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Original Article

Maternal determinants of immunization status of children aged 12–23 months in urban slums of Varanasi, India

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ABSTRACT

Problem considered: The risk of health problems from vaccine-preventable diseases is highest in those who experience barriers in accessing immunization services. These barriers could be cost, location, lack of awareness of immunization services and their health benefits or other limiting factors.

Material & methods: The present study was conducted to identify the determinants of complete immunization status among children aged 12–23 months in urban slums of Varanasi in India. A modified WHO EPI cluster sampling method has been used for sample selection. Data on 384 children were collected using pretested questionnaire through house to house visit. Chi-square test, bivariate and multivariate logistic regression were used to assess the factors associated with complete immunization status in the urban slums of Varanasi.

Results: Only 57.03% children have received the complete recommended immunization schedule under universal immunization program. Significant determinants of the complete immunization were maternal age (OR = 1.86, 95% CI 1.54–3.23), parity less than three (OR = 2.84, 95% CI 1.98–3.73), employment status of mother (OR = 1.39, 95% CI 1.21–2.63) and mother's education higher than secondary level (OR = 1.59, 95% CI 1.30–2.88).

Conclusion: More than half the way is complete to achieve the target of universal immunization against vaccine preventable diseases among children, but there is need to address the issue of dropout. Mother's education, low parity, maternal age and employment status

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of mothers are main factors associated with adherence of immunization schedule. It is necessary that interventions should be strengthened to minimize immunization dropout in the vulnerable children.

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1. Introduction

Vaccination and immunization have been acknowledged as an effective preventive strategy for several communicable diseases.¹ An immunization campaign carried out by the World Health Organization (WHO) from 1967 to 1977 eradicated the natural occurrence of smallpox. Poliomyelitis is another disease which is going to be eradicated. Since the launch of Global Polio Eradication Initiative by WHO and its partners in 1988, worldwide number of cases of poliomyelitis has fallen by over 99%. In India, number of cases have dropped down from 0.2 million cases per year to 42 cases in year 2010 and polio eradication stage has been achieved during the year 2014.^{2,3} During 1999–2003, deaths due to measles dropped worldwide by almost 40% and some regions have set a target of eliminating the disease.²

India launched Universal Immunization Program (UIP) with the objective to cover at least 85% of all infants by year 1990.⁴ Further, a national socio-demographic goal was setup in National Population Policy (NPP 2000) to achieve universal immunization against all vaccine preventable diseases by year 2010.⁵

When India became independent sixty years ago, the country's population was a mere 350 million. Since 1947, the growth of population in India is more than threefold while urban population growth has been six folds.⁶ Most of this urban growth is due to rural–urban migration leading to the creation of new slum areas. With the rapid growth of megacities, the risk of outbreak of vaccine preventable disease always exists due to high population density, continuous incursion of a new pool of infective agents with the immigrants and poor coverage of primary immunization in urban slums.^{4,7,8} In many studies, it was shown that mother's knowledge of immunization and vaccination were significantly associated with full immunization.⁹ It was reported in earlier studies that complete age appropriate vaccination was less than 50% in India, for BCG and OPV age appropriate vaccination was less than 80% and for DPT and Measles age appropriate vaccination was less than 60%.¹⁰ This study was therefore conducted to identify maternal characteristics associated with immunization coverage among children aged 12–23 months in the urban slums of Varanasi, India.

2. Material and methods

Varanasi is one of the oldest living cities of India, having more than 200 slums in year 2008 as per records of Varanasi Municipal Corporation. A community based cross-sectional

study design has been employed from January 2009 to March 2009 to establish immunization pattern and factors associated to non-adherence to immunization program. The study population consists of mothers of children aged 12–23 months at the time of survey conducted, who were residents of urban slums of the Varanasi.

To identify the determinants of non-adherence of immunization schedule for categorical variables with proportion of 50% children belongs to either category of possible non-adherence (independent) variable, it was assumed that the baseline probability was 0.6 and alternative probability was 0.8 with 95% power at $\alpha = 0.05$ for two tailed hypotheses, required number of children was 216, assuming a design effect of 1.5 and 10% non-response estimated number (216) was escalated to 357 children.^{11,12} Design effect was calculated using the equation.

$$D_{eff} = 1 + (m - 1)\rho$$

where D_{eff} : Design effect; m : no of subjects in a cluster; ρ : intracluster correlation coefficient.

The sampling procedure of this study was based on the WHO thirty cluster methodology.¹³ In the first phase, thirty urban slum areas of Varanasi were selected randomly from total 228 slums listed in municipal corporation list. In the second stage from each slum area minimum twelve children were included in the study. If in any household more than one child was present all children were included in the study. The first household in each cluster was selected by random walk method, and the rest of them were selected from the contiguous household till the required number of children was attained. Information was collected either from the mother of identified child or head of the household after obtaining a signed informed consent form.

3. Data collection

To obtain information on the socio-demographic characteristics of mothers, including the mother's knowledge about the immunization program and possible factors of non-compliance or partial immunization, we used a structured questionnaire after pretesting and validation. The universal immunization program in India includes one dose of BCG administered intradermally on the outer upper left arm or shoulder (over the deltoid muscle insertion) at birth, a single dose of measles given subcutaneously on the left upper arm at the age of 9 months, and three doses of DPT^{1–3} given intramuscularly on the outer mid-thigh at 6, 10 and 14 weeks of ages respectively.

Table 1 – Socio-economic characteristics of the households.

Variables	Number of households	Percentage distribution
Monthly income in INR		
<2000	173	28.8
2000–5000	288	48.0
>5000	139	23.2
Religion		
Hindu	569	94.8
Muslim	31	5.2
Family size		
<4	161	26.8
4–6	230	38.3
6–8	120	20.0
>8	89	14.8
Sex of head of household		
Male	558	93.0
Female	42	7.0
Note: Total Household (600).		

Vaccination status was determined first by examining the vaccination card of the child. In its absence, a history was taken that include a description of the site, and when and how vaccinations were administered. Moreover, an evidence of scar on the skin over the insertion of deltoid muscle on the left upper arm was used as a confirmation of receipt of BCG. A child is defined as “not immunized” if there was no evidence from the card, observation or history. On the other hand, a child is considered as “completed immunization” if there were evidence (by card, observation or history) of administration of all antigens in the schedule (excluding a birth dose of oral polio vaccine) and “partially immunized” if any one of the doses were missing.

4. Data analysis

The data obtained was entered and analyzed using SPSS 16.0. Adherence to the recommended schedule was estimated by calculating the proportion of children who completed immunization at 12 months of age. The association between socio-demographic characteristics of the mother and her knowledge of immunization with adherence to immunization has been evaluated using chi-square test. Univariate and multinomial logistic regression analyses were performed with immunization status as dependent variable.

5. Results

Table 1 shows the socio-economic characteristics of the households ($n = 600$) included in the study sample. Most of the household (76.8%) belongs to the income less than five thousand INR per month. Majority of the household follows Hindu religion. In 14.8% households, more than eight members were found to reside in a household.

There were 384 children aged 12–23 months in total 600 visited household with at least one recently delivered woman. Table 2 reflects the socio-demographic characteristics of the

mother of children aged 12–23 months. Most of the women belong to 20–24 years age group (38.6%). 41% women are illiterate whereas only 15% were educated up-to high school and above. Majority of the women are unemployed or housewife e.g. 85% and only 11% are self-employed and 4% are employed in the sample.

Fig. 1 shows the vaccination time of different antigens amongst children in urban slums of Varanasi. Approximately 80% of the vaccination was as per scheduled time for all antigens. Adherence to recommended time schedule for immunization was found highest for BCG (approximately 85%) and lowest (67%) for DPT2. Fig. 2 shows the percentage coverage for various antigens among these children. Majority (92%) of the children have received BCG. First dose of Polio was received by 83%, second by 75% and third by only 69%. Similarly, the coverage of DPT1 was 82% and 66% for DPT 3. The vaccination coverage among the sampled children declined from the first dose to the last dose of antigen and consequently the dropout rate has increased. Out of those 354 children who have received BCG, 10% have not received Polio 1, 18% have not received Polio 2 and 25% have not taken Polio 3. Only 59% children have received Measles vaccination. It is evident from the univariate analysis (Table 3) that children were more likely to complete the immunization schedule if their mothers were less than 30 years old ($OR = 2.35$, 95% CI 1.54–3.57, $p = 0.001$), educated beyond secondary level ($OR = 2.67$, 95% CI 1.41–5.07, $p = 0.002$), had maximum two children ($OR = 4.36$, 95% CI 2.82–6.74, $p = 0.001$), sex of child is male ($OR = 1.53$, 95% CI 1.02–2.30, $p = 0.03$), aware of type of vaccine ($OR = 1.83$, 95% CI 1.21–2.77, $p = 0.003$), aware of benefits of immunization

Table 2 – Socio-demographic characteristics of the responding mothers.

Variables	Number of mothers	Percentage distribution
Present age (in years)		
Less than 20	45	11.7
20–24	148	38.6
25–29	113	29.4
30–34	71	18.5
More than 34	7	1.8
Education		
Illiterate	156	40.9
Primary	41	10.6
Middle	127	33.2
High school & above	60	15.3
Employment status		
Employed	17	4.4
Self-employed	42	10.9
Unemployment/housewife	325	84.6
Number of children per respondent		
One	126	32.9
Two	103	26.8
Three	77	20.0
Four and above	78	20.3
Sex of children		
Male	214	55.7
Female	170	44.3
Note: sample size (n) is 384.

Fig. 1 – Pattern of immunization at various ages of children.

(OR = 1.82, 95% CI 1.21–2.75, $p = 0.004$) and aware of side effects of vaccine (OR = 2.44, 95% CI 1.52–3.90, $p = 0.001$).

Table 4 shows the result of multivariate logistic regression analysis which revealed that children were more likely to complete the immunization schedule if a mother is less than

30 years of age (OR = 1.86, 95% CI 1.54–3.23, $p = 0.02$), parity less than or equal to two (OR = 2.84, 95% CI 1.98–3.73, $p = 0.01$), employed (OR = 1.39, 95% CI 1.2–2.63, $p = 0.03$) and educated more than secondary level (OR = 1.59, 95% CI 1.30–2.88, $p = 0.02$).

Fig. 2 – Coverage and dropout of various antigens (calculated in comparison with children who received BCG vaccination).

Table 3 – Association between maternal characteristics and complete immunization (n = 384).

Maternal variables	Fully immunized children	Total children	OR (95% CI)	p-value
Age of mother (in years)				
Less than 30	153	235	2.35 (1.54–3.57)	0.001
Greater than or equal to 30	66	149		
Parity of mother				
≤2	163	229	4.36 (2.82–6.74)	0.001
>2	56	155		
Employment status				
Employed	42	59	2.06 (1.13–3.78)	0.02
Unemployed/housewife	177	325		
Education				
Post-secondary	44	60	2.67 (1.41–5.07)	0.002
Primary/secondary	175	324		
Sex of the child				
Male	132	214	1.53 (1.02–2.30)	0.03
Female	87	170		
Awareness of type of vaccine				
Yes	115	177	1.83 (1.21–2.77)	0.003
No	104	207		
Awareness of benefit of vaccine				
Yes	116	179	1.82 (1.21–2.75)	0.004
No	103	205		
Awareness of side effects				
Yes	63	116	2.44 (1.52–3.90)	0.001
No	156	268		

6. Discussion

The problem of dropout has different program related consequences as compared to unimmunized group. It reflects wide gaps in the health care delivery system. The finding of this study indicates that the children living in urban slums belong to the disadvantage subgroup and not availing the benefits of the urban residence. This study suggests high vaccination coverage for vaccines that are given within first few week of birth e.g. 83%–92%. But the coverage for measles vaccine, given before the first birthday of the child, was poor with only 58.85% received this vaccine. This difference is the same in the rest of the studies across the world.^{14–17} High coverage of measles vaccine provides herd immunity thereby decreasing risk for measles exposure and affording

protection to the small proportion of individuals who are not vaccinated.¹⁴

Non-adherence to immunization schedule was also a reason of concern in the study population. For all the antigens more than 15% children were vaccinated after the scheduled time of vaccination which may decrease the efficiency of the vaccine and may not produce fruitful results. It is recommended that BCG be given either at birth or at the time of earliest contact with the child to avoid childhood tuberculosis. Transplacental maternal anti-measles antibodies persist in the child for as long as 9 months. These antibodies protect the child against measles, hence measles usually occurs after 9 months. In the study population 20% of children were not immunized against measles as per time schedules of universal immunization program which may increase the risk of developing measles.

A great deal of research has been found that factors associated with immunization providers are some of the most significant factors having positive influence on immunization.^{1,9,18} However, the present study focused on maternal characteristics and their knowledge and found that maternal age, maternal employment status, maternal education, parity of mother, were the most important factors influencing complete immunization. The finding that younger mothers were more likely (OR = 1.86, 95% CI 1.54–3.23, $p = 0.02$) to have fully immunized children could be due to the fact that they are likely to have fewer children and are thus self-motivated to provide care, this has been also supported by the findings of other studies,^{9,19} while few studies have found dis-similar results.²⁰ In addition, mothers who were employed had a more chance (OR = 1.39, 95% CI 1.21–2.63, $p = 0.03$) of having their children immunized than unemployed mothers, this finding appears at same with numerous studies linking maternal employment to a reduction in financial obstacles to vaccination, especially if these obstacles include money and

Table 4 – Multivariate logistic regression analysis presenting odds ratio and its 95% confidence interval for factors associated with complete immunization (n = 384).

Variables	OR	95% CI	p-value
Age of mother (in years)			
Less than 30	1.86	1.54–3.23	0.02
Greater than or equal to 30			
Parity of mother			
≤2	2.84	1.98–3.73	0.01
>2			
Employment status			
Employed	1.39	1.21–2.63	0.03
Unemployed/housewife			
Education			
Post-secondary	1.59	1.30–2.88	0.02
Primary/secondary			

transportation.^{21,22} While one author found no relationship between maternal employment and complete immunization of child, many authors have reported inverse relationship between maternal employment and complete immunization of child.⁹ Education was independently associated with complete immunization of the children. Mothers who are secondary or more educated have more probability (OR = 1.59, 95% CI 1.30–2.88, $p = 0.02$) of having their children immunized than less educated mothers. Educated mothers have been found to better use the knowledge received from health workers during ANC.²³ Education of mother was found to be significantly correlated with the rate of full immunization in a previous study.^{4,24} Present study suggests that parity less than three increases the chances (OR = 2.84, 95% CI 1.98–3.73, $p = 0.01$) of a child completing the immunization schedule. This is closely related to the finding of a study concluded that higher birth order was associated with under immunization.⁴ The study concludes that mothers with three or more children may not be motivated to provide immunization for the child most recently born.²⁵

Studies carried out to identify factors associated with the complete immunization have made recommendations to improve completion rates based on findings. Improvement in mother's knowledge of immunization, interventions aimed at bringing children to immunization centers on time for initial immunization, offering immunization to appropriate locations to reduce travel time, have all been suggested.²⁶

7. Limitations

The cross-sectional study design that was utilized is less powerful than any analytical design for evaluating risk factors. However because of its relative low cost and simplicity, the methodology has been commonly used and in recent years been extended to health related surveys with different and multiple objectives.

8. Conclusion

The finding of the present study revealed a low immunization completion rate among children surveyed and factors identified which are related to mothers that were associated with complete immunization of children in Varanasi slums. The goal of achieving universal immunization, especially in the disadvantaged groups, vulnerable urban slum population with poor health care delivery system, needs more efforts to deal with dropout.

Conflicts of interest

All authors have none to declare.

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