal delivery of vaccines, especially in remote areas.

The first case of COVID-19 in Colombia was reported on 6 March 2020; approximately a year later (as of 20 March 2021), over two million COVID-19 cases were registered.[7] Government public health measures started by mid-March of 2020 and included a nationwide lockdown, isolation, social distancing and school closures. The lockdown ended in September 2020, but other infection control measures remained.[8]

In Colombia, where 23% of the population live in rural areas and where there are high levels of socioeconomic and health inequities,[9] populations face severe disparities and barriers to accessing healthcare services.[10] General health services and many activities affecting healthcare access (eg, transportation) were affected by the pandemic due to lockdown and isolation measures issued by the government at the national level, despite WHO recommendations regarding vaccination programmes[11] and continuous efforts from local governments to guarantee universal access. Consequently, immunisation coverage may have decreased during the pandemic, with potentially differential impacts between urban and rural populations.[4 12] However, data regarding immunisation coverage through the pandemic have not been systematically reported. Therefore, we aimed to assess the impact of the COVID-19 pandemic on routine childhood vaccination coverage in Colombia, overall and according to rural or urban residence, state and vaccine type.

METHODS

Settings

Data for vaccination coverage for children <5 years of age were extracted from the official records of the Expanded Program on Immunization from the Colombian National Ministry of Health (at the state level) between March and October 2019 and during the same period in 2020; these periods were chosen because the isolation measures imposed by the national government due to the COVID-19 pandemic started in March 2020 and ended by 1 September 2020.[13] No individual-level data were used; instead, state-level coverage levels were analysed. The databases of the immunisation programme are updated by trained nurses through an informatics system and contain vaccination data from every child in the country. Accuracy and completeness of the data are assessed through a continuous quality data review.[14] Coverage rates were calculated as the proportion of the number of doses administered and total inhabitants (official population data by year) of each age group (<12 months, 12–23 months and 5 years).[15] Month-by-month relative differences in vaccination coverage were calculated between 2019 and 2020. Negative values indicate an increase in coverage rates in 2020 vs 2019 (online supplemental table A1).

Vaccines

Vaccines included in the Colombian Expanded Program on Immunization during the study period for children <12 months were the BCG, hepatitis B, inactivated polio vaccine (IPV), oral polio vaccine (OPV)+IPV, pentavalent (three doses), rotavirus (two doses), seasonal influenza (two doses) and pneumococcal vaccines (two doses); the pentavalent vaccine, which contains diphtheria, pertussis and tetanus (DPT), *Haemophilus influenzae* type b and hepatitis B vaccines. The hepatitis B vaccine is first administered as a monovalent vaccine at birth and is subsequently given as part of the pentavalent vaccine at 2, 4 and 6 months of age. At 12–23 months, the vaccine schedule includes measles, mumps and rubella (MMR), varicella, pneumococcal reinforcement, hepatitis A and yellow fever vaccines, as well as OPV and DPT first doses. For 5-year-old children, the schedule includes boosters for MMR and second boosters for DPT and OPV.[16] Except for the two doses of the seasonal influenza vaccine, all vaccines were included in these analyses. The seasonal influenza vaccine was excluded since it is mainly delivered in yearly campaigns and not month by month.[17]

Statistical analysis

To estimate changes in vaccination coverage, we calculated absolute differences between 2019 and 2020 coverage rates during the study period. According to official reports, 2019 can be assumed to be a typical year in terms of immunisation processes.[18] The vaccination figures analysed in the current study were stratified by geographical regions according to their physical, cultural and climatic characteristics, as reported elsewhere: Amazon, Andean, Bogotá, Caribbean, Eastern Plains and Pacific regions[19] (online supplemental table A2). Official counts of people residing in rural areas within each state and region[20] were used to establish the referent for the rural population (ie, for calculating proportions). A two-level multilevel linear regression model was used to assess the effect of rural residence on absolute differences in vaccination coverage between 2019 and 2020; geographical area was considered a level 2 variable, and rural residence was considered a level 1 variable. We evaluated data on rural residence and vaccination coverage clustered by geographical region. P values of <0.05 were considered the threshold for statistical significance. All analyses were carried out via Stata V.16.[21]

RESULTS

A total of 2 128 642 children were included in 2019, with the following distribution: <12 months (n=680 127), 12–23 months (n=702 452) and 5 years (n=746 063). A total of 2 110 767 children were included in 2020, with the following distribution: 676 153 (<12 months), 700 319 (12–23 months) and 734 295 (5 years) (online appendix table A2). For 2019, the coverage achieved for October was 78.7% (95% CI 77.7% to 79.8%) in children <12 months, 77.1% (95% CI 75.8% to 78.4%) in children 12–23 months and 73.6% (95% CI 71.8% to 75.4%) for children 5 years of age. For the same period in 2020, the achieved coverage rates were 61.1% (95% CI 59.4% to 62.7%), 61.8% (95% CI 60.0% to 63.7%) and 63.2% (95% CI 58.9% to 67.3%), respectively. When considering all vaccines at all ages, the average absolute difference between years was 14.4% (95% CI 12.3% to 16.6%).

We observed absolute differences in the coverage by region between years (F-test p<0.001), in descending order: Amazon (25.2%, 95% CI 22.84% to 27.8%), Eastern Plains (19.4%, 95% CI 17.7% to 21.05%), Pacific (19.3%, 95% CI 17.8% to 20.7%), Andean (15.6%, 95% CI 14.3% to 16.8%), Caribbean (9.1%, 95% CI 8.1% to 10.2%) and Bogotá (6.6%, 95% CI 5.2% to 8.0%).

When examining data for specific vaccines, age groups and across regions, the vaccines that decreased the least and the most, respectively, between 2019 and 2020 were the hepatitis B (absolute difference in coverage of 13.1%) and pneumococcal (second dose) (absolute difference in coverage of 19.2%) vaccines for children <12 months. For children 12–23 months of age, the smallest absolute difference was found for the varicella vaccine (14.6%) and the largest difference was found for the yellow fever vaccine (16.4%). For 5-year-old children, the smallest and largest absolute differences were found for the DPT second booster (10.2%) and the OPV second booster (11.4%). Absolute differences in vaccine coverage for each vaccine are presented in tables 1–3. Effects of rural residence on absolute

Table 1 Percentages of vaccination coverage in 2019 and 2020 and absolute differences between years by region in children <12 months of age (2019, n=680 127; 2020 n=676 153)

Vaccine	Year Diff	Region: Amazon	Andean	Bogotá	Caribbean	Eastern Plains	Pacific	Total
BCG	2019	82.1	73.7	84.6	75.8	83.9	69.0	76.5
	2020	53.8	60.0	77.9	69.5	63.1	55.4	62.3
	Diff	28.3	13.7	6.7	6.3	20.8	13.6	14.2
Hepatitis B	2019	73.4	73.3	84.7	74.5	76.0	65.1	73.2
	2020	48.0	59.8	78.1	68.6	59.5	51.6	60.1
	Diff	25.5	13.5	6.6	5.9	16.5	13.6	13.1
IPV	2019	84.8	78.2	73.9	82.2	89.5	77.8	81.6
	2020	54.6	62.8	65.9	71.5	65.4	57.2	63.9
	Diff	30.2	15.4	8.0	10.7	24.1	20.6	17.7
OPV+IPV	2019	78.2	80.1	75.2	80.2	77.1	74.3	78.6
	2020	46.8	61.9	65.8	69.0	58.4	49.4	59.8
	Diff	31.4	18.2	9.4	11.2	18.7	24.8	18.8
Penta first dose	2019	84.5	78.2	74.0	82.3	89.1	77.1	81.5
	2020	54.9	62.9	65.9	71.9	66.4	57.6	64.2
	Diff	29.6	15.3	8.1	10.5	22.7	19.5	17.2
Penta second dose	2019	82.7	79.3	75.3	82.4	86.3	76.0	81.1
	2020	50.7	62.6	65.7	71.4	63.2	53.4	62.4
	Diff	32.1	16.7	9.6	11.1	23.1	22.6	18.7
Penta third dose	2019	78.5	80.1	75.2	80.3	77.2	74.0	78.6
	2020	46.9	61.9	65.8	69.6	58.6	49.7	60.1
	Diff	31.6	18.2	9.4	10.7	18.6	24.3	18.6
Rota first dose	2019	77.6	77.4	72.4	78.9	79.5	71.4	77.2
	2020	48.7	61.5	65.1	67.6	58.0	51.1	59.7
	Diff	28.9	15.9	7.3	11.2	21.5	20.3	17.5
Rota second dose	2019	77.0	78.8	72.3	79.8	79.9	71.9	77.8
	2020	47.3	61.8	65.1	68.4	59.5	50.0	59.8
	Diff	29.7	17.0	7.2	11.4	20.4	21.9	18.0
Pneumococcal first dose	2019	84.5	79.1	76.5	83.2	90.8	77.0	82.2
	2020	54.8	62.9	67.4	72.0	64.3	57.1	64.0
	Diff	29.7	16.2	9.1	11.2	26.5	19.9	18.2
Pneumococcal second dose	2019	82.3	79.8	76.3	82.9	87.7	75.5	81.4
	2020	50.5	62.6	67.2	70.7	63.5	52.9	62.2
	Diff	31.9	17.2	9.1	12.1	24.2	22.6	19.2

BCG, Bacillus Calmette-Guérin; Diff, 2019–2020 difference; IPV, inactivated polio vaccine; OPV, oral polio vaccine; Penta, pentavalent vaccine; Rota, rotavirus.

differences in coverage between years were mainly observed in children <12 months and children 5 years of age. The BCG and hepatitis B vaccines showed the greatest differences in coverage proportions when comparing rural and urban areas, with estimated effects (betas) of 0.453 (95% CI 0.21 to 0.68) and 0.490 (95% CI 0.24 to 0.73), respectively (table 4). Taking the BCG vaccine as an illustrative example, it is expected that for each percentage increase in the proportion of coverage in the rural population, the difference in coverage between years increased by 0.453 percentage units.

DISCUSSION

This study found that Colombia's vaccination coverages of routine childhood immunisations were affected during the COVID-19 pandemic. A 14.4% reduction was estimated in immunisation coverage among Colombian children in 2020 compared with the same period in 2019. The greatest declines in coverage were observed among children <12 months who are living in rural areas. Certain regions, such as the Amazon, Eastern Plains and Pacific regions, showed statistically significant reductions in coverage compared with other regions. It is likely that measures such as isolation and lockdown during the pandemic as well as the changes in public health priorities contributed to the observed reduction in vaccination coverage.

Others have previously reported that those living in less deprived areas may be less affected by emergency situations[22] and may be less vulnerable to health service disruptions caused by disease outbreaks, natural disasters or protracted armed conflict.[23] Given this, there may be a differential effect on uptake of vaccinations through the pandemic based on pre-existing vulnerabilities. This is particularly important in the Colombian context, given that 5% reductions in mass immunisations have been associated with a threefold increase in cases of vaccine-preventable diseases.[24]

Beyond the increase in global morbidity and mortality and disruptions to the economic and social well-being of individuals and communities across the world,[25] the COVID-19 pandemic and associated restrictions have contributed to the delay in the provision of non-vital medical services such as vaccination. Risk–benefit analysis has shown that the deaths prevented by sustaining routine childhood immunisations far outweigh the excess risk of COVID-19 deaths associated with visits to vaccination clinics,

Table 2 Percentages of vaccination coverage in 2019 and 2020 and absolute differences between years by region in children 12–23 months of age (2019, n=702 452; 2020, n=700 319)

Vaccine	Year Diff	Region						Total
		Amazon	Andean	Bogotá	Caribbean	Eastern Plains	Pacific	
MMR	2019	80.3	80.8	78.0	79.8	83.3	76.7	80.0
	2020	57.7	64.1	70.9	72.6	64.6	57.1	65.1
	Diff	22.6	16.7	7.1	7.2	18.8	19.6	14.9
Varicella	2019	80.0	80.0	79.1	78.1	82.4	76.5	79.1
	2020	56.5	63.7	71.4	72.0	62.6	57.7	64.5
	Diff	23.5	16.3	7.7	6.1	19.8	18.9	14.6
Pneumococcal reinf.	2019	78.4	80.0	74.3	78.4	79.7	75.0	78.4
	2020	56.1	63.4	69.5	71.1	61.6	55.4	63.6
	Diff	22.3	16.6	4.8	7.3	18.1	19.7	14.7
Hepatitis A	2019	80.8	81.4	79.3	79.9	82.3	76.7	80.2
	2020	57.6	64.2	71.5	72.7	65.4	57.3	65.3
	Diff	23.2	17.2	7.8	7.2	16.9	19.4	14.9
Yellow fever	2019	81.6	79.0	69.8	77.3	85.5	71.1	78.3
	2020	58.4	61.4	63.4	66.6	65.4	52.3	61.8
	Diff	23.3	17.6	6.4	10.8	20.1	18.8	16.4
OPV first reinf	2019	67.6	79.7	70.8	75.3	74.5	67.3	73.8
	2020	50.1	61.7	63.9	64.6	56.0	48.6	58.4
	Diff	17.5	17.9	6.9	10.8	18.5	18.7	15.4
DPT first reinf	2019	67.6	79.9	70.8	75.2	74.5	66.9	73.8
	2020	49.7	62.0	63.8	64.3	55.9	48.7	58.3
	Diff	17.9	18.0	7.0	10.9	18.6	18.2	15.5

Diff, 2019–2020 difference; DPT, diphtheria, pertussis and tetanus; MMR, measles, mumps and rubella; OPV, oral polio vaccine; reinf, reinforcement.

especially for children.[26] As such, efforts are needed to guarantee continuity in vaccine uptake, given that lockdown and isolation measures have negatively impacted national coverage during 2020, especially among rural populations. Although there have been successful efforts to reduce rural/urban inequalities,[6] new vaccination agendas (including those proposed for COVID-19 containment) must include special actions to overcome lags in routine childhood immunisation for at-risk regions.

As measures to control the spread of the virus are gradually lifted, some settings (eg, schools and childcare centres) reopen, and social activities increase, transmission of the SARS-CoV-2 virus is expected to rise. In such circumstances, and given that confinement has been associated with rapid decreases in other infectious diseases,[27] an increase in the number of cases of vaccine-preventable conditions in children who missed vaccinations during the pandemic is expected, thereby posing a twofold challenge to public health systems.

Factors associated with the lag in vaccination processes likely include public actions (ie, isolation and infection control measures), individual characteristics such as poverty/socioeconomic status or cultural traits,[28] and misinformation on diseases and vaccinations, including people's concerns about contagion and the safety of vaccines and their potential side effects (which has increased during pandemic times).[29] These threats affect conventional vaccination programmes operating in the midst of new vaccination processes against COVID-19[30] and need to be considered in the near future to reactivate normal immunisation processes. We considered that mass communication and health education strategies aimed

Table 3 Percentages of vaccination coverage in 2019 and 2020 and absolute differences between years by region in children 5 years of age (2019, n=746 063; 2020, n=734 295)

Vaccine	Year Diff	Region						Total
		Amazon	Andean	Bogotá	Caribbean	Eastern Plains	Pacific	
MMR reinf	2019	70.7	77.6	81.4	72.4	72.8	68.6	73.2
	2020	53.3	67.9	80.5	65.5	59.8	53.2	62.2
	Diff	17.4	9.7	0.9	6.9	13.0	15.4	10.9
OPV second reinf	2019	70.3	77.4	80.4	72.5	72.4	69.0	73.1
	2020	53.0	66.9	79.0	65.5	59.2	52.2	61.7
	Diff	17.4	10.5	1.4	7.0	13.3	16.8	11.4
DPT second reinf	2019	70.4	77.3	80.7	72.2	72.4	68.6	72.9
	2020	53.0	68.1	82.8	66.5	60.0	53.3	62.7
	Diff	17.4	9.2	–2.1	5.6	12.4	15.3	10.2

Diff, 2019–2020 difference; DPT, diphtheria, pertussis and tetanus; MMR, measles, mumps and rubella; OPV, oral polio vaccine; reinf, reinforcement.

Table 4 Effect of rural residence on absolute differences in vaccination coverage

Age group	Vaccine	Effect on vaccination proportions (betas)*	95% CI
<12 months	BCG	0.453	0.218 to 0.689
	Hepatitis B	0.490	0.248 to 0.732
	IPV	0.361	0.156 to 0.565
	OPV+IPV	0.269	0.062 to 0.476
	Penta first dose	0.368	0.173 to 0.562
	Penta second dose	0.388	0.192 to 0.584
	Penta third dose	0.290	0.089 to 0.491
	Rota first dose	0.373	0.182 to 0.563
	Rota second dose	0.359	0.163 to 0.555
	Pneumococcal first dose	0.332	0.139 to 0.524
	Pneumococcal second dose	0.387	0.189 to 0.586
12–23 months	MMR	0.142	−0.048 to 0.334
	Varicella	0.208	−0.007 to 0.423
	Pneumococcal reinf	0.167	−0.031 to 0.366
	Hepatitis A	0.162	−0.040 to 0.366
	Yellow fever	0.120	−0.083 to 0.325
	OPV first reinf	0.103	−0.082 to 0.290
	DPT first reinf	0.126	−0.059 to 0.312
5 years	MMR reinf	0.253	0.057 to 0.449
	OPV second reinf	0.224	0.016 to 0.433
	DPT second reinf	0.284	0.083 to 0.485

*Multilevel model effects clustering by region. States were the unit of analysis.
DPT, diphtheria, pertussis and tetanus; IPV, inactivated polio vaccine; MMR, measles, mumps and rubella; OPV, oral polio vaccine; Penta, pentavalent vaccine; Reinf, reinforcement; Rota, rotavirus.

at the general population are recommended to address these concerns.

We acknowledge some study limitations. Official records were used in this study. Due to the mandatory nature of the vaccination notification and the periodic data quality assessments that are applied, we considered this study used the best information source for the country; however, the opportunity to update datasets can be delayed in remote/rural areas due to isolation measures and therefore differential bias in coverage reporting could be expected; nonetheless, there are no precise data reported on the delay of the information. Inequity measures other than rural population proportion were not evaluated due to insufficient data availability. However, rural residence has previously been associated with low socioeconomic indicators, such as poverty and reduced educational attainment in Colombia[31] and in other contexts such as the USA.[32] Our results must be considered in the context of similar resource-limited settings.

Our findings demonstrate a reduction in vaccination coverage during the COVID-19 pandemic in Colombia, with greater impacts on rural and younger children. Further research is needed to assess the downstream implications on spread of vaccine-preventable diseases and potential reduced opportunity for comprehensive care of infants and young children that often accompany vaccination efforts.

Contributors JM-M conceived the study and performed the analysis and interpretation of the data. JCRS and CLBC contributed towards the acquisition of data for the work. JM-M, SMB, JCRS, CLBC, PB-L and JADIH-V drafted the manuscript and revised it critically for important intellectual content.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval This analysis used public secondary (deidentified) information collected as part of standard public health practice. Ethics approval was granted by the institutional committee of human ethics of the Fundación Santa Fe de Bogotá Hospital (approval ID: CCEI-12 640-2020).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request from the Colombian Ministry of Health and Social Protection. Restrictions apply to the availability of these data, which were used under licence for this study. Data are available from the authors with the permission of the Ministry of Health and Social Protection.

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