

ORIGINAL ARTICLE

Impact of the COVID-19 Pandemic on Some Vaccine-Preventable Diseases at a Tertiary Government Hospital in the Philippines

Cressie Anne A. Allanigue, MD, DPPS; Arlene S. Dy-Co, MD, FPPS, FPIDSP

Department of Pediatrics, National Children's Hospital

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ABSTRACT

Background/Objectives: Limited research has been conducted in the Philippines to look into cases of vaccine-preventable diseases (VPD) after the COVID-19 pandemic. This study aimed to assess the impact of the COVID-19 pandemic on pertussis, tetanus, diphtheria, measles, and *Haemophilus influenzae type b* (Hib) disease in children admitted at a tertiary government hospital in the Philippines.

Methods: This was an analytical cross-sectional study of admitted pediatric patients diagnosed with pertussis, tetanus, diphtheria, measles, and Hib disease from January 2018-December 2019 (pre-COVID-19 pandemic) and January 2022-December 2023 (post-COVID-19 pandemic). The study utilized a retrospective review of patient medical records.

Results: Ninety-five charts were reviewed (31 pre-pandemic and 64 post-pandemic). For both periods, the incidence of VPDs was highest among patients 0-12 months old (80.65% pre-pandemic and 73.44% post-pandemic). The majority did not receive the recommended age-appropriate vaccines (85.71% pre-pandemic, 61.22% post-pandemic). During both time periods, majority of cases had no co-morbidities. There was a significant drop in measles admissions (99.6%, p-value of <0.0001), and a significant increase in Hib admissions (0.30%, p-value of <0.0001) after the COVID-19 pandemic. The increase in the proportion of patients who had pertussis and diphtheria post-pandemic was not statistically significant. No case of tetanus was recorded during both periods. Majority of patients were discharged improved (87.10% pre-pandemic, 87.50% post-pandemic) however, there was a significantly higher mortality rate from VPDs post-pandemic (12.50%, p-value of 0.03).

Conclusion: For both pre- and post-pandemic periods, VPDs affected mostly infants with no known comorbidities, but with incomplete immunization status. There was an increase in the proportion of hospital admissions due to pertussis, diphtheria and Hib, while a notable decrease in measles admissions after the COVID-19 pandemic. There was a considerably higher mortality rate attributed to VPDs post-pandemic.

KEYWORDS: COVID-19 Pandemic, Vaccine-Preventable Diseases, Immunization, Vaccination, Philippines, Pediatric Infectious Diseases

INTRODUCTION

The development of vaccines and implementation of immunization programs have significantly prevented more than 20 life-threatening diseases worldwide.¹ Because of vaccination, morbidity has decreased by 90% to 100% compared to annual cases in the 20th century.² However, immunization campaigns were severely affected when the coronavirus disease 2019 (COVID-19) was declared a global pandemic in March 2020. Twenty-three (23) million children worldwide missed their recommended vaccines that year.³ The greatest decline was observed in April 2020, when 33% fewer DTP3 doses were administered globally.⁴ Measles and polio vaccination campaigns have also suffered severe setbacks due to the pandemic. Measles vaccination campaigns were stopped in 27 countries and polio vaccination campaigns were postponed in 38 countries.⁵ As a result, measles-containing vaccine (MCV1) coverage dropped to 84% in 2020, while the estimated

CORRESPONDENCE:Dr. Cressie Anne A. Allanigue
caallanigue@gmail.com

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DTP3 and polio global coverage dropped to 83%. This led to about 17.1 million zero-dose children recorded who did not receive the first dose of DTP, an increase of 3.5 million from 2019.⁶

In the Philippines, prior to the pandemic, the country's DPT3 vaccination coverage fell by 14 percentage points between 2010 and 2019. This resulted from vaccine stock-outs and vaccine hesitancy due to concerns about potential or real adverse effects of vaccination.⁷ The country's immunization program however was further challenged when routine childhood vaccination was temporarily suspended due to the COVID-19 pandemic restrictions. As a result of global disruptions in childhood immunization programs, approximately 80 million children under the age of 1 are estimated to be at risk of VPDs.⁵

In a local study done by Domai et al in 2022, pre-pandemic, the largest measles outbreak in the WHO Western Pacific Region occurred in the Philippines during 2018-2019, comprising roughly 7.7% of the 72,496 recorded measles cases between 2016-2019. This affected mostly unvaccinated children with a 3.2% case fatality rate. Fifty-nine percent (59%) of the 178 deaths occurred in children between the ages of 9 months and 5 years, and eighty-five percent (85%) did not receive any MCV. While measles vaccination coverage in the country was already declining prior to the COVID-19 outbreak, the additional reduction was attributed to the 'Dengvaxia' controversy during the latter part of 2017. Meanwhile, there was a reduction in reported measles cases in 2020 likely due to COVID-19 restrictions. At the same time, MCV1 coverage in the Philippines declined further to 72%, with more than 90 million children missing their measles vaccine doses by October 2020.⁸

According to Inayat (2020), the COVID-19 pandemic could have significant impact on immunization programs and initiatives. Negative effects include temporary discontinuation of routine immunization campaigns leading to millions of delayed and missed vaccination schedules which can cause outbreaks of VPDs. On the other hand, a positive effect on immunization programs was the increase in public awareness on the benefits of vaccination, which could greatly increase vaccine uptake.⁹ A modelling study by Robertson et al. in 2020 projected that a reduction in essential childhood healthcare in low- and middle-income countries (LMICs) would, at most, result in a 9.8% monthly increase in the mortality rate of children under the age of five. A large portion of this would be directly related to deaths from VPDs brought on by disruptions in immunization services.¹⁰

The COVID-19 pandemic may have prevented the spread of some infectious diseases through lockdowns and physical barriers, but the decline in vaccination rates and the subsequent lifting of COVID-19 restrictions raise the likelihood of VPD outbreaks among children. There is paucity of data on the effect of the COVID-19 pandemic on VPDs in the country and to our knowledge, limited researches have been conducted to look into this concern, hence this study looked into the impact of the COVID-19 pandemic on the incidence and outcome of some vaccine-preventable diseases namely pertussis, tetanus, diphtheria, measles, and *Haemophilus influenzae* type b (Hib) in children admitted at the National Children's Hospital in Quezon City, Philippines.

METHODS

Study Design

This was an analytical cross-sectional study of pediatric patients diagnosed with pertussis, tetanus, diphtheria, measles, and Hib disease and admitted at a tertiary pediatric government hospital in Quezon City from January 1, 2018 to December 31, 2019 (pre-COVID-19 pandemic) and January 1, 2022 to December 31, 2023 (post-COVID-19 pandemic). The study utilized a retrospective review of patient medical records.

The **pre-COVID-19 pandemic** refers to the two-year period from January 2018 to December 2019, before the COVID-19 pandemic was declared. The **post-COVID-19 pandemic** refers to the two-year period from January 2022 to December 2023, following the lifting of the lockdown and enhanced community quarantine in December 2021.

Population and Sample Size

A minimum sample size of 9 patients for the years 2018-2019 and another 9 patients for the years 2022-2023 was required. This was based on the mean difference in the proportion of patients with pertussis, tetanus, diphtheria, measles, and Hib disease relative to the total admissions during these time periods. The computations were done using a significance level of 5% and a power of 90%.

This study employed total enumeration of all patients aged 0 to 18 years old diagnosed with pertussis, tetanus, diphtheria, & Hib disease (both clinical and laboratory-confirmed) and admitted at National Children's Hospital (NCH) for the periods of January 2018 - December 2019 (pre-COVID-19 pandemic) and January 2022 - December 2023 (post-COVID-19 pandemic). A total of 261 patients were admitted for

measles pre-pandemic hence simple random sampling was done for the period of 2018-2019 using computer-generated random numbers wherein the calculated size was $n=9$. Total enumeration was done between 2022 and 2023 due to the limited number of cases.

Data Collection

The study was conducted at the National Children’s Hospital (NCH), a tertiary government pediatric referral center in Quezon City, Philippines. Data on VPDs was collected from the medical charts and reports from the hospital’s surveillance unit for the two time periods: January 2018-December 2019 (pre COVID-19 pandemic) and January 2022-December 2023 (post COVID-19 pandemic). The study commenced upon approval by the hospital’s Institutional Review Board (NCH-IRB). Consent for retrieval and review of surveillance reports, laboratory data and medical charts were likewise secured from the heads of the Hospital Epidemiology and Surveillance Unit (HESU), Department of Laboratory and Pathology Services, and Hospital Health Information Management Department (HHIMD). Charts of patients diagnosed with pertussis, tetanus, diphtheria, measles, and Hib for the periods of January 2018-December 2019 and January 2022-December 2023 were reviewed. A patient data form was used to capture information on age, sex, immunization status, co-morbidity, and outcomes of patients with VPDs during both periods. The total number of cases for each VPD for both periods was also recorded. The data gathered was encoded in Microsoft Excel for subsequent statistical analysis. Confidentiality of data was maintained by assigning a code for each patient record. The data was stored in a password-protected file, and access was granted only to the investigators. Data will be kept for up to five years from inception.

Statistical Analysis

Descriptive statistics was used to summarize the clinical characteristics and outcomes of patients. The total number of admissions for each time period was likewise determined. Cases involving pertussis, tetanus, diphtheria, measles and Hib were summarized using frequencies and proportions. Chi-square was used to compare the frequencies and proportions of cases pre and post-pandemic. Fisher's exact test was used when the assumptions of the Chi-square test were not met. A significance level of $p < 0.05$ was employed.

RESULTS

A total of 95 charts (31 pre-pandemic and 64 post-pandemic) were retrieved and reviewed however, based on census, 32 charts pre-pandemic should have been included. Table 1 shows the characteristics of children admitted for vaccine-preventable diseases. There was no significant difference in patient characteristics for both time periods.

The incidence of VPDs was highest among patients 0 to 12 months of age for both time periods (80.65% pre-pandemic and 73.44% post-pandemic) and notably higher in male patients (64.52% pre-pandemic and 62.50% post-pandemic). Majority of patients admitted for VPDs were incompletely immunized (85.71% pre-pandemic and 61.22% post-pandemic).

Majority of patients for both time periods had no co-morbidities. Among patients with co-morbidities who were seen post-pandemic, majority had an underlying pulmonary condition (see Table 2).

Table 1. Characteristics of children with VPDs pre- and post-COVID-19 pandemic

Baseline characteristics of patients	Pre COVID-19 pandemic (2018-2019) n=31 n (%)	Post COVID-19 pandemic (2022-2023) n=64 n (%)	p-value
Age			0.80*
0-12 months	25 (80.65%)	47 (73.44%)	
1-4 years old	6 (19.35%)	11 (17.19%)	
5-9 years old	0	2 (3.13%)	
10-14 years old	0	2 (3.13%)	
15-18 years old	0	2 (3.13%)	
Sex			0.85**
Male	20 (64.52%)	40 (62.50%)	
Female	11 (35.48%)	24 (37.50%)	
Immunization Status	n=28	n=49	0.06*
Complete for age	4 (14.29%)	15 (30.61%)	
Incomplete for age	24 (85.71%)	30 (61.22%)	
Without immunization	0	4 (8.16%)	
Unknown/No available record	3	15	
Comorbidities			0.10**
Without	28 (90.32%)	49 (76.56%)	
With	3 (9.68%)	15 (23.44%)	

*Fisher's exact test **Chi square test

Table 3 shows the characteristics of children with pertussis who were admitted during both study periods. A total of 18 cases (both clinically-diagnosed and laboratory-confirmed) were admitted pre-pandemic however, only 17 charts were retrieved and reviewed. For both periods, children who developed pertussis were between 0 to 12 months (100%), mostly male (52.94%) with no comorbidities. Majority had incomplete vaccination against pertussis.

Table 4 shows the characteristics of children with diphtheria who were admitted during both study periods. Pre-pandemic, there was only one case of diphtheria in a 4 year old child but post-pandemic there were 2 cases of clinically-diagnosed and 1 case of laboratory-confirmed diphtheria. The immunization status of all patients admitted for diphtheria for both

time periods were unknown as all records were not available for review.

Table 2. Comorbidities of patients with VPDs pre- and post-COVID-19 pandemic

Comorbidities according to organ system	Pre COVID-19 pandemic (2018-2019) n=31 n (%)	Post COVID-19 pandemic (2022-2023) n=64 n (%)
No comorbidity	28 (90.32%)	49 (76.56%)
Pulmonary	0	4 (6.25%)
Neurologic	1 (3.22%)	3 (4.68%)
Surgical	1 (3.22%)	3 (4.68%)
Cardiovascular	0	2 (3.12%)
Cardiovascular and Genetics	1 (3.22%)	1 (1.56%)
Neurologic and Pulmonary	0	1 (1.56%)
Neurologic, Endocrine and Genetics	0	1 (1.56%)
Rheumatologic	0	0
Endocrine	0	0
Psychiatric	0	0
Dermatologic	0	0
Renal	0	0
Hematologic	0	0
Oncologic	0	0
Gastrointestinal	0	0
Other Infectious	0	0

Table 3. Characteristics of children with pertussis pre- and post- COVID-19 pandemic (n=34)

Baseline characteristics of patients with pertussis	Pre COVID-19 pandemic (2018-2019) n=17 n (%)	Post COVID-19 pandemic (2022-2023) n=17 n (%)	p-value
Age			---
0-12 months	17 (100%)	17 (100%)	
1-4 years old	0	0	
5-9 years old	0	0	
10-14 years old	0	0	
15-18 years old	0	0	
Sex			>0.9999*
Male	9 (52.94%)	9 (52.94%)	
Female	8 (47.06%)	8 (47.06%)	
Immunization Status			0.48**
Complete for age	2 (12.50%)	3 (20.00%)	
Incomplete for age	14 (87.50%)	11 (73.33%)	
Without immunization	0	1 (6.67%)	
Unknown/No available record	1	2	
Co-morbidities			>0.9999**
Without	15 (88.24%)	16 (94.12%)	
With	2 (11.76%)	1 (5.88%)	

*Chi square test **Fisher's exact test

Table 4. Characteristics of children with diphtheria pre- and post- COVID-19 pandemic (n=4)

Baseline characteristics of patients with diphtheria	Pre COVID-19 pandemic (2018-2019) n=1 n (%)	Post COVID-19 pandemic (2022-2023) n=3 n (%)	p-value
Age			>0.9999*
0-12 months	0	0	
1-4 years old	1 (100%)	1 (33.33%)	
5-9 years old	0	1 (33.33%)	
10-14 years old	0	1 (33.33%)	
15-18 years old	0	0	
Sex			>0.9999*
Male	0	2 (66.67%)	
Female	1 (100%)	1 (33.33%)	
Immunization Status			---
Complete for age	0	0	
Incomplete for age	0	0	
Without immunization	0	0	
Unknown/No available record	1	3	
Co-morbidities			>0.9999*
Without	1 (100%)	2 (66.67%)	
With	0	1 (33.33%)	

*Fisher's exact test

Table 5 shows the characteristics of children who developed measles pre- and post-pandemic. A total of 261 patients were admitted pre-pandemic, but as per sample size calculation, only 9 subjects were included in the study. Majority (55.56%) belonged to the 1-4 years old age group. Post-pandemic, there was one patient who belonged to the 0-12 months age group. Patients who developed measles pre-pandemic were mostly males with incomplete vaccination (77.78%). The majority had no underlying comorbidities (88.89%).

Table 5. Characteristics of children with measles pre- and post- COVID-19 pandemic (n=10)

Baseline characteristics of patients with measles	Pre COVID-19 pandemic (2018-2019) n=9 n (%)	Post COVID-19 pandemic (2022-2023) n=1 n (%)	p-value
Age			>0.9999*
0-12 months	4 (44.44%)	1 (100%)	
1-4 years old	5 (55.56%)	0	
5-9 years old	0	0	
10-14 years old	0	0	
15-18 years old	0	0	
Sex			>0.9999*
Male	7 (77.78%)	1 (100%)	
Female	2 (22.22%)	0	
Immunization Status			>0.9999*
Complete for age	2 (22.22%)	0	
Incomplete for age	7 (77.78%)	1 (100%)	
Without immunization	0	0	
Unknown/No available record	0	0	
Co-morbidities			>0.9999*
Without	8 (88.89%)	1 (100%)	
With	1 (11.11%)	0	

*Fisher's exact test

Table 6 shows the characteristics of children with Hib disease pre- and post- pandemic. Hib was highest among children 0-12 months old for both time periods (100% pre-pandemic, 67.44% post-pandemic). Moreover, patients were mostly males, with no comorbidities and with incomplete vaccination status.

Table 7 summarizes the proportion of admitted cases of VPDs pre- and post-COVID-19 pandemic. There was a 99.6% reduction in hospital admissions due to measles cases (p-value of <0.0001) from 261 pre-pandemic to 1 in the two years post-pandemic. On the other hand, there was a 0.30% increase (*computed based on change in proportion of cases/total admissions per period*) in the proportion of Hib cases post-pandemic (p-value of <0.0001). The increase in the proportion of patients diagnosed with pertussis and diphtheria post-pandemic was not statistically significant. No case of tetanus was recorded during both time periods.

Table 8 shows the outcome of all admissions for both time periods. Majority of patients were discharged improved (87.10% pre-pandemic, 87.50% post-pandemic) however, there was a significantly higher mortality rate from VPDs post-pandemic (12.50%, p-value 0.03).

Table 6. Characteristics of children with Hib disease pre- and post- COVID-19 pandemic (n=47)

Baseline characteristics of patients with Hib infection	Pre COVID-19 pandemic (2018-2019) n=4 n (%)	Post COVID-19 pandemic (2022-2023) n=43 n (%)	p-value
Age			0.69*
0-12 months	4 (100%)	29 (67.44%)	
1-4 years old	0	10 (23.26%)	
5-9 years old	0	1 (2.33%)	
10-14 years old	0	1 (2.33%)	
15-18 years old	0	2 (4.65%)	
Sex			>0.9999*
Male	3 (75.00%)	29 (67.44%)	
Female	1 (25.00%)	14 (32.56%)	
Immunization Status			0.45*
Complete for age	0	12 (36.36%)	
Incomplete for age	3 (100%)	18 (54.55%)	
Without immunization	0	3 (9.09%)	
Unknown/No available record	1	10	
Co-morbidities			0.56*
Without	4 (100%)	30 (69.77%)	
With	0	13 (30.23%)	

*Fisher's exact test

Table 7. Number (%) of admitted cases in relation to total number of admissions of VPDs from January 2018-December 2019 (pre-COVID-19 pandemic) versus January 2022-December 2023 (post-COVID-19 pandemic)

Diseases	Pre COVID-19 pandemic (2018-2019) n (%)	Post COVID-19 pandemic (2022-2023) n (%)	Change in proportion	p-value
Pertussis	18 (0.09%)	17 (0.13%)	+0.04%	0.38*
Tetanus	0	0	0	---
Measles	261 (1.37%)	1 (0.01%)	-1.36%	<0.0001**
Diphtheria	1 (0.01%)	3 (0.02%)	+0.015%	0.31
Hib Infections	4 (0.02%)	43 (0.32%)	+0.30%	<0.0001*
Other diagnoses (non-VPDs)	18756 (98.51%)	13275 (99.52%)		
Total admissions (N)	19040	13339		

*Chi-square test **Fisher's exact test

Table 8. Outcome of children with VPDs pre- and post-COVID-19 pandemic

Outcome	Pre COVID-19 pandemic (2018-2019) n=31 n (%)	Post COVID-19 pandemic (2022-2023) n=64 n (%)	P value (Fisher's exact test)
Discharged	27 (87.10%)	56 (87.50%)	0.03
Improved			
Readmitted	1 (3.23%)	0	
Transferred to Other Institution	2 (6.45%)	0	
Mortality	1 (3.23%)	8 (12.50%)	

Table 9 shows patient outcomes for all VPD admissions pre- and post- pandemic.

Table 9. Outcome of children with VPDs pre- and post-COVID-19 pandemic

Outcome per disease	Pertussis		Diphtheria		Measles		Hib infections	
	Pre pandemic n=17 n (%)	Post pandemic n=17 n (%)	Pre pandemic n=1 n (%)	Post pandemic n=3 n (%)	Pre pandemic n=9 n (%)	Post pandemic n=1 n (%)	Pre pandemic n=4 n (%)	Post pandemic n=43 n (%)
Discharged	16 (94.12%)	17 (100%)	0	1 (33.33%)	7 (77.78%)	1 (100%)	4 (100%)	37 (86.05%)
Improved								
Readmitted	1 (5.88%)	0	0	0	0	0	0	0
Transferred to Other Institution	0	0	1 (100%)	0	1 (11.1%)	0	0	0
Mortality	0	0	0	2 (66.67%)	1 (11.1%)	0	0	6 (13.95%)
P value (Fisher's exact test)	>0.9999		0.50		>0.9999		>0.9999	

Table 10 shows the case fatalities pre- and post-pandemic. The highest was recorded for diphtheria post-pandemic (2 mortalities of 3 cases, 66.67%), followed by Hib (13.95%), with no recorded mortality for both diseases pre-pandemic. For measles, the recorded CFR was 6.13% pre-pandemic versus zero post-

pandemic. No mortalities were recorded for both pertussis and tetanus for both periods.

Table 10. Case fatalities from VPDs pre- and post- COVID-19 pandemic

Diseases	Pre COVID-19 pandemic 2018-2019		Post COVID-19 pandemic 2022-2023		Change in proportion	P value (Fisher's exact test)
	No of deaths/cases	*CFR (%)	No of deaths/cases	*CFR (%)		
Pertussis	0/17	0	0/17	0	0	---
Tetanus	0	0	0	0	0	---
Measles	16/261	6.13%	0/1	0	-6.13%	>0.9999
Diphtheria	0/1	0	2/3	66.67%	+66.67%	>0.9999
Hib Infections	0/4	0	6/43	13.95%	+13.95%	>0.9999

*Case fatality rate

DISCUSSION

Overall, children admitted for vaccine-preventable diseases before and after the COVID-19 pandemic had incomplete vaccination status and belonged to the less than 1-year-old age group, followed by children between 1-4 years of age. This suggests that the burden of VPDs remain to be highest in children <5. Pertussis and Hib cases clustered among infants, while measles cases were seen among children 1-4 years old. Many of these children did not receive the recommended age-appropriate vaccines, increasing their susceptibility to vaccine preventable diseases.

Diphtheria cases were seen in children between 1 to 14 years old. This reflects susceptibility even of older children and adolescents to the disease and highlights the need for diphtheria toxoid to be administered repeatedly to maintain immunity in these populations.

In this study, there was male predominance for all VPDs for both periods. A study by Green et al. (2022) which looked into gender differences in measles incidence rates, implied that sex difference favoring young males is more likely attributed to physiological and biological differences rather than behavioral factors.¹¹

The majority of patients in our study had no comorbidities. However, among those who developed VPDs post-pandemic, it was noted that most had underlying pulmonary comorbidity.

The COVID-19 pandemic disrupted routine health services, including vaccination. This resulted to a decline in immunization coverage and exposed children to vaccine-preventable infections. Our study proved this with the increased proportion of admissions for pertussis, diphtheria and Hib. While the lockdown caused an immediate decline in VPDs, surges in cases were expected once restrictions were lifted and person to person interactions resumed. This explains the significant rise (0.30%) in the proportion of admitted

Hib cases post-pandemic. Our findings reflect the projections of Kitano et al. in Japan in 2021. He demonstrated that even though COVID-19 mitigation measures may have reduced the rate of Hib transmission, the ongoing decrease in the Hib vaccination rate due to COVID-19 restrictions resulted in an additional burden of invasive Hib disease over the following ten years.¹² The same findings were seen in the Netherlands, that children under five years old had more Hib cases in 2022 than in pre-pandemic years.¹³ This is a reflection of the effect of millions of delayed and missed scheduled vaccinations due to discontinuation of routine immunization campaigns during the COVID-19 pandemic. This reiterates the importance of timely vaccination to maintain high population immunity against VPDs.

Our study showed an increase in admissions, albeit insignificant, for pertussis (0.04%) and diphtheria (0.015%) post-pandemic. Although a study by Tessier et al. in 2022 reported a substantial decline in pertussis cases from April 2020 onwards which was attributable to COVID-19 lockdown measures¹⁴, the concurrent documented drop in pertussis vaccination rates during the pandemic is believed to contribute to disease transmission as restrictions relaxed. This even resulted in outbreaks even after the study period, as a notable increase in pertussis cases from January 1 to March 30, 2024 with over 1,112 cases documented (34 times higher when compared to the same period in 2023). This prompted local government units (LGUs) to declare a pertussis outbreak^{15,16}. An increase in diphtheria cases post-pandemic was also seen in the studies of Rana et al.¹⁷ and Ogunniyi et al.¹⁸ in 2023. These were attributed to inadequate vaccination coverage during the lockdown. Cases of VPDs are still expected to increase in the years to come due to decline in population immunity for these highly transmissible diseases, hence, strengthening childhood immunization programs along with continued surveillance is suggested.

As for measles, our findings revealed a reduction in admissions (99.6% reduction) after the COVID-19 pandemic. The pre-pandemic period covered in this study (2018-2019) coincided with the largest measles outbreak ever documented in the Philippines.⁸ In response to this, a measles vaccination campaign was launched, though halted temporarily due to the pandemic. Despite this, supplemental immunization activities (SIA) resumed in phases from July 2020 to February 2021, targeting children from 6-59 months⁷. This campaign resulted in an almost 92% nationwide vaccination coverage for measles and rubella vaccines.⁷

The substantial drop in measles admissions during and after the pandemic was probably caused by these containment measures, the implementation of COVID-19 restrictions, and the stage of the measles epidemic cycle. With the decline in MCV1 coverage to 72% in 2020 along with repeated outbreaks of measles in the Philippines, actions such as strengthening routine immunization and catch-up campaigns, emphasizing the importance of prevention and control strategies, and addressing barriers to vaccination are warranted to prevent future outbreaks and reduce measles mortality.

There was no case of tetanus admitted during the two time periods despite interruptions in immunization services caused by the pandemic. This was mainly ascribed to continuing strategies to sustain maternal and neonatal tetanus elimination (MNTE) such as widescale TTCV (tetanus toxoid-containing vaccine) coverage among pregnant women along with the implementation of SIAs. While vaccination significantly contributes to the decline in tetanus, other contributing factors include improvement in obstetric practices such as performing deliveries in health facilities and increased training of birth attendants. We should however remain vigilant despite zero tetanus cases as the decline in DTP coverage is expected to cause a surge in these diseases.

While the majority (over 87%) of patients admitted for VPDs were discharged improved during both time periods, there was a general increase in the proportion of mortalities from VPDs post-pandemic. The higher percentage of children with pulmonary comorbidities who were admitted post-pandemic (15% versus 3% pre-pandemic), could have contributed to an increased risk for complications and mortality in our study population. The highest documented case fatality rate was for diphtheria (66.67%), and Hib (13.95%) post-pandemic, although this was not statistically significant when compared to pre-pandemic rates. Disease severity upon admission and presence of comorbidities could have contributed to poor outcomes.

This study was limited and only looked into 5 vaccine-preventable diseases (diphtheria, tetanus, pertussis, measles, and Hib). The study population may also not have been representative of VPD cases in the Philippines as only hospitalized children were included in only one government institution. Lastly, data on vaccination status may also be inaccurate and may have been affected by recall bias as the source of information (i.e. vaccination card or caregiver report) was not properly recorded in the medical charts. These limitations should be considered and addressed in

future studies to get a more accurate picture of the state of VPDs in the country.

CONCLUSION

For both pre- and post- pandemic periods, VPDs affected mostly infants with no known comorbidities, but with incomplete immunization status. Generally, there was an increase in the proportion of hospital admissions for pertussis, diphtheria and Hib infection after the COVID-19 pandemic but a notable decrease in the number of measles admissions post-COVID-19 pandemic with no case of tetanus for both periods. Majority of patients admitted for VPDs during the pre- and post- pandemic periods were discharged improved. There was a considerably higher mortality rate post-pandemic.

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Conflicts of Interest

None declared.

REFERENCES

1. World Health Organization. Immunization coverage [Internet]. [place unknown]: World Health Organization; 2023 [updated 2024 July 15; cited 2024 Jan 4]. Available from: <https://www.who.int/news-room/fact-sheets/detail/immunization-coverage>.
2. Orenstein WA, Ahmed R. Simply put: vaccination saves lives. *Proc Natl Acad Sci* [Internet]. 2017 [cited 2024 Jan 4];114(16):4031. Available from: <https://pubmed.ncbi.nlm.nih.gov/28396427/> DOI:10.1073/pnas.1704507114.
3. Watt, J. Global rise in vaccine-preventable diseases highlights urgent actions needed to save lives and alleviate future suffering [Internet]. [place unknown]: InterAction; 2022 May 13 [cited 2024 Jan 4]. Available from: <https://www.interaction.org/blog/global-rise-in-vaccine-preventable-diseases-highlights-urgent-actions-needed-to-save-lives-and-alleviate-future-suffering/>
4. Shet A, Carr L, Danovaro-Holliday MC, Sodha S, Prospero C, Wunderlich J, Wonodi C, Reynolds W, Mirza I, Gacic-Dobo M, O'Brien K, Lindstrand A. Impact of the SARS-CoV-2 pandemic on routine immunization services: evidence of disruption and recovery from 170 countries and territories. *Lancet Glob Health* [Internet]. 2021 Dec 21 [cited 2024 Jan 4]; 10(2):e186-e194. Available from: <https://www.sciencedirect.com/science/article/pii/S2214109X2100512X>
5. World Health Organization. At least 80 million children under one at risk of diseases such as diphtheria, measles and polio as COVID-19 disrupts routine vaccination efforts, warn Gavi, WHO and UNICEF [Internet]. [place unknown]: World Health Organization; 2020 May 22 [cited 2024 Jan 4]. Available from: <https://www.who.int/news/item/22-05-2020-at-least-80-million-children-under-one-at-risk-of-diseases-such-as-diphtheria-measles-and-polio-as-covid-19-disrupts-routine-vaccination-efforts-warn-gavi-who-and-unicef>
6. Muhoza P, Danovaro-Holliday MC, Diallo MS, Murphy P, Sodha SV, Requejo JH, Wallace AS. Routine Vaccination Coverage - Worldwide. *MMWR Morb Mortal Wkly Rep*. [Internet]. 2020 [cited 2024 Jan 4];70(43):1495–500. Available from: <https://doi.org/10.15585/mmwr.mm7043a1> (Erratum in: *MMWR Morb Mortal Wkly Rep*. 2021 Nov 19; 70(46):1620).
7. World Health Organization. WHO and Philippines: covering lost grounds to end polio and measles during the COVID-19 pandemic [Internet]. [place unknown]: World Health Organization; 2020 [cited 2024 Jan 4]. Available from: <https://www.who.int/about/accountability/results/who-results-report-2020-mtr/country-story/2020/who-and-philippines-covering-lost-grounds-to-end-polio-and-measles-during-the-covid-19-pandemic>
8. Domai F, Agrupis KA, Han SM, Sayo AR, Ramirez J, Nepomuceno R. Measles outbreak in the Philippines: epidemiological and clinical characteristics of hospitalized children, 2016-2019. *The Lancet Regional Health* [Internet]. 2022 Feb [cited 2024 Jan 4]; 19(100334). Available from: <https://www.thelancet.com/journals/lanwpc/article> DOI:<https://doi.org/10.1016/j.lanwpc.2021.100334>
9. Inayat Ali. Impact of COVID-19 on vaccination programs: adverse or positive? *Human Vaccines & Immunotherapeutics* [Internet]. 2020 Sep 22 [cited 2024 Jan 4]; 16:11, 2594-2600. Available from: <https://www.tandfonline.com/doi/full/10.1080/21645515.2020.1787065#abstract> DOI: 10.1080/21645515.2020.1787065
10. Robertson T, Carter ED, Chou VB, Stegmuller A, Jackson B, Tam Y. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *Lancet Glob Health* [Internet]. 2020 Jul [cited 2024 Jan 4]; 8(7): e901-e908. Available from: [https://pubmed.ncbi.nlm.nih.gov/32405459/doi/10.1016/S2214-109X\(20\)30229-1](https://pubmed.ncbi.nlm.nih.gov/32405459/doi/10.1016/S2214-109X(20)30229-1).
11. Green, M.S., Schwartz, N. & Peer, V. Gender differences in measles incidence rates in a multi-year, pooled analysis, based on national data from seven high income countries. *BMC Infect Dis* [Internet]. 2022 [cited 2024 Jan 4];22(358). Available from: <https://bmcinfectdis.biomedcentral.com/articles> DOI:10.1186/s12879-022-07340-3
12. Kitano, T., Aoki, H. A model for the incremental burden of invasive *Haemophilus influenzae* type b due to a decline of childhood vaccination during the COVID-19 outbreak:

- A dynamic transmission model in Japan. Vaccine [Internet]. 2021 Jan 8 [cited 2024 Jan 4]; 39(2):343-349. Available from: <https://doi.org/10.1016/j.vaccine.2020.11.053>
13. RIVM. National Immunisation Programme: slightly more cases in 2022, but fewer than before the COVID-19 pandemic [Internet]. Netherlands: RIVM; 2023 Nov 23 [cited 2024 Jan 4]. Available from: <https://www.rivm.nl/en/news/national-immunisation-programme-slightly-more-cases-in-2022-but-fewer-than-before-covid>
 14. Tessier E, Campbell H, Ribeiro S, Rai Y, Burton S, Roy P, Fry N, Litt D, Amirthalingam G. Impact of the COVID-19 pandemic on *Bordetella pertussis* infections in England. BMC Public Health [Internet]. 2022 [cited 2024 Jan 4]; 22(405). Available from: <https://doi.org/10.1186/s12889-022-12830-9>
 15. Valmonte, K. LIST: Cities, provinces that have declared a whooping cough outbreak [Internet]. Philippines: Rappler; 2024 Mar 26 [cited 2024 May]. Available from: <https://www.rappler.com/philippines/list-cities-provinces-that-declared-pertussis-whooping-cough-outbreak-2024/>
 16. Department of Health. Pertussis cases rising; Gov't replenishing vaccines, private stocks available [Internet]. Philippines: Department of Health; 2024 April 9 [cited 2024 May]. Available from: <https://doh.gov.ph/press-release/pertussis-cases-rising-govt-replenishing-vaccines-private-stocks-available/>
 17. Rana MS, Usman M, Alam MM, Tahir M, Ikram A, Zaidi SSZ, Kashif M, Massab U, Faryal R, Anas M, Ullah N, Salman M. Changes in the prevalence of infectious diseases before and after the COVID-19 pandemic in Pakistan. J Infect [Internet]. 2023 Apr [cited 2024 Jan 4]; 86(4):415-416. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9852260/> DOI: 10.1016/j.jinf.2023.01.020. Epub 2023 Jan 20. PMID: 36682628; PMCID: PMC9852260.
 18. Tolulope J. Ogunniyi, Mustapha Abdulrazaq, Fortune B. Effiong, Roseline D. Dine. The re-emergence of diphtheria in Nigeria: Descriptive assessment of the post-COVID-19 crisis management. Health Science Reports [Internet]. 2023 Nov [cited 2024 Jan 4]; 6(11). Available from: <https://doi.org/10.1002/hsr2.1680>