Original Research Article

Effect of Initial Two Years of COVID-19 Pandemic on Coverage of Various Types of Vaccines Covered under the National Immunization Schedule in a Tertiary Care Hospital of Rajasthan, India

ABSTRACT

Introduction:
Immunization is one of the most cost-effective public health interventions responsible for saving lives of numerous children. COVID-19 pandemic induced disruptions in the routine immunization services has resulted in India responsible for 2.7 million children unvaccinated. Present study aimed to estimate the changes in coverage of various types of vaccines in initial two years of COVID-19 pandemic in a tertiary-care hospital in Jaipur, Rajasthan, India.

Methods:
This was a record based ecological study conducted retrospectively at paediatric tertiary-care hospital, Jaipur. Data of number of doses of each vaccine administered to children (0-16 years) as per the National Immunization Schedule for the period January 2019 to December 2021 were retrieved from the immunization records. Percent change was used to compare levels with pre-pandemic year 2019. Simple moving average method was used to depict the trend in vaccine doses administered.

Results:
A downward trend was observed in the total doses of vaccines administered in both years 2020 and 2021 with the overall percent change being -26.4% and -22.5% respectively. The year 2020 recorded maximum negative difference of -62.4% in dose of Td (10 years) followed by DPT Booster-2 (-51.5%). The year 2021 recorded maximum negative difference in dose of Td (16 years) (-51.4%) followed by OPV-3 and Pentavalent-3 (-36.1% each).

Conclusion:
The total vaccine doses administered along with the majority of the vaccine under the immunization schedule have shown a negative percent change extending till December 2021. It is recommended to monitor the catch-up immunization levels and strengthen the health system to prevent such disruption in futures. Also, awareness through online or offline media can be customized as per caregivers of different age-groups of children.

Keywords: Routine Immunization, COVID-19, Polio, DPT, Vaccination

1. INTRODUCTION

The emergence of the novel corona virus was declared as a Public Health Emergency of International Concern (PHEIC) on 30th January 2020 and as a pandemic on 11th March 2020

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Introduction: Immunisation is one of the most cost-effective public health interventions that has saved countless children's lives. However, the disruption caused by the COVID-19 pandemic has resulted in India having 2.7 million unvaccinated children due to the interruption of regular immunisation services. The present study, conducted in a tertiary-care hospital in Jaipur, Rajasthan, India, aimed to determine the changes in vaccine coverage during the first two years of the pandemic.
Methods:
This retrospectively record-based epidemiological study was conducted to examine how many vaccine doses were administrated to children between the ages of 0-16 years from January 2019 to December 2021, following the National Immunisation Schedule. The study looked at the percentage change from pre-pandemic levels in 2019. A simple moving average method was used to illustrate the trend in vaccine doses given.
Results:
A downward trend was observed in the total doses of vaccines administered in 2020 and 2021, with the overall per cent change being -26.4% and -22.5%, respectively. In 2020, a maximum negative difference of -62.4% in the dose of Td (10 years) was recorded, followed by DPT Booster-2 (-51.5%), and in 2021, was recorded a maximum negative difference in the dose of Td (16 years) (-51.4%

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1. INTRODUCTION
On January 30th, 2020, the novel coronavirus was declared a Public Health Emergency of International Concern (PHEIC). It was declared a pandemic on March 11th, 2020 [1]. Governments took action by implementing measures such as country-wide lockdowns, travel restrictions, and social distancing in response to this issue [2]. Due to the pandemic, regular immunisation services were disrupted as only essential and emergency medical services were available in both the public and private sectors, which has caused a decrease in essential immunisation coverage in all WHO Regions, with the South-East Asian Region being the most affected with a 9% drop [3]. In 2021, about 18 million children did not receive any immunisation services, similar to the number of zero-dose children recorded sixteen years ago in 2005 [3]. Of the top ten countries with the highest number of unvaccinated children, India has the highest count at 2.7 million, followed by Nigeria. These two countries account for 62% of all zero-dose children [3].
Immunisation is a highly cost-effective public health intervention that protects many children from illness and disability, ultimately improving their quality of life [4]. The Indian government has launched "Mission Indradhanush," the most extensive

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[1]. This led to governments implementing measures like country-wide lockdowns, travel restrictions, and social distancing. [2] Routine immunization services were disrupted during the pandemic as only essential and emergency medical services were operational in both the public and the private sector. This has resulted in a drop in the essential immunization service coverage in all WHO Regions with the South-East Asian Region being most affected with a drop of 9% [3]. Also, 18 million children were left out by immunization services (zero-dose children) in the year 2021, a figure last seen about sixteen years ago (2005). [3] Amongst the ten countries accountable for the 62% of zero-dose children, India reported the highest number of (2.7 million) children unvaccinated followed by Nigeria. [3]

Immunization is one of the most cost-effective public health interventions responsible for protecting numerous children from illness and disability and ultimately enhancing their quality of life [4]. The Indian government launched "*Mission Indradhanush*" which is the world's biggest immunization programme with respect to number of beneficiaries, quantities and different types of vaccines and vast regional distribution that caters to approximately 27 million newborns per year. [5] Disruption of the routine immunization schedule of children is a major risk for lessening of herd immunity below threshold levels and ultimately resulting in outbreaks of vaccine preventable diseases (VPDs) that would further overwhelm the health systems. [6] Although the full immunization coverage in children aged 12-23 months has recorded considerable improvement at the national level to 76% and in Rajasthan to 80.4% as per the National Family Health Survey, 2019-20 [7], COVID-19 induced disruption may negatively impact the work put in to increase the immunization coverage and at worst lead to emergence of outbreaks of VPDs.

Many studies have reported the disruption for each vaccine in the immunization schedule, however only for initial months of year 2020 [8-10]. Few studies have only reported disruption in the routine immunization services and given the total decrease in the vaccine coverage [11]. The present study was conducted with the objective to estimate the changes in coverage of various types of vaccines covered under National Immunization Schedule, in initial two years of COVID-19 pandemic at a tertiary-care paediatric hospital in Jaipur, Rajasthan, India.

2. MATERIAL AND METHODS

The present study was a record-based ecological study that was conducted retrospectively at an immunization centre of a tertiary-care paediatric hospital in Jaipur, Rajasthan. Purposive sampling was done for the selection this institute as it was attached to a government teaching medical college and catered to large volumes of paediatric patients and here all children between 0 and 16 years of age were routinely vaccinated free of cost as per the National Immunization Schedule (NIS) under the Universal Immunization Programme (UIP). The vaccination for pneumococcal pneumonia (PCV) was added to immunization schedule in the year 2019 in Rajasthan. In the immunization centre of the present study, the birth dose vaccines (Hepatitis-B dose, OPV-0 dose and BCG) are not given routinely (only to those who were admitted in the hospital or had missed them) since the service of institutional delivery was not available.

2.1 Data Collection and Statistical Analysis

Data were collected for a duration of three years, i.e. 1st January 2019 to 31st December 2021 so as to compare the COVID-19 pandemic period (years 2020 and 2021) with matched periods of the pre-pandemic year 2019. There were no ethical issues involved in the conduct of this study.Informed consent was not necessary because only anonymized routine record data were analysed retrospectively. The data for number of vaccine doses administered were retrieved from the 'beneficiary immunization record' registers which was then triangulated with the 'vaccine stock' registers by the investigator. Data on both the periods of

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2. Material and Methods

The present study was a record-based ecological study conducted retrospectively at an immunisation centre of a tertiary-care paediatric hospital in Jaipur, Rajasthan. Purposive sampling was done for selecting this institute as it was attached to a government-teaching medical college and catered to many paediatric patients. Here all children between 0 and 16 years of age were routinely vaccinated free of cost as per the National Immunization Schedule (NIS) under the Universal Immunization Programme (UIP). The vaccination for pneumococcal pneumonia (PCV) was added to the immunisation schedule in 2019 in Rajasthan. In the immunisation centre of the present study, the birth dose vaccines (Hepatitis-B dose, OPV-0 dose and BCG) are not given routinely (only to those who were admitted to the hospital or had missed them) since the service of institutional delivery was not available.

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The authors do not state the sample of their study nor the type of sampling they used to select it. Furthermore, no inclusion or exclusion criteria are defined for this sample. The authors should review these aspects.

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3. RESULTS

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3. results
A downward trend was observed in the total vaccine doses administered from January 2019 to December 2021. Various specific periods of the COVID-19 pandemic have been highlighted in Figure-1.
There was an overall negative per cent difference in the total doses of vaccines administered in the year 2020 (-26.4%) and year 2021 (-22.5%). Since the PCV administration began in 2019, a positive per cent change has been shown by it. On comparing individual vaccine coverage with the base year 2019, it was found that the year 2020 recorded a maximum negative difference in dose of Td (10 years) (-62.4%) followed by DPT Booster-2 (-51.5%); the year 2021 recorded maximum negative difference in dose of Td (16 years) (-51.4%) followed by OPV-3 and Pentavalent-3 (-36.1% each). (Figure-2, 3)

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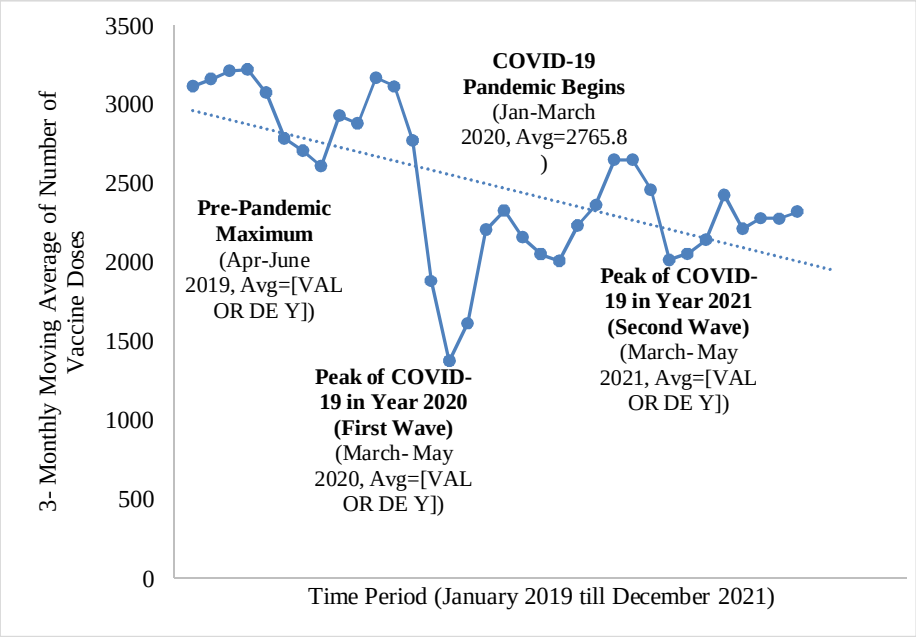

Figure-1: Trend in Time Series Analysis: 3-monthly Moving Average for January 2019-December 2021

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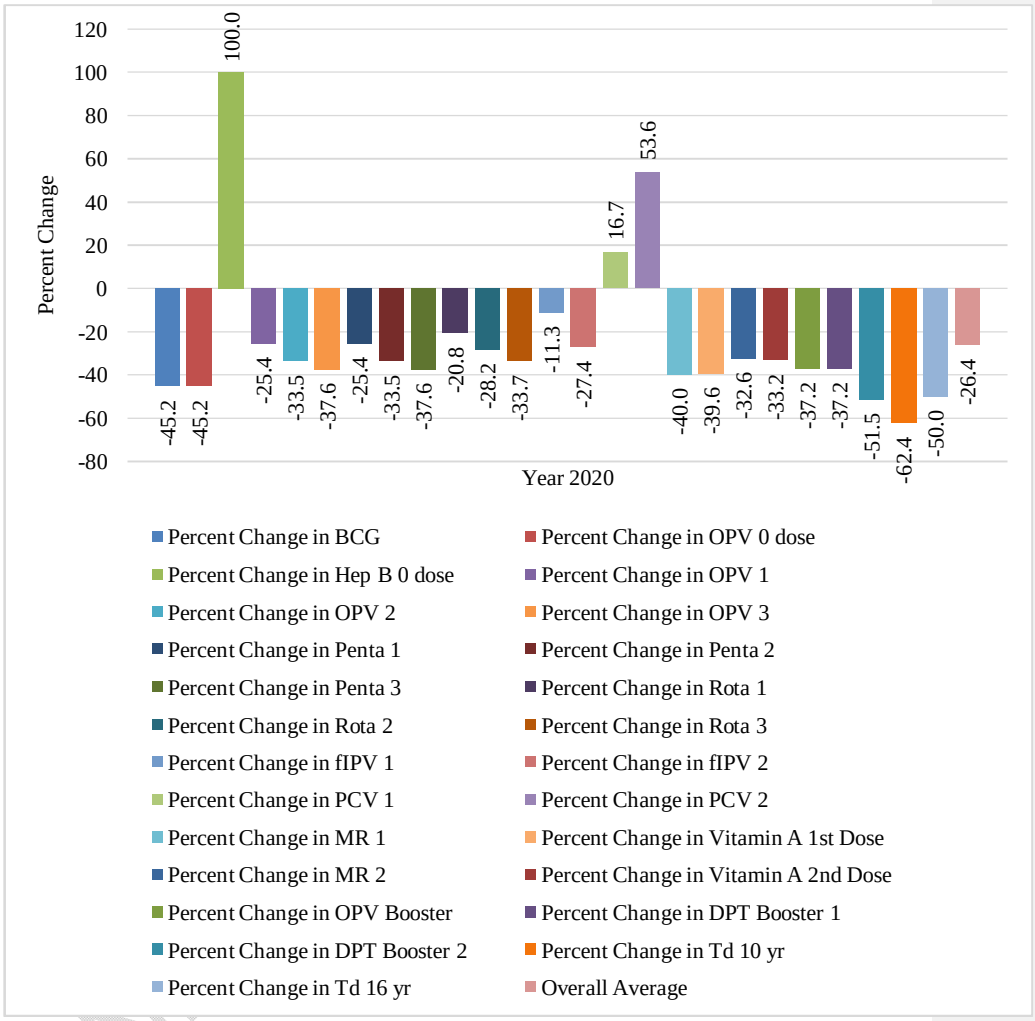

Figure-2: Percent Change in Various Types of Vaccine Coverage in the Year 2020 on Comparison with Base Year 2019

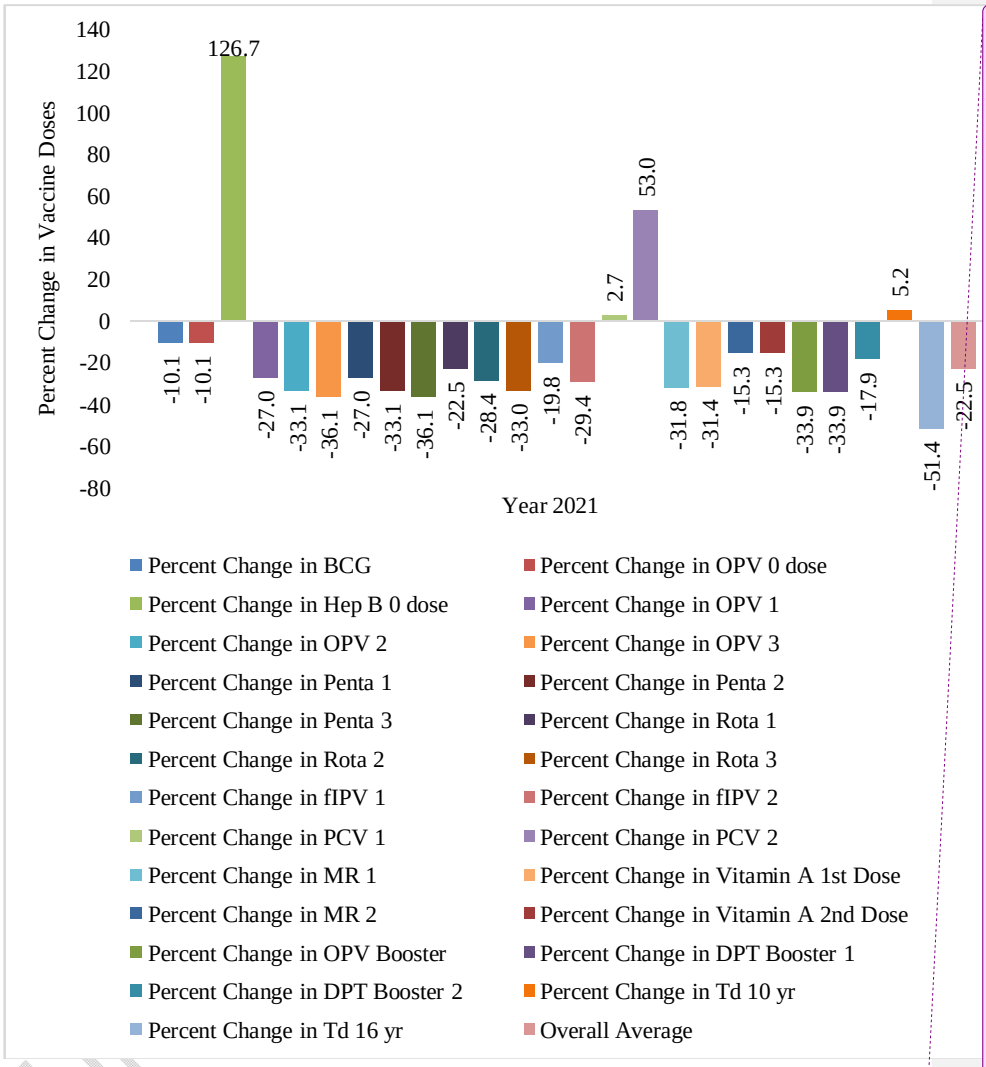

Figure-3: Percent Change in Various Types of Vaccine Coverage in the Year 2021 on Comparison with Base Year 2019

4. DISCUSSION

The government of Rajasthan imposed lockdown restrictive measures in a phased manner from 22nd March 2020 till 30th June 2020. Subsequently, the un-lockdown was done in a phased manner. However, with the surge in the COVID-19 cases during the second wave another lockdown was initiated from 17th April 2021 till 8th June 2021. Although both these periods of lockdown were in the second quarter of their respective years, the impact was seen throughout the year. These periods coincide with the findings of the present study

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4. DISCUSSION

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In the present study, the overall decline in the OPV third and booster doses was -37.6% and -37.2% in 2020. In 2021, no improvement was seen, and the decline was reported to be -36.1% and -33.9%, respectively. In another study from India by Chakrabarti A. et al. [13], a 60% decline in the final dose of polio series was reported. This was higher than the present study, as they reported only for April 2020, whereas this study evaluated the impact of the pandemic for the entire year. Harris et al. [14] included 19 countries (both HICs and LMICs). They reported the most significant decline in OPV with a median decrease of -79% (IQR -42% to -79%) administered during infancy. As per WHO [15], the wild poliovirus type 1 is endemic in Pakistan and Afghanistan. Since both these countries are neighbours of India, it is crucial to study the status of vaccine administration in these countries. Around 50 million children in Pakistan missed polio vaccination in 2020 [16]. Laghman et al. [17], in their study in Afghanistan, reported a 21.4% significant ($p < 0.01$) decline in the total immunisation coverage and a 28% decline in measles and OPV4, which were the most affected vaccines. In other LMICs, Mansour Z et al. [18] reported the second-highest change in OPV (-28%) in their study in Lebanon. Wale Tegegne A et al. [19] reported a 62.2% prevalence of incomplete immunisation with a dropout rate of 13.6% for OPV0 to OPV3 in the South Region, Ethiopia. This negative trend was similar to the findings of the present study. However, many of these studies report findings for 2020, and there is a need to gather evidence for 2021 as continuing this negative trend into 2021 is a matter of concern.
The present study reports a decline in the BCG doses administered by -45.2% in 2020, which subsequently increased to -10.1% in 2021. Chakrabarti A et al. [13] reported an approximately 30% decline in BCG administration in May 2021 at the district leve

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where the total vaccine doses administered reported a negative percent change of -26.4% and -22.5% in years 2020 and 2021 respectively. Summan A et al. [12] in their study concluded that the immunization coverage was 2% lower for BCG and hepB0 to 9% for DPT3 and 10% for polio-3 in COVID-affected children as compared with unaffected children. These values were lower than the present study as they were at a national level and did not include the impact of the second wave of the COVID-19, which was more severe.

In the present study the overall decline in the OPV third dose and booster dose was -37.6% and -37.2% in the year 2020. In the year 2021 no improvement was seen and the decline was reported to be -36.1% and -33.9%, respectively. In another study from India by Chakrabarti A et al. [13], a 60% decline in the final dose of polio series was reported. This was higher than the present study as they have reported only for April 2020, whereas this study evaluated impact of the pandemic for the entire year. Harris et al. [14] in their study included 19 different countries (both HICs and LMICs) and reported the greatest decline in OPV with a median decrease of -79% (IQR -42% to -79%) administered during infancy. As per WHO [15] the wild poliovirus type 1 is endemic in Pakistan and Afghanistan. Since, both these countries are neighbours of India, it is important to study the status of vaccine administration in these countries as well. Around 50 million children missed polio vaccination in 2020 in Pakistan [16]. Laghman et al. [17] in their study in Afghanistan reported a 21.4% significant ($p< 0.01$) decline in the total immunization coverage and 28% decline in measles and OPV4 which were the most affected vaccines. In other LMICs, Mansour Z et al. [18] reported the second highest change in OPV (-28%) in their study in Lebanon. Wale Tegegne A et al. [19] reported 62.2% prevalence of incomplete immunization with dropout rate of 13.6% for OPV0 to OPV3 in South Region, Ethiopia. This negative trend was similar to findings of the present study. However, many of these studies report findings for 2020 and there is a need to gather evidence for 2021 as continuation of this negative trend into 2021 is a matter of concern.

The present study reports decline in the BCG doses administered by -45.2% in the year 2020 which subsequently increased to -10.1% in the year 2021. Chakrabarti A et al. [13] reported approximately 30% decline BCG administration in May 2021 at district-level in India. This was higher than the present study as the declination reported was only for one month, whereas, the present study reports for an entire year. Also, the BCG vaccines were given only to in-patient children in the present study. Silveira et al. [20] in their study in Brazil reported less declination in BCG administration as compared to other vaccines. However, studies by Adilo et al. (Ethiopia) [21] and Osei et al. (Gambia) [22] reported more declination in BCG vaccine coverage relative to other vaccines. Chandir et al. [23] in their study in Sindh Province of Pakistan reported highest decline of 40.6% for BCG amongst other vaccines. This may be because of country-wise differences in the COVID-19 restrictive measures, vaccine supply disruptions or different priorities of the caregivers.

The measles and DPT-3 vaccinations are reliable indicators for monitoring age-appropriate vaccination [24].The drop in first and second dose of MR was -40% and -32.6% in the present study (year 2020). Harris et al. [14] reported median decrease of -9% (IQR -3% to -31%) in the school-entry aged children receiving measles vaccination (MR2) across 19 countries included in their study. Mansour Z et al. [18] in their study in the public sector in Lebanon, reported the highest negative percentage change in measles vaccines (-38%). McDonald HI et al. [25] in their study in England reported 20% decline in MMR vaccination. This value is less than the present study probably because of inter-regional differences. Ackerson BK et al. [26] reported a decline in measles vaccine administration by 93% in the week beginning April which remaining lower till August 2020 in California. This is higher than present study as the values were of a particular week which had the maximum impact of COVID, whereas ours was a yearly analysis. The present study also reports a fall in the doses of DPT containing vaccines. In the year 2020, pentavalent-3 and DPT booster-2 doses declined by 37.6% and 51.5%, which did not recover to pre-pandemic levels even by end of year 2021 with decline in doses of pentavalent-3 and DPT booster-1by 36.1% and

33.9%. A study by Patel P et al. [27] in Ahmedabad reported a reduction in reduction in DPT booster at 5 years (96.66%), pentavalent-3 (78.94%) and MR (78.57%). These values were higher than present study as they reflected different time period studied as well as regional differences in COVID cases. Harris et al. [14] also reported overall decline in DTP and measles coverage rates for all ages.

Levels of second dose of PCV in the present study showed a positive change during years 2020 and 2021 by 53% and 53.6%, probably because they had been introduced in the immunization schedule in 2019 itself in Rajasthan. Other studies report a negative change in the doses of PCV administered. Moreno-Montoya J et al. [28] in their study in Colombia reported the greatest reduction for second dose of pneumococcal vaccine in children <12 months of age by 19.2% (95% CI 14.8% to 23.7%). Mansour Z et al. [18] reported decline in PCV13 (-14%) in the public sector in Lebanon.

4.1 Strengths:

The entire trend of the vaccination from pre-pandemic, first wave and second wave of the pandemic has been described. The impact on different vaccine coverage under the UIP has been detailed for both the years.

4.2 Recommendations:

Monitoring in the status of catch-up immunizations is the need of the hour. The entire year 2021 reflect a downward trend which is a matter of concern. It is recommended to strengthen the surveillance for VPDs. Similar studies in every institute and every State should be promoted. This will help give the complete picture of effect of COVID-19 on coverage of various types of vaccines.

4.3 Limitations:

This study was conducted in tertiary-care paediatric hospital based in Jaipur, hence the findings cannot be generalised to the entire country. The moving average method used in the study to describe the trend of vaccine doses administered has its own limitations.

5. CONCLUSION

This study concludes that beside slight improvement in vaccine coverage in the year 2021 in comparison to year 2020, the vaccine count of majority of vaccines showed negative percent change in years 2020 and 2021 from the base year 2019. Apart from strengthening the health system to prevent future disruption in immunization services, it is recommended to establish the actual gap in vaccination levels and set relevant indicators to monitor the catch-up immunization levels. As a long term approach, awareness through information, education and communication (IEC) can be customized as per caregivers of different age-groups of children.

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Page 1: [1] Comment [DT1] **Dr. Orlando Téllez Almenares** **6/29/2023 2:59:00 PM**

It would be convenient if the authors improved abstract redaction. I suggest some modifications that I show in the following paragraph:

Introduction: Immunisation is one of the most cost-effective public health interventions that has saved countless children's lives. However, the disruption caused by the COVID-19 pandemic has resulted in India having 2.7 million unvaccinated children due to the interruption of regular immunisation services. The present study, conducted in a tertiary-care hospital in Jaipur, Rajasthan, India, aimed to determine the changes in vaccine coverage during the first two years of the pandemic.
Methods:
This retrospectively record-based epidemiological study was conducted to examine how many vaccine doses were administrated to children between the ages of 0-16 years from January 2019 to December 2021, following the National Immunisation Schedule. The study looked at the percentage change from pre-pandemic levels in 2019. A simple moving average method was used to illustrate the trend in vaccine doses given.
Results:
A downward trend was observed in the total doses of vaccines administered in 2020 and 2021, with the overall per cent change being -26.4% and -22.5%, respectively. In 2020, a maximum negative difference of -62.4% in the dose of Td (10 years) was recorded, followed by DPT Booster-2 (-51.5%), and in 2021, was recorded a maximum negative difference in the dose of Td (16 years) (-51.4%) followed by OPV-3 and Pentavalent-3 (-36.1% each).
Conclusion:
The total vaccine doses administered and the majority of the vaccine under the immunisation schedule have shown a negative per cent change extending till December 2021. Monitoring the catch-up immunisation levels and strengthening the health system to prevent such future disruption is recommended. Also, awareness through online or offline media can be customised as per caregivers of different age groups of children.

On the other hand, I suggest improving the authors' information in the abstract's material and methods section. They need to declare the sample and population of the study and what type of sampling they took into account for picking out their study sample.

Page 1: [2] Comment [DT2] **Dr. Orlando Téllez Almenares** **6/29/2023 3:25:00 PM**

It would be convenient if the authors improved abstract redaction. I suggest some modifications that I show in the following paragraph:

1. INTRODUCTION
On January 30th, 2020, the novel coronavirus was declared a Public Health Emergency of International Concern (PHEIC). It was declared a pandemic on March 11th, 2020 [1]. Governments took action by implementing measures such as country-wide lockdowns, travel restrictions, and social distancing in response to this issue [2]. Due to the pandemic, regular immunisation services were disrupted as only essential and emergency medical services were available in both the public and private sectors, which has caused a decrease in essential immunisation coverage in all WHO Regions, with the South-East Asian Region being the most affected with a 9% drop [3]. In 2021, about 18 million children did not receive any immunisation services, similar to the number of zero-dose children recorded sixteen years ago in 2005 [3]. Of the top ten countries with the highest number of unvaccinated children, India has the highest count at 2.7 million, followed by Nigeria. These two countries account for 62% of all zero-dose children [3].
Immunisation is a highly cost-effective public health intervention that protects many children from illness and disability, ultimately improving their quality of life [4]. The Indian government has launched "Mission Indradhanush," the most extensive immunisation worldwide programme regarding beneficiaries, vaccine quantities, regional distribution, and types of vaccines available. This program aims to immunise approximately 27 million newborns annually [5]. Children's regular immunisation schedule disruption is a significant risk for lessening herd immunity below threshold levels and ultimately resulting in outbreaks of vaccine-preventable diseases (VPDs) that would further overwhelm the health systems. [6] The National Family Health Survey of 2019-20 shows that full immunisation coverage for children aged 12-23 months has improved nationally to 76% and in Rajasthan to 80.4%. However, the COVID-19 pandemic may disrupt efforts to increase immunisation coverage and potentially lead to outbreaks of vaccine-preventable diseases.

The figures must be separated by an en dash, nota hyphen.

The quotes must be before the comma, dog, colon or semicolon.

Page 5: [3] Comment [DT6]	Dr. Orlando Téllez Almenares	6/29/2023 4:13:00 PM

It would be convenient if the authors improved abstract redaction. I suggest some modifications that I show in the following paragraph:

4. DISCUSSION

The government of Rajasthan imposed restrictive lockdown measures in a phased manner from 22nd March 2020 till 30th June 2020. Subsequently, the un-lockdown was done in a phased manner. However, with the surge in COVID-19 cases during the second wave, another lockdown was initiated from 17th April 2021 till 8th June 2021. Although both these lockdown periods were in the second quarter of their respective years, the impact was seen throughout the year. These periods coincide with the findings of the present study, where the total vaccine doses administered reported a negative per cent change of -26.4% and -22.5% in the years 2020 and 2021, respectively. Summan A et al. [12] concluded that the immunisation coverage was 2% lower for BCG and hepB0 to 9% for DPT3 and 10% for polio-3 in COVID-affected children compared with unaffected children. These values were lower than the present study as they were at a national level and did not include the impact of the second wave of COVID-19, which was more severe.

In the present study, the overall decline in the OPV third and booster doses was -37.6% and -37.2% in 2020. In 2021, no improvement was seen, and the decline was reported to be -36.1% and -33.9%, respectively. In another study from India by Chakrabarti A. et al. [13], a 60% decline in the final dose of polio series was reported. This was higher than the present study, as they reported only for April 2020, whereas this study evaluated the impact of the pandemic for the entire year. Harris et al. [14] included 19 countries (both HICs and LMICs). They reported the most significant decline in OPV with a median decrease of -79% (IQR -42% to -79%) administered during infancy. As per WHO [15], the wild poliovirus type 1 is endemic in Pakistan and Afghanistan. Since both these countries are neighbours of India, it is crucial to study the status of vaccine administration in these countries. Around 50 million children in Pakistan missed polio vaccination in 2020 [16]. Laghman et al. [17], in their study in Afghanistan, reported a 21.4% significant ($p< 0.01$) decline in the total immunisation coverage and a 28% decline in measles and OPV4, which were the most affected vaccines. In other LMICs, Mansour Z et al. [18] reported the second-highest change in OPV (-28%) in their study in Lebanon. Wale Tegegne A et al. [19] reported a 62.2% prevalence of incomplete immunisation with a dropout rate of 13.6% for OPV0 to OPV3 in the South Region, Ethiopia. This negative trend was similar to the findings of the present study. However, many of these studies report findings for 2020, and there is a need to gather evidence for 2021 as continuing this negative trend into 2021 is a matter of concern.

The present study reports a decline in the BCG doses administered by -45.2% in 2020, which subsequently increased to -10.1% in 2021. Chakrabarti A et al. [13] reported an approximately 30% decline in BCG administration in May 2021 at the district level in India which was higher than the present study as the decline reported was only for one month. In contrast, the present study reports for an entire year. Also, the present study gave the BCG vaccines to in-patient children. Silveira et al. [20], in their study in Brazil, reported less declination in BCG administration than in other vaccines. However, studies by Adilo et al. (Ethiopia) [21] and Osei et al. (Gambia) [22] reported more declination in BCG vaccine coverage relative to other vaccines. Chandir et al. [23], in their study in the Sindh Province of Pakistan, reported the highest decline of 40.6% for BCG, amongst other vaccines. This may be because of country-wise differences in the COVID-19 restrictive measures, vaccine supply disruptions or different priorities of the caregivers.

The measles and DPT-3 vaccinations are reliable indicators for monitoring age-appropriate vaccination [24]. The drop in the first and second doses of MR was -40% and -32.6% in the present study (2020). Harris et al. [14] reported a median decrease of -9% (IQR -3% to -31%) in the school-entry-aged children receiving measles vaccination (MR2) across 19 countries included in their study. Mansour Z et al. [18], in their study in the public sector in Lebanon, reported the highest negative percentage change in measles vaccines (-38%). In their study in England, McDonald HI et al. [25] reported a 20% decline in MMR vaccination. This value is less than the present study because of inter-regional differences. Ackerson BK et al. [26] reported a decline in measles vaccine

administration by 93% in the week beginning April, which remained lower until August 2020 in California, which is higher than the present study as the values were of a particular week with the maximum COVID impact, whereas ours was a yearly analysis. The present study also reports a fall in the doses of DPT-containing vaccines. In the year 2020, pentavalent-3 and DPT booster-2 doses declined by 37.6% and 51.5%, which did not recover to pre-pandemic levels even by the end of the year 2021 with the decline in doses of pentavalent-3 and DPT booster-1by 36.1% and 33.9%. A study by Patel P et al. [27] in Ahmedabad reported a reduction in reduction in DPT booster at five years (96.66%), pentavalent-3 (78.94%) and MR (78.57%). These values were higher than the present study, reflecting different periods studied and regional differences in COVID cases. Harris et al. [14] also reported declining coverage rates for all ages.

The study found a positive change of 53% and 53.6% in the PCV second dose levels between 2020 and 2021. This increase may be attributed to the introduction of PCV in the immunisation schedule 2019 in Rajasthan. However, other studies have reported a decline in the doses of PCV administered. For instance, Moreno-Montoya J et al. found in their study in Colombia that there was a reduction of 19.2% (95% CI 14.8% to 23.7%) for the second dose of pneumococcal vaccine in children under 12 months. Similarly, Mansour Z et al. reported a decrease of 14% in PCV13 in the public sector in Lebanon.