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Research Article

Timeliness of primary childhood vaccination in a rural area of Puducherry, South India: evidence from routine management information system

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ABSTRACT

Background: Immunization plays an important role in reducing mortality due to vaccine preventable diseases in children. In areas with high vaccine coverage, age-appropriate vaccination or timeliness of vaccination will be helpful in assessing quality of vaccination program. The objective was to assess the delay in primary childhood vaccination in a primary health center (PHC) of rural Puducherry.
Methods: A record based study was conducted in a primary health center situated in rural Puducherry using data from immunization and antenatal records. Children born between 1st January 2009 and 30th November 2013 were included in the study. Delay in vaccination of diphtheria-tetanus-pertussis 1 (DPT1), DPT2, DPT3 and measles were studied.
Results: A total of 457 children were included, 52.5% were males, and 47.5% were females. Immunization coverage was 100% for all vaccines. Delay in vaccination more than 2 weeks from the due date of vaccination for DPT1, DPT2, DPT3 and measles were 7.4%, 41.9%, 64.4% and 38.8% respectively. Median (interquartile range) days of delay for DPT1, DPT2, DPT3 and measles was found to be 6 (4-8), 13 (7-20), 19 (12-30) and 11 (4-24) respectively. Children with higher birth order were vaccinated with significant delay for DPT3 ($p = 0.008$). Delay in vaccination was less in children from the village where PHC is located ($p < 0.001$).
Conclusion: Vaccination coverage for DPT and measles is high. There are delays in vaccination for DPT and measles, though not so high, there is scope for improving timeliness of vaccination in this rural area.

Keywords: Age-appropriate vaccination, Immunization coverage, Primary immunization, Vaccination delay

INTRODUCTION

Immunization is one of the cost-effective ways of preventing childhood morbidity and mortality. Every year immunization averts 2-3 million under-five deaths worldwide from diphtheria, pertussis, tetanus, polio, and measles.[1] Global vaccine plan aims at providing immunization for ≥90% children nationally and ≥80% children in districts.[2] Globally, 80% of eligible children were vaccinated against diphtheria-tetanus-pertussis 3 (DPT3) in 2012.[3] Though the coverage shows satisfactory improvement, the children who are vaccinated late may have same risk of acquiring disease like the non-vaccinated children during the days of delay. Few studies have demonstrated the effect of delayed vaccination (DPT) on child survival.[4] The timeliness of vaccination is important to produce appropriate levels of antibody at right

time to prevent vaccine preventable diseases. The children in developing countries especially in rural areas are more vulnerable due to the existence of several predisposing factors like malnutrition, over-crowding, low socio-economic status, poor access to health care system and poor awareness among mothers regarding child care.

National Immunization Schedule (NIS) in India recommends Bacille Calmette–Guérin (BCG), DPT, oral polio vaccine (OPV) and measles in children <1 year of age.[5] These vaccines are provided in all health care centers throughout India at free of cost and the coverage rate varies from place to place. District Level Household Surveys (2007-2008) shows vaccine coverage for most districts in southern states like Tamil Nadu and Kerala was more than 90%.[6] Various strategies like outreach immunization session, Mother and Child Tracking System, involvement of ASHA, Anganwadi workers and village volunteers, were adopted by Government of India to improve coverage of immunization service throughout India and it has yielded success.[7,8] In places with high vaccination coverage timeliness of vaccination can be used as an additive indicator in monitoring of immunization program. Though there are a number of studies on immunization coverage, data on timeliness of vaccine administration is scarce. With this background, this study aimed at identifying the delay in primary childhood vaccination provided under NIS and associated factors for delay in a rural primary care setting of Puducherry.

METHODS

Study setting and study population

A record based study was undertaken in a rural primary health centre (PHC) of Puducherry, a Union territory in the southern part of India. The PHC is located in Ramanathapuram, 15 km from the main town, Puducherry. This centre caters for 9854 people spread over four villages namely - Ramanathapuram, Pillayarkuppam, Thondamanatham and Thuthipet. PHC is located in Ramanathapuram. Pillayarkuppam and Thuthipet are around 3 km and Thondamanatham is 1.5-2 km from the Centre. Birth rate in PHC area is around 12.5 per 1000 population. In PHC apart from daily outpatient services, special clinic for under-five children is held once in a week on Fridays. Immunization for children will be carried out once in a week during under-five clinic. On an average 25 children attend under-five clinic every week. Details regarding name of the child, date of birth, name of the vaccine received were entered in immunization register as well as in under-five "road to health" card. Entries in these registers were maintained by Public Health Nurse, in-charge of each area. These entries were checked and monitored by a medical officer in charge once in a month. At the end of every month, number of eligible children to receive vaccines for the next month and number of children not received due vaccines in the past month were updated and children are tracked by making house visits.

In this study, all children who completed 1 year of age and born between 1st January 2009 and 30th November 2012 were included. The immunization coverage for primary vaccines is more than 95% in this PHC service area in all these 3 years. Children shifted to other areas within 1 year after birth, children those who are vaccinated in other health facilities and children with incomplete immunization date entries were not included. Out of the total 256 sessions planned during the reference period, 242 were held, and 14 were canceled due to public holidays or local festivals.

Study variable and sources of data

Primary vaccines are vaccines that are given within 1st year of birth, *viz.* BCG, OPV, DPT and Measles. As per NIS, BCG and zero dose OPV is given at birth. DPT1, DPT2, DPT3 and measles are given at 6, 10, 14 weeks and 9 months respectively.

"Delay in immunization" is operationally defined as when child has received vaccine - DPT1, DPT2, DPT3 and measles after 8th week, 12th week, 16th week and 9 months plus 2 weeks respectively (after 2 weeks of due date). The same definition was used in other studies also.[9-11] Information on gender of the child, proximity to health center and birth order were also extracted from records.

Data retrieval was done during November 2013. Data on date of birth, gender, area of the residence and date of immunization for measles and DPT were extracted from immunization register. Antenatal register was referred for birth order of each child. The date of BCG vaccination and zero dose OPV was not available in the immunization register as most of the children received these vaccines in higher centers where delivery had occurred. DPT and OPV are given at the same day for all children and hence DPT and measles were the vaccines considered for the study.

Data entry and statistics

Data were entered in EpiData 3.1. Statistical analyses were done using IBM developed SPSS version 20. Proportions were used to describe the characteristics of the study population and the delay in immunization for DPT1, DPT2, DPT3 and measles. The median days of delay from the due date was calculated for each vaccine under study. Nonparametric test was used to compare the median days of delay for vaccine DPT3 and measles across the groups of gender, birth order and presence of PHC in the village.

RESULTS

During the reference period, a total of 457 children were vaccinated in health center. Of 457 children, 240 (52.5%) were males and 217 (47.5%) were females. Most of the study children were either first or second order of birth. 219 (47.9%), 220 (48.1%) and 18 (3.9%) were of birth order one, two and three respectively. The village Ramanathapuram had 101 (22.1%) of the total study population and 356 (87.9%) were from surrounding villages.

During the study period around 28 children (5.6%) out of 502 children born during the reference period in the service area were vaccinated in health facilities other than PHC and 17 children (3.4%) shifted to other area before completion of vaccination.

The proportion of children vaccinated 2 weeks later from the due date for DPT1, DPT2, DPT3 and measles was 7.4%, 41.1%, 64.6% and 38.8%, respectively. The proportion of children with delayed immunization and the number of days of delay increased as the schedule of vaccine increases from the date of birth ($p < 0.001$) (Table 1).

There was no statistically significant difference in median days of delay in DPT3 ($p = 0.14$) and Measles ($p = 0.74$) vaccination across gender. There was statistically significant difference in median days of delay across birth order for DPT3 ($p = 0.008$). The village where health center is located has less days of delay compared with other village of service area, which is statistically significant for DPT3 ($p = 0.001$) and measles ($p < 0.01$) (Table 2).

DISCUSSION

This study conducted in a primary care setting of South India provides information on timeliness of primary vaccines in children <1 year of age. Though immunization coverage in the study setting is more than 95%, there is a delay in vaccination for all vaccines included in the study. This shows that high immunization coverage does not ensure good quality of immunization, i.e., age-appropriate vaccination.

Table 1: Distribution of vaccine delay and duration of delay for primary vaccinations (*n*=457).

Name of vaccine	Vaccinated within 2 weeks from due date *n* (%)	Vaccinated with more than 2 weeks of delay from due date *n* (%)*	Median days of delay in vaccination (IQR)**
DPT1	423 (92.6)	34 (7.4)	6 (4-8)
DPT2	266 (58.1)	191 (41.9)	13 (7-20)
DPT3	162 (35.5)	295 (64.5)	19 (12-30)
Measles	280 (61.2)	177 (38.8)	11 (4-24)

*Cochrane Q-test ($p<0.001$), **Friedman's test ($p<0.001$), DPT: Diphtheria-tetanus-pertussis

The median days of delay in vaccination for DTP1 was 6 days (interquartile range [IQR] 4-8), and it increased for the subsequent doses. For DPT3 it is 19 median days of delay (IQR 4-2). A study conducted in Ballabgarh, North India showed delay for DPT1, DPT2, DPT3 and measles were 3.4, 6, 6.9 and 6.4 weeks, respectively. The same study also reported delay to decrease over years from 1990 to 2004. Our study included children born between 2009 and 2012, this one decadal difference and improvement in health services may be one of the reasons for lesser days of delay in our study. Both studies show that the delay increases with subsequent doses of vaccine.[9]

The study shows 7.4, 41.9 and 64.5% of children vaccinated with more than 2 weeks of delay for DPT1, DPT2 and DPT3 vaccines, respectively. A study conducted in a tertiary care center in Ghana using same operational definition for delay showed 11%, and 15% children were vaccinated with delay for DPT2 and DPT3, respectively.[10] The health status of the children seeking service in tertiary care, the literacy level of parents', access to health care center may be different while compared to the present study setting. However, a study conducted in Kenya among 12-23 month's children showed only 2.2% of children received vaccine in the target month, and the coverage for all vaccine was only 31.1%.[12]

There is no significant difference in delay of immunization based on gender. Studies conducted from India had shown gender disparities in coverage (lesser vaccine coverage among girls), but not in timeliness of vaccine.[11] A study conducted in urban and rural areas of Iran among 28, 139 children of 12-23 months of age also found no correlation between gender and delay in vaccination.[13] Children from the village where PHC located had better timeliness of vaccination for both DPT3 and measles, while compared to

Table 2: Distribution of factors associated with delay in DPT3 and measles.

Character	Median delay for DPT3 (IQR)	*p* value	Median delay for measles (IQR)	*p* value
Gender				
Male	17 (12-28)	0.14*	10 (4-24)	0.74
Female	20 (12-34)		11 (4-24)	
Village with PHC				
With PH	15 (8-25)	0.001*	6 (2-12)	<0.001
Other villages	20 (13-32)		13 (5-25)	
Birth order				
1	17 (11-26)	0.008**	18.5 (4-22)	0.18
2	20 (13-36)		12 (5-26)	
≥3	25 (14-35)		13 (7-19)	

*Mann-Whitney *U*-test, **Kruskal-Wallis hypothesis test, PHC: Primary health center, IQR: Interquartile range, DPT: Diphtheria-tetanus-pertussis

children from other villages of service area. The study shows a significant difference in delay in vaccination for children with higher birth order. This may be related to the behavior of the mothers on child care.[11,14] In the study, children of first birth order received vaccine within 17 median days. The third or more birth order children received vaccine with 25 median delayed days. Similar results were found in secondary analysis of NFHS one results. The children of four or more birth order have 1.52 times increased risk of delayed vaccination.[15]

Children who were vaccinated in facilities other than PHC and children who were shifted to other areas were not included in the study as vaccination dates were not available. As it was a record based study we couldn't capture factors like education, occupation and economic status of the mother that may affect the timeliness of vaccination.

In our study, coverage was >95% for DPT3 but 64.5% of children received it after 2 weeks of the due date. As timeliness of vaccination reflects on the quality, it can be used as a monitoring indicator in settings where coverage is high. Innovative strategies to decrease the delay in vaccination can be tried. Conducting outreach immunization, better involvement of village volunteers or ASHA, mHealth initiatives may be useful in reducing the delays.

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