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Original Research Article

Measles delay in India: the role of parents' behaviour

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ABSTRACT

Background: Objectives were to identify the factors influencing the timeliness of measles immunisation in India, as well as to explore whether parental behaviour in health care seeking facilities varies depending on the gender of child.
Methods: A cross-sectional study was undertaken in India using secondary data from the fourth phase of the district level household and facility survey (DLHS 4). To estimate the age-specific coverage rates scientifically and thoroughly Kaplan-Meier survival analysis was applied. The risk factors for delayed measles immunisation were identified by using cox proportional hazard regression model.
Results: Individual factors, social factors, awareness, and facilitatory factors all have a significant impact on the timeliness of measles immunisation in India. Additionally, it can also be concluded that in the case of a male child, institutional delivery significantly improves health-seeking behaviour among the parents compared to a female child.
Conclusions: Numerous elements like the place of residence, economic position, and caste limit the timeliness of measles immunisation in India. Parents' health-seeking behaviour is also significant in the list of influential factors, like mother's antenatal visit during pregnancy, the child's place of delivery, and motivation for child immunisation. In India child's gender and birth order discovered to have an impact on measles immunisation timeliness. Furthermore, we discovered that parents' health-seeking behaviour is not gender-neutral, but rather favours male child more.

Keywords: Immunisation timeliness, Measles, Cox proportional hazard regression, India

INTRODUCTION

Child immunisation is contemplated as one of the illustrious success chronicles of modern medicines. It is largely considered to be one of the most effective and cost-efficient public health treatments.[1,2] In addition, every year full immunisation avoids 4-5 million child fatalities from vaccine-preventable diseases (VPDs) such as diphtheria, tetanus, pertussis (whooping cough), influenza, and measles. The world health organization considers a child to be fully immunised if he or she has received one dose of the BCG (Bacille Calmette-Guerin) vaccine at birth, three doses of polio and DPT (diphtheria, tetanus toxoids, and pertussis) vaccines at 6 weeks, 10 weeks, and 14 weeks, respectively, and a measles vaccine at 9 months. But, if full immunisation is considered a necessary condition for preventing child deaths from preventable diseases, timely vaccine administration has to be sufficient; as the effectiveness of vaccines largely depends on their schedule.[3] Vaccine programmes have a lower impact on disease burden when given early or late, especially in high-risk groups. Therefore, if a child is immunised earlier than scheduled or lately or if the interval between vaccine doses is increased, then despite having access to health care services the prime objective of vaccine protection from the VPDs may not be attained.[4]

The provision of health care services is not just enough to access those services; certain socioeconomic variables, such as customs, and beliefs also influence the extent of accessibility. Particularly, in the case of child health care services, the gender of the child is one such variable.[5-7] Gender inequality or gender biases in terms of opportunity is a global concept and it has been a social evil in India for decades now. It is practised in all aspects of life, ranging from education, personal autonomy, and health or health care facilities.[8] Antecedent studies divulged that in India, girls are less likely to be immunised. This disparity leads to an estimated 40% greater risk of compromised health in girls as compared to their counterparts.[9] Gender inequality is a multifaceted issue, impacting women's health, educational attainment and economic conditions, but a growing concern is, does gender bias exist in accessing health care services?[10] Despite knowing the benefits of child health care, there exists a possibility of gender-based asymmetric behaviour on the part of parents in accessing child health care services.[11] The presence of such gender biases may weaken the link between parental behaviour with regards to, being concerned about the health care programmes and efficiency in accessing the same. The DLHS 4 report shows that around 65% of children in India aged 12-23 months of age are fully immunised, however, this ratio drops to 34% on average when it comes to timely immunisation. At this point, case of measles immunisation requires more attention because the survey also reveals that in India out of all the children aged 12-23 months around 76% have been immunised against measles, and as low as 25.5% have been immunised on time. In this milieu current study is attempt to determine factors that influence timeliness of measles immunisation in India and to investigate if parental behaviour in healthcare facilities varies by gender of child.

METHODS

Data source and sampling methodology

The current study is a cross-sectional analysis based on data from India's fourth round of the district level of the household and facility survey. The DLHS-4 included both a household survey and a facility survey. Except for the nine states covered by the annual health survey (AHS), both of these district level household and facility survey components had been implemented in the districts of all states and union territories. The survey was conducted from 2011 to 2012 and was made available on request to the general public in the year 2015-2016.

The DLHS was carried out using a multi-stage, stratified sampling approach. In the first step, the census district was chosen as the primary sampling unit (PSU) with a probability proportionate to the PSU population size. The second stage involved selecting and enumerating households within each geographical division. The immunisation card was used to collect information about child immunisation. However, for children who did not have an immunisation card, the mother's claim of immunisation was acknowledged and recorded as legitimate information on the childhood immunisation status.

The survey was carried out following three independent questionnaires: the household questionnaire, which included inquiries about household members, socioeconomic characteristics of the household, possession of assets, and so on; the questionnaire on ever-married women (aged 15-49 years) primarily focused on maternal and child care; and the facility questionnaire, included comprehensive inquiries about human resources available, physical infrastructure, and services provided at health facilities.

Measurement of variables and operational definition

We estimated the incidence of immunisation coverage and immunisation timeliness for each of the age-specific vaccines. Following Zaidi et al and Noh et al immunisations status was classified as "early" if they were administered 3 days before recommended age.[12,13] Immunisations were defined as "delayed" if they were administered more than 28 days after the recommended age and the remaining immunisations within these time frames were considered "timely". And in the current study, we only considered two classifications: timely and delayed immunisation, with category "early" combined with timely vaccination due to the small sample size.

Table 1: Classification of immunisation status.

Vaccines	Recommended age	Early	Timely	Late
BCG	At birth/ 0 days	-	days	>28 days
DPT1	42 days	<39 days	39-70 days	>70 days
DPT2	70 days	<67 days	67-98 days	>98 days
DPT3	98 days	<95 days	95-126 days	>126 days
OPV1	42 days	<39 days	39-70 days	>70 days
OPV2	70 days	<67 days	67-98 days	>98 days
OPV3	98 days	<95 days	95-126 days	>126 days
Measles	275 days	<272 days	272-303 days	>303 days

Authors edited this table from Zaidi et al, Noh et al and WHO.[12-14]

Statistical analysis

Children included in the analysis were 12-23 months of age, who had received one dose of BCG, three doses of oral polio vaccine (OPV), three doses of DPT and one dose of measles vaccines. Time to event immunisation for each vaccine was obtained from immunisation dates and date of birth recorded in the DLHS 4-unit level file. Firstly, the non-parametric Kaplan-Meier survival analysis was applied to estimate the age-specific coverage rates scientifically and thoroughly. In comparison to up-to-date immunisation coverage, assessment of delay in age-appropriate immunisation offers more information regarding immunisation timeliness.[15-17] In our study, the time variable was specified as the age (in days) that a child had survived before receiving a specific dose of vaccine. Thus, the failure or event of interest is a positive event specified as vaccine uptake, and the outcome variable was the time (in days) to a specific event, that is until a child received the vaccine. Secondly, risk factors for delayed immunisation were identified using cox proportional hazard regression model. Since our data had a large number of missing observations, hence in the presence of censoring and covariates, we did not know what particular distribution the pre-existing data followed. However, the primary benefit of cox proportional hazards regression is that it allows us to fit survival models without having to know or assume the distribution. As a result, having an approach that works effectively without requiring a certain distribution is quite valuable, and the model was applied accordingly. We estimated the cox proportional hazards model of the following form (using Stata version 13).

$$h(t) = h_0(t)e(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p)$$

Where t is the time, x_s are the covariates, β_s are the regression coefficients and h_0 (t) is the baseline hazard function, i.e., the hazard function under $x = 0$. Here are predicted hazard is the timeliness of measles immunisation.

RESULTS

Characteristics of the study population

Table 2 illustrates the demographic characteristics of the study population. It was observed that of the 13961 children, approximately 59% were from rural areas, as against 41% (approximately) urban children. Taking a look at the religious distribution, we noticed that the percentage of children who practice Hinduism was the greatest in the sample (69.72%). And, the percentage of Muslim and Christian children were 10.84 and 9.63 respectively. When the distribution of children across social-economic classes was analyzed, the majority of the children were found to be from the OBC category. The percentage of the mother with secondary and above education was high (31.92%) and 51.87% of them were within the age group 25-34. Almost 87% of the mothers attended recommended antenatal care visits. The proportion of male children was 52.74% against 47.26% of female children and 36.79% of children were in the BPL category (Table 2).

Table 2: Socio-economic features of the study population (n=13961).

Variables	Category	N	%
Place of residence	Rural	8244	59.05
	Urban	5717	40.95
Religion	Hindu	9734	69.72
	Muslim	1513	10.84
	Christian	1344	9.63
	Others	1370	9.81
Social class	SC	3321	23.79
	ST	2313	16.57
	OBC	5151	36.90
	General	3176	22.75
Mother's education	Illiterate	1038	7.43
	Primary	2174	15.57
	Upper primary	2909	20.84
	Secondary	3384	24.24
	Higher secondary and above	4456	31.92
Maternal age (Years)	Up to 18	224	1.60
	19-24	5826	41.73
	25-34	7241	51.87
	35 and above	670	4.80
Father's education	Illiterate	47	0.34
	Primary	2544	18.22
	Upper primary	3041	21.78
	Secondary	3475	24.89
	Higher secondary and above	4854	34.77
Ante-natal care	< 3 ANC visit	1596	11.40
	≥ 3 ANC visit	12365	88.60
Place of delivery	Non-institutional	1306	9.40
	Institutional	12655	90.60
Gender of the child	Male	7363	52.74
	Female	6598	47.26
Birth order	≤ 2	11528	82.60
	> 2	2433	17.40
Economic status	APL	8705	62.35
	BPL	5136	36.79
	Don't know	120	0.86

Compiled by the authors from DLHS 4-unit file.

Timeliness of immunisation coverage

In this section, we have attempted to explore the coverage for all the doses of full immunization among all the children aged 12-23 months. The existing figures (Table 3) reveal the highest immunization coverage which has been observed in BCG (90.70%). The second-best figure was registered for measles at 76.97% followed by OPV3 and DPT 3 at 73.29% and 72.42% respectively. However, the timeliness of immunization coverage was found to be inadequate. On average, 63% of the children who had been immunized had got their vaccine on time. Measles immunization had the highest delay of all of the age-specific immunizations, only 50.30% of measles-immunized children received the vaccine on time. In other words, more than half of the eligible children were immunized lately.

Table 3: Immunisation coverage among children aged 12-23 months.

Vaccine	Immunization coverage[1] (%)	Timely immunization coverage[2] (%)
BCG	90.70	73.60 (32.53)
DPT3	72.42	65.70 (36.50)
OPV3	73.29	63.60 (35.20)
Measles	76.97	50.30 (23.33)

Computed by the authors from DLHS 4-unit file.
[1]Percentage figure in column 2 has been computed from the state fact sheet (DLHS 4). Data from each of the separate factsheets was aggregated to produce national. [2]Figures in column 3 are calculated among the children who have received immunization from unit file DLHS 4 and figures in the parenthesis in column 3 shows timely immunization out of all the children aged 12-23 months.

Immunisation coverage: Kaplan-Meier analysis

The Kaplan-Meier survival curve explores the extent of immunisation coverage among all the children regardless of their immunisation status. An estimate of age-appropriate immunisation coverage has been shown in Figure 1. Panel A of the Figure estimates age-appropriate immunisation coverage for BCG, followed by DPT3, OPV3 and measles in panel B, C and D respectively.

The appropriate age for BCG vaccine is at birth or within 28 days of birth as recommended by WHO for delayed immunisation. Thus, the timeliness of immunisation coverage for the BCG vaccine was estimated at 28 days. Although the total BCG immunisation coverage in India was around 90% our study revealed that the age-appropriate immunisation coverage was around 32.53% within the recommended schedule. Moving to the DPT and OPV vaccines, the recommended delayed immunisation schedule for both DPT 3 and OPV 3 was 126 days and merely 35% of the children aged 12-23 months had received the vaccine on time. The minimum recommended age for Measles immunisation is 9 months or 275 days (approximately) and the recommended schedule for a delayed vaccine is 303 days (approximately). Thus, age-appropriate immunisation coverage for the measles vaccine was estimated at 303 days. The Kaplan Meier curve revealed that the age-appropriate immunisation coverage of the measles vaccine was 23.33%. The highest delay in immunisation coverage was observed in the case of the measles vaccine. Hence, next, we seek to find the determinants which act as risk factors associated with delayed measles immunisation in India.

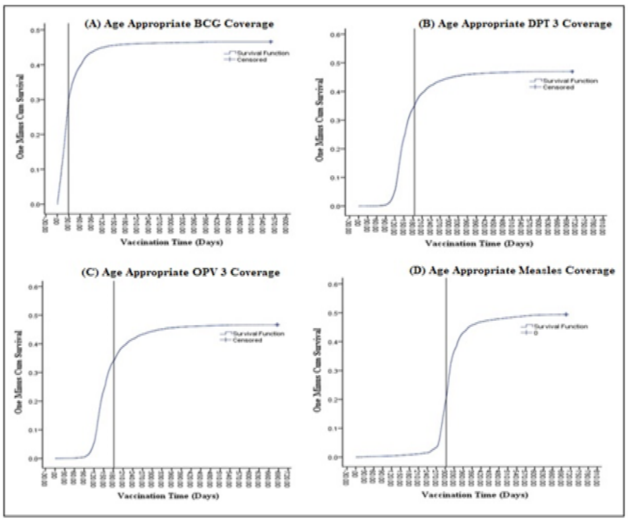

Figure 1: Age-related coverage for specific vaccines (1-Survival analysis).

Prepared by the authors from DLHS 4-unit file.

Factors associated with measles delay in India

To identify risk factors for timeliness of immunisation, we estimated the cox proportional hazards model using the following formula and the result has been presented in Table 4.

$$h(t) = h_0(t)e[\beta_1 Res + \beta_2 PD + \beta_3 ANC + \beta_4 Mt + \beta_5 BO + \beta_6 GD + \beta_7 (GD * PD) + \beta_8\, Caste + \beta_9 Class + \beta_{10} Region]$$

Before analysing the regression findings, it is vital to notice that the different diagnostic test statistics reported in the final rows of Table 4 validate the model's suitability. Pointing towards the analysis, the cox proportional hazard regression analysis revealed the risk of delayed coverage of measles immunisation in 0.08 times more for urban children compared to their rural counterparts. The regression results also revealed that children born in a non-institutional set-up had a 0.19 times higher likelihood of delayed immunisation. Antenatal check-ups were found to have a considerable influence on the timeliness of immunisation coverage. It was noticed that babies born to mothers who have had three or more recommended antenatal check-ups were 0.32 times more likely to have timely immunised than their counterparts. Similar to ante-natal care, the risk of immunisation delay was found to be 0.26 times less for children whose mothers were motivated for immunisation by health professionals or family members. Higher birth order of the child was associated with delayed immunisation. Precisely, children of higher birth order had a 0.16 times higher likelihood of delayed immunisation than their counterparts (Table 4).

Table 4: Predictors of delayed measles immunisation with cox proportional hazard regression, dependent variables: measles time to event.

Indicators	Hazard ratio	Z value
Place of residence (Rural)	1.08	2.94
Place of delivery (Institutional)	1.19	2.90
Ante-natal check-up (ANC) (≥3)	1.33	6.69
Motivation for immunisation (Motivated)	1.26	5.41
Birth order of the child (>2)	0.84	-5.45
Gender of the child (Male)	1.15	1.82
Interaction, girl institution delivery	0.87	-1.74
Social class (Backward class)	0.81	-7.04
Socio-economic status (APL)	1.03	2.16
Region (North)	0.75	-8.30
Diagnostic statistics		Log pseudo-likelihood -59870.46 Wald chi-square 267.89
Test of proportional hazards assumption		Chi square- 13.21 (21.23)

The primary factors of the study are the gender of the child and the interaction variable (Gender and institutional delivery). The hazard ratio of the gender of the child provides substantial evidence in favour of gender discrimination in timely immunisation coverage. The risk of immunisation delay was 0.15 times greater for female children than male children. Furthermore, if the infant was born under an institutional set-up, the discrimination becomes more effective (1.15+0.87=2.02).

The current study showed a caste-based variance in the timeliness of immunisation coverage. Backwards-class children had a 0.19-fold increase in the probability of vaccine delay compared to the general class. Regional differences in child immunisation tend to alter the spectrum of vaccines accessible across the country. In the present study, we observed that the risk of delayed immunisation was 0.25 times more for children belonging to the northern region compared to the rest of the country. The study also indicated that the incidence of delayed immunisation is 0.03 times higher for children belonging to BPL households compare to their counterparts.

DISCUSSION

The extended programme on immunisation (EPI) in India has increased immunisation rates for the whole set of basic vaccines, but little is known regarding the timeliness of immunisation. Despite having relatively high immunisation coverage a gap in the timeliness of children's immunisation was observed in the study. Though 77% of the children aged 12-23 months were measles immunised, 40% of them had received the vaccine time or at the recommended age. BCG immunisation recorded 63.5% timely immunisation, despite having around 90 per cent date immunisation coverage. The figure for delayed immunisation stood around 26% for both DPT 3 and OPV 3. Previous studies done in Sub-Saharan and low-middle-income countries also reported delays in age-appropriate immunisation despite high immunisation coverage.[18-20] Moreover, we found that delayed measles immunisation in India was associated with factors like place of residence, cultural affiliation, gender and birth order of the child, health-seeking behaviours and socioeconomic status. Consistent with the previous study, we observed that urban children were associated with delayed immunisation as than the children living in rural areas.[21] People in rural locations have easy access to health care at government hospitals that provide free immunisations, and community health workers in collaboration with public health centres have also done an excellent job of spreading the immunisation message in villages. Furthermore, health care services do not reach adequately the pocket slums that exist in urban areas.[22] This might had attributed to the difference in timely immunisation between rural and urban children. In the analysis, we found that health-seeking behaviours such as antenatal check-ups, institutional delivery, and motivation for immunisation were positively related to timely immunisation. ANC visits provide a platform to encourage healthcare usage, such as institutional delivery, post-natal check-ups, and family planning. Moreover, during the ANC visit the learning sessions that are exposed to wood be mothers, also emphasize the importance of the timely immunization of the babies.[5,23] The finding of our study is consistent with the work of Noh et al, Babirye et al and Shrivastwa et al.[13,16,24] Previous studies revealed that higher birth order and lower socioeconomic status were the two prominent factors associated with delayed immunisation.[15,25,26] Furthermore, a study performed in African countries found that immunisation delays were associated with having more children in the household and having a lower socioeconomic position.[16] In our analysis of DLHS 4 data on the predictors of delayed measles immunisation, similar indicators were found to be related to the hazard of delayed immunisation.

One of the most powerful drivers of gender discrimination in Indian society is the persistent preference for a son. Owing to this, men and women have different allocations of material assets, rights, opportunities, and responsibilities. Furthermore, such gender-based discrimination prevents female children from obtaining enough nutrition, preventative care, and treatment for diseases, resulting in increased female mortality and poor health.[27, 28] Previous studies found that in India, female children were less likely to get immunised, leading to 40% higher risk of health problems in female children compared to their counterparts.[9] Our analysis showed that the age-appropriate immunisation coverage of male children was higher than their female counterparts which is consistent with the results of the previous studies.[29-31] Additionally, it was observed that if the infant was born under an institutional setup, the discrimination becomes more effective. This suggests that, while institutional delivery enhances parents' health-seeking behaviour, it differs depending on the gender of the child, and it mostly benefits sons. And, if the newborn is a girl, the parents become gender prejudiced and hesitant to use their knowledge of child health care gained through pre-birth care and institutional delivery.

Limitations

There were a few flaws in the study. Since just the month and year of birth were known for each child, the date of birth of the child was obtained by setting the first date of the month as the birthdate. As a result, the vaccination age was somewhat overestimated. Furthermore, as the study only considered living children, that might lead to an overestimation of vaccination probability. Lastly, the study's scope was limited to some extent since data for nine states was not available.

CONCLUSION

Immunisation coverage in India has significantly increased over the years. But, the extent of timeliness of immunisation is quite unsatisfactory. We observed significant delays in receipt of recommended child immunisation in India and the case of measles delay is a serious matter of concern. More than half of the children aged 12-23 months were immunised lately. Socio-economic and regional inequalities play a significant role in determining the incidence of measles timeliness in India. In addition, we also observed the prevalence of gender inequalities in immunisation coverage in India. Parental behaviour in health care seeking facilities varied depending on the gender of the child as well. Parents were more likely to use their awareness towards the male child in a better way compared to their female child, resulting in gender discrimination in accessing health facilities. Thus, this evil practice needs to be addressed socially and programmatically. The government and local administration must work together with the community leaders to increase awareness regarding gender equality in particular and child health-related issues in general. In addition, India needs to develop innovative techniques to enhance the timeliness of childhood immunisation and emphasis should be given to the improvement of economic status and the creation of opportunities for households belonging to marginalised sections for better utilisation of health facilities.

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