

Original Research Article

Vaccination coverage and factors associated with incomplete childhood vaccination among children aged 12-59 months in Miagao, Iloilo, Philippines

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ABSTRACT

Background: Complete Vaccination has made a significant contribution to the prevention of infectious diseases among children. However, not all children were completely vaccinated. This study aimed to determine the vaccination coverage, timeliness, and maternal-related factors associated with incomplete vaccination of children in Miagao, Iloilo, Philippines.

Methods: A cross-sectional study of children aged 12-59 months at the time the study was conducted between April 15 and 26, 2019 in Miagao, Iloilo. A total of 515 children were selected using a two-stage random sampling design. The data were collected from the Target Client Lists records, encoded, and analyzed using SPSS v21. Binary logistic regression was used to determine the factors associated with incomplete vaccination. Crude and adjusted odds ratio (AOR) with their confidence interval were reported.

Results: The complete vaccination coverage among children was low at 28.7%. Among those completely vaccinated, 2.7% to 88.5% had untimely Vaccination. Significant factors associated with incomplete Vaccination were children born at home (AOR=2.1; 95% CI: 1.32-3.36) and mothers who had two or less postnatal visits (AOR=3.4; 95% CI: 1.39-8.44). Age and number of antenatal visits of the mothers did not influence the outcome.

Conclusions: Maternal related factors significantly associated with incomplete vaccination were the place of child delivery and the number of postnatal visits of mothers. The study recommends educating mothers on the importance of postnatal visits and enhancing maternal health services, especially the promotion of facility-based delivery.

Keywords: Vaccination coverage, Vaccination timeliness, Incomplete vaccination, Factors associated with vaccination, Children vaccination

INTRODUCTION

The world health organization (WHO) estimates that 1.5 million children worldwide continue to die from vaccine-preventable diseases every year because of sub-optimal vaccination coverage. Vaccination had rendered protection to children and the rest of the unvaccinated population against vaccine-preventable diseases (VPDs)

through herd immunity.¹ The expanded program on immunization (EPI), which started in 1974, aims to promote children's universal immunization, especially in developing countries. The EPI targeted seven VPDs as part of routine essential vaccination: tuberculosis, poliomyelitis, diphtheria, whooping cough, tetanus, measles, and hepatitis B. Children are most vulnerable to pathogens due to weak immune system. Vaccination gave these children the protection they needed until the age

when their bodies could already develop the necessary defenses such as cellular and antibody production against various pathogens.^{2,3}

The WHO declared that global vaccination target coverage was 85% to produce herd immunity. For the past decades, substantial progress has been made in vaccination coverage throughout the world since the establishment of the EPI. For instance, in 2018, the coverage of DTP1 90%, DTP3 86%, and MCV 86% have surpassed the target coverage. However, pressing challenges to achieve high immunization coverage levels for all recommended vaccines remain.⁴

In the Philippines, the EPI is mandated by law through republic act no. 10152 of 2011 to provide free routine vaccination for 11 diseases through devolved health systems. Health services, including vaccination, are decentralized to the local government units (LGUs). The Department of Health (DOH) serves mainly as an advisory and regulatory body to LGUs providing technical support, capability building, and procurement of vaccines. The target vaccination coverage of 85% had never been achieved, despite the efforts of the government. The vaccination coverage of children aged 12-23 months dropped from 77% to 70% in 2017, which caused a rise in the number of cases of vaccine-preventable diseases (VPDs), especially measles.⁴

High vaccination coverage significantly reduced the incidence of infectious diseases, while low vaccination coverage had resulted in increased cases of infectious diseases among children.⁵ A high prevalence of incomplete vaccination status among children has contributed significantly to low vaccination coverage.⁶ The Philippines EPI has shown inconsistent results in terms of coverage and timeliness of vaccine administration in the past two decades. There has been a lack of local and regional studies on vaccination coverage and factors associated with incomplete vaccination. In 2014, the vaccination coverage dipped to 65%, and a large proportion of children ranged from 38% to 65%, although vaccinated had untimely administration. Only 10% had complete and timely basic vaccination.⁹ Thus, the researchers conducted this study to determine the vaccination coverage, the proportion of untimely or delayed vaccination among completely vaccinated children, and maternal factors associated with incomplete vaccination among children aged 12-59 months in Miagao, Iloilo, Philippines.

METHODS

Study design and population

The cross-sectional study design was conducted in the immunization clinic of the primary health care facility of Miagao, Iloilo, Philippines. The study population included children aged 12-59 months at data collection from April 15 to 26, 2019. The study population was

children born from May 11, 2014, to April 11, 2018, who attended the immunization clinic and whose mothers were residents of Miagao, Iloilo.

Sampling design

The study population was selected using the two-stage random sampling design. The primary sampling unit was the barangay health station (BHS) catchment block. There were 18 BHS catchment blocks in Miagao, Iloilo. Each BHS catchment block has four to eight villages as determined by the municipal health office.

Seven BHS catchment blocks were selected using simple random sampling. The complete list of households in each catchment block became the basis for second-stage sampling. Included in the list were households with children born from May 11, 2014, to April 11, 2018, with immunization records in the health center. The study utilized data from the target client list (TCL) for prenatal care immunization to determine the immunization status of children aged 12-59 months. The list served as the sampling frame for the selection of the sampling unit.

Seventy-five households were randomly selected from the sampling frame using simple random sampling. Only one child per household was selected. In cases when the household had two or more qualified children, a lottery technique was used to select one child. A total of 525 children aged 12-59 months old were randomly selected as a sampling unit. Only 515 were analyzed since the ten children had incomplete information, and they can no longer be traced. All the relevant exposure information of the subjects was gathered using the target client list records.

Data collection procedure

The researchers collected data from the target client list (TCL) reports for nutrition and the expanded program for immunization. The exposure and the outcome variables such as seven EPI vaccinations, age of children, dates of vaccinations, distance of residence from the health center, antenatal and postnatal visits, and place of child delivery were taken from the TCL records. The distance of the residence was considered near if the house was located at the town proper. The house located outside the town proper was considered far. The health personnel, parents, or guardians of children were interviewed for any missing and incomplete information.

The outcome variable was the vaccination status of a child, categorized as complete and incomplete. A child who received all the basic EPI vaccines was labelled completely vaccinated. The basic EPI vaccines in this study include BCG (one dose), hepatitis B (one dose), pentavalent (three doses), oral polio (three doses), pneumococcal conjugate (three doses), inactivated polio (one dose), and MMR (two doses). Incomplete

vaccination refers to a child who missed at least one vaccination schedule.

In the expanded program of immunization (EPI), each vaccine is given to the child at the recommended age in months. In this study, the timeliness of vaccination refers to the age (in months) when children received the vaccines - either timely (not delayed) or untimely (delayed). Children who received the vaccines within the recommended age in months were considered timely. Vaccination given outside the recommended age in the month was considered untimely.

Inclusion criteria

Inclusion criteria were children aged 12 to 59 months or children born from May 11, 2014, to April 11, 2018, have attended the Miagao immunization clinic, with complete records in the target client list (TCL) for the expanded program for immunization, and mother's prenatal and postpartum care.

Exclusion criteria

Exclusion criteria were children in the TCL whose age was younger than 12 months and older than 59 months at the time of data collection, children with incomplete or missing immunization records, and those not recorded in the TCL of Miagao immunization clinic.

Data analysis

Data collection forms and records were checked for completeness and consistency. The raw data were encoded and cleaned using microsoft excel version 2010. The frequencies and percentages were computed for descriptive analysis. Multivariate analysis using binary logistic regression was used to determine the factors associated with incomplete vaccination at p value ≤ 0.05 . Both the crude and adjusted odds ratio (AOR) with their confidence interval were computed using SPSS v21.

Ethical approval

The study was carried out after getting approval from the ethical clearance of the Division of Biological Sciences, College of Arts and Sciences, University of the Philippines Visayas. Then the data were collected after getting written consent from the municipal health office.

RESULTS

Characteristics of mothers of children in the study

Table 1 summarizes the characteristics of mothers of children in the study population. A total of 515 children aged 12-59 months old were included in the analysis. The majority of the mothers were young aged 24 years old and below 37.9%. Who lived far from the health centers 71.5%. Ninety-two 92% percent of the mothers had 4-7

antenatal visits, while only 5.6% had three or less postnatal visits. Although the Philippines' health care law prohibits birthing at non-medical facilities, many mothers still give birth at home or in none accredited birthing facilities 8.9%.

Table 1: Characteristics of mothers of children aged 12-59 months enrolled in immunization clinic, Miagao health center, Iloilo (n=515).

Factor	Category	N	%
Age of the mother (yrs)	24 and below	195	37.9
	25-30	165	32.0
	31 and above	155	30.1
The distance of residence from the health center	Near	147	28.5
	Far	368	71.5
No. of antenatal visit	3 and below	29	5.6
	4-7	474	92.0
	8 and above	12	2.3
No. of postnatal visit	2 and below	355	68.9
	3 and above	160	31.1
Place of child delivery	Home	46	8.9
	Health facility	469	91.1

Vaccination coverage among children

Overall, the proportion of children who were completely and incompletely vaccinated was 28.7% (148) and 71.3% (367), respectively. Complete vaccination refers to children who received the 14 doses of routine EPI vaccines from 0 to 12 months of age, regardless of whether these vaccines were given on schedule or not. Children who missed or failed to receive at least one of the doses of EPI vaccine from 0 to 12 months of age were recorded as incompletely vaccinated.

Table 2 shows the vaccination coverage rates of each routine EPI vaccines for children. The lowest vaccination coverage was IPV (58.1%), and the highest was the first dose of the pentavalent vaccine (97.3%). Vaccination coverage below 90% includes IPV (58.1%), PCV 1 (65%), PCV 2 (63.9%), PCV 3 (61.9%), hepatitis B (73%), and MMR 2 (77.5%). All vaccines with two or more doses had decreasing coverage trends. The MMR vaccination had a 15.6% decreased in coverage rate. The MMR vaccination rate started at a high coverage rate, MMR1 (91.8%), while the second dose (MMR2) decreased significantly 77.5%.

Vaccination timeliness among completely vaccinated children

Mothers of each child from day 0 were given an immunization schedule card. The card contains a list of routine EPI vaccines and the dates when the child should supposed to receive the vaccines. In this study, the vaccination age range was set to seven days before and after the actual date of vaccination written in the

immunization schedule card. Timeliness is the proportion of immunized children who received their vaccine on time or within the recommended age range. Any vaccination within the set range was recorded as “not delayed”; whereas, immunization outside the set age range was considered ‘delayed’. Table 3 shows the vaccination timeliness for each of the routine EPI vaccines among the 148 completely vaccinated children. The prevalence of delayed vaccination ranged from 2.7% (MMR2) to 88.5% (PCV3). An increasing prevalence

trend of delayed vaccination was seen among vaccines with two or more doses such as PCV and pentavalent vaccines. The BCG, a vaccine that should be administered within 24 hours after birth, had one of the highest vaccination coverage 91.7% and delayed vaccination time 57.4%. The IPV and PCV vaccines had the highest prevalence of vaccination delayed at 87.8% and 88.5%, respectively. The MMR 1 and MMR 2 had the lowest vaccination delayed at 29.7% and 2.7%, respectively.

Table 2: Vaccination coverage of each EPI vaccines among children aged 12-59 months in immunization clinic, Miagao, Iloilo (n=515).

Types of vaccine	Doses	Children who received the vaccine		Children who did not receive the vaccine	
		N	%	N	%
BCG	1	472	91.7	43	8.3
Hepatitis B	1	376	73.0	139	27.0
Pentavalent	1	501	97.3	14	2.7
	2	494	95.9	21	4.1
	3	486	94.4	29	5.6
Oral polio vaccine (OPV)	1	500	97.1	15	2.9
	2	494	95.9	21	4.1
	3	485	94.2	30	5.8
Pneumococcal conjugate vaccine (PCV)	1	335	65.0	180	35.0
	2	329	63.9	186	36.1
	3	319	61.9	196	38.1
Inactivated polio vaccine (IPV)	1	299	58.1	216	41.9
Measles mumps rubella (MMR)	1	473	91.8	42	8.2
	2	399	77.5	116	22.5

Table 3: Vaccination timeliness of each core EPI vaccines among children with complete vaccination, immunization clinic, Miagao, Iloilo (n=148).

Type of vaccine	No. of dose	Recommended age of administration	Timeliness			
			Not delayed		Delayed	
			N	%	N	%
BCG	1	At birth	63	42.6	85	57.4
Hepatitis B	1	At birth	136	91.9	12	8.1
Pentavalent	1	1½ month	41	27.7	107	72.3
	2	2½ months	28	18.9	120	81.1
	3	3½ months	26	17.6	122	82.4
Oral polio vaccine (OPV)	1	1½ month	38	25.7	110	74.3
	2	2½ months	22	14.9	126	85.1
	3	3½ months	39	26.4	109	73.6
Pneumococcal conjugate vaccine (PCV)	1	1½ month	49	33.1	99	66.9
	2	2½ months	44	29.7	104	70.3
	3	3½ months	17	11.5	131	88.5
Inactivated polio vaccine (IPV)	1	3½ months	18	12.2	130	87.8
Measles mumps rubella (MMR)	1	9 months	104	70.3	44	29.7
	2	12 months	144	97.3	4	2.7

Table 4: Univariate and multivariate analysis of maternal-factors associated with incomplete vaccination among children aged 12-59 months old, immunization clinic, Miagao, Iloilo (n=515).

Variables	Category	Univariate analysis		Multivariate analysis	
		Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Mother's age	24 and below	1.187 (0.753-1.872)	0.229		
	25-30	1.532 (0.940-2.499)			
	31 and above	1			
Distance from health center	Near	0.566 (0.376-0.851)	0.006*	0.799 (0.495-1.290)	0.358
	Far	1		1	
Antenatal visits	3 and below	1.875 (0.459-7.658)	0.610		
	4-7	1.794 (0.560-5.749)			
	8 and above	1			
Postnatal visits	2 and below	2.151 (1.442-3.208)	0.000*	3.431 (1.396-8.435)	0.007*
	3 and above	1		1	
Place of delivery	Home	2.814 (1.165-6.796)	0.021*	2.104 (1.316-3.363)	0.002*
	Health facility	1		1	

P value ≤ 0.05 .**Factors associated with incomplete childhood vaccination**

Maternal factors associated with vaccination coverage were determined using binary logistic regression (Table 4). The results of the univariate analysis showed that the distance of mothers' households to the Immunization Clinic, the number of postnatal visits, and place of delivery were significantly associated with incomplete childhood vaccination. Multivariate analysis of significant factors showed that the number of postnatal visits and place of delivery remained to be significant. The distance of the mother's house to the immunization clinic was no longer independently associated with incomplete vaccination after controlling for the effects of other variables. The age of the mother was not significantly associated with incomplete vaccination.

Children born from mothers who had two or less postnatal visits were 3.43 times more likely to have an incomplete vaccination than those children born from mothers with three or more postnatal visits (AOR=3.431; 95% CI=1.396-8.435). The child's place of delivery was a significant variable for vaccination status. In this study, children born at home were 2.1 times more likely to have an incomplete vaccination than those children born at health facilities, holding the effects of other variables AOR=2.104; 95% CI=1.316-3.363.

DISCUSSION

The goal of the expanded program of immunization (EPI) is to maintain basic vaccine coverage of at least 85% to protect the population, especially children, from serious vaccine-preventable diseases through herd immunity.⁷

Complete vaccination was the proportion of children who received all the 14 doses of routine basic vaccines from 0 to 12 months of age. In this study, the municipality of

Miagao had low complete vaccination coverage 28.7%. Although the BCG, pentavalent, OPV, and MMR1 were administered to more than 90% of the target population, most of the EPI vaccines were below the target coverage. Complete vaccination provides full immunity to infants and children and indirectly affects the unvaccinated community through herd protection. However, this broader effect of vaccination is dependent on the level of coverage sufficient to interrupt the transmission of infectious agents. Previous studies have shown that low vaccination coverage is associated with re-emergence of various infectious diseases that have already been eradicated, such as polio and measles, and lead to significant morbidity and death.⁸ The Philippines' national immunization program did not reach the 85% target coverage for the past 25 years. The coverage dipped to 65% in 2014, and the highest coverage achieved was in 2016 at 80%. Consequently, the incidence of vaccine-preventable diseases such as measles, pertussis, and diphtheria has dramatically increased.⁹

All vaccines with multiple doses had a decreasing trend in coverage. The most significant was a 15.6% decreased in coverage between MMR1 (91.8%) and MMR 2 (77.5%). The low vaccination coverage could have contributed to the measles outbreak in the Philippines that started in late 2017 until mid-2019.⁹ The time gap between pentavalent, oral polio, and pneumococcal conjugate vaccines within doses is at least four weeks, while between MMR vaccine doses is at least three months. Mothers/guardians of children tend to forget to bring their children to the immunization center for the succeeding vaccine doses due to long-time gaps and the absence of a monitoring system.¹⁰ The inactivated polio vaccine (IPV) had the lowest coverage in Miagao at 58.1%. One possible explanation could be the unavailability of enough vaccines. The price of IPV remained excessively high and unaffordable since its introduction in 2014. The problem

of availability and affordability of the vaccine had contributed to the low coverage.¹¹

Timeliness is the proportion of immunized children who received their vaccine on time or within the recommended age range. For the past decades, timeliness had been an emerging issue in the expanded program of immunizations. However, the health department had only included vaccination coverage as an indicator of EPI's success, but not the timeliness of vaccination. High vaccination coverage does not necessarily mean timely vaccination, and high coverage may have a low level of timeliness.¹² In this study, the untimely (delayed) vaccination coverage ranged from 2.7% (MMR1) to 88.5% (PCV3). More than half (57.4%) of the BCG vaccination was delayed or untimely. IPV (87.8%) and PCV (88.5%) vaccine have the highest proportion of delayed Vaccination. Delayed administration of vaccines increases the child's risk for VPDs.¹³ At the same time, vaccines administered too early to result in a weak or sub-optimal immune response that decreases the ability of the vaccines to prevent diseases.¹⁴ The optimal efficacy of the EPI vaccines happened if administered at the age-appropriate time, and delayed vaccination renders a child unprotected against infections for an extended period.^{15,16} Despite high immunization coverage, countries like China, Israel, and Russia have had measles outbreaks and BCG outbreaks in rural areas of Bangladesh, all attributed to untimely or delayed vaccinations.^{17,18} Untimely vaccination could have contributed to the VPDs outbreaks in the Philippines in the past, however, there has been no formal studies conducted on the impact or contribution of untimely vaccination on resurgence of VPDs among children.

The multivariate analysis showed two maternal factors, postnatal visit ($p=0.007$) and place of child delivery ($p=0.002$) significantly associated with incomplete childhood vaccination. Children born from mothers having two or less postnatal visits were 3.4 times more likely to have an incomplete childhood vaccination than those born from mothers with three or more postnatal visits ($\text{AOR}=3.431$, $p=0.007$) holding the effects of other variables. Postnatal visits are essential to both mother and child. During postnatal visits, mothers are clinically examined and counselled, while infants are assessed for vital clinical signs of severe illness and referred to as needed. Furthermore, mothers have a chance to be educated about child health care, most importantly, about childhood vaccination and the importance of having a complete childhood vaccination. The WHO recommended that all mothers and babies need at least four postnatal check-ups in the first six weeks.¹⁹

The 'no home birthing policy' was enacted by the Philippine government in the year 2011 to promote facility-based deliveries, minimize maternal and infant mortality. Despite the government's efforts, this study shows that 8.9% of the mothers had home-based deliveries (Table 1). The data also showed that children

born at home were 2.1 times more likely to have an incomplete childhood vaccination than those born at health facilities ($\text{AOR}=2.104$, $p=0.002$), the finding agrees with that of other studies.²⁰ Children born at health facilities have immediate access to vaccines, particularly those that should be administered within 24 hours after birth, such as BCG and hepatitis B.

The study had several limitations despite obtaining significant evidence. The effects of other factors that might have influenced the outcome were not assessed. The other factors include vaccine availability, the number of health care personnel, and logistical support. The study did not address mothers' level of education, knowledge, attitude, and perceptions towards children's immunization, which other studies have found to be significantly associated with the outcome of interest.²⁰ However, despite these limitations, the findings would still be valuable in contributing information on childhood immunization barriers in rural areas. The study concluded that the proportion of completely vaccinated children in rural area of Miagao was far below the national target coverage. Among the fully vaccinated children, a significant number have untimely vaccination. Mothers with post-natal visits of two or less, and who gave birth at home were factors significantly associated with incomplete vaccination of children.

CONCLUSION

Therefore, the study recommends regular information and communication campaigns to educate mothers about the importance of postnatal visits. Postnatal counselling concerns both the health of the mother and child. Further study should be conducted to determine why some mothers gave birth at home instead of accredited birthing facilities. More studies on the effects of availability, affordability and accessibility of accredited birthing facilities and incomplete vaccination should be explored.

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