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Vaccine hesitancy affecting immunization status in rural and urban regions of Ahmedabad District, Gujarat, India: a cross-sectional study

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Abstract

Immunization is one of the most efficient interventions to reduce morbidity and mortality in children. Despite such interventions, immunization coverage is not sufficient. Our objective is to determine the factors affecting the immunization status of children in rural and urban areas of the Ahmedabad district. A community-based cross-sectional study was carried out where children in the age group of 0-72 months in rural and urban communities were surveyed. Data were collected from mothers and caregivers who were willing to participate in the study. Data were analyzed using STATA MP 14.2. A total of 9, 466 responses were collected. Out of these, 7, 441 children were in the age-group of 12-72 months and hence were included to determine immunization status. Most children were fully immunized in both rural (86.40%) and urban (89.22%) areas. Vaccine hesitancy, family type, maternal education, unavailability of immunization card, place of immunization, and immunization facilitator were significantly associated with a child being partial/unimmunized. It was observed that socio demographic factors and vaccine hesitancy on part of the caregiver were important factors associated with the immunization status of children. Future strategies and interventions should focus on optimizing the timing and proper dissemination of information in both rural and urban areas in order to improve vaccine uptake.

Keywords: Immunization, India, rural, urban, vaccine hesitancy.

Introduction

Immunization is one of the most efficient and successful approaches in the field of public health. The World Health Organization (WHO) has defined immunization as the process where an individual is made immune or resistant to an infectious disease by the administration of a vaccine[1]. WHO estimates that between 2010 and 2015, 10 million deaths were prevented due to immunization across the globe[1]. Immunization is also a cost-effective preventive measure that maintains health by reducing morbidities that can affect an individual's health along the life course[2]. Efforts to improve immunization coverage are essential to achieve the Sustainable Development Goals of reducing child mortality and promoting good health[3].

While progress has been made in reducing child mortality, numerous children are still at risk for vaccine-preventable diseases. Ten countries account for 11.7 and 19.4 million under or unvaccinated children in the world[4], of which India accounts for 2.6 million unprotected children[4].

Most studies till date have documented geography, residence (rural/urban), socioeconomic status, and gender as some of the major determinants of variation in immunization coverage[5]. Recently parental hesitancy to vaccinate has been linked to the suboptimal uptake of vaccines against infectious diseases[6]. According to a report published by the SAGE Working Group, vaccine hesitancy is described as a behavioral phenomenon that refers to "delay in acceptance, or refusal of vaccines despite availability of vaccination services. It is complex and context-specific; varying across time; place and vaccines; and influenced by factors such as complacency, convenience, and confidence"[7].

The Government of India has taken many initiatives to deal with low immunization coverage. Mission *Indradhanush*, one of the successful programs, has increased full immunization coverage from 1% to 6.7% in its first two phases. After four phases, more than 25.3 million children have been vaccinated, as reported in 2017[8]. However, National Family Health Survey report (NFHS) Gujarat showed changes in the coverage trends of all basic immunizations overtime[9]. Our objectives are to understand the determinants of low immunization coverage; to see if geographic variation exists; and also to target the interventions to improve the immunization coverage in the Ahmedabad district of Gujarat.

Methodology

Study Design and Setting: A community-based cross-sectional study was carried out from July 2018 to September 2019 in the Ahmedabad district of Gujarat. This study was part of a larger longitudinal study called the Maternal and Child Health Demographic Survey (MCHDS)[10]. The survey was conducted in

three areas of the Ahmedabad district, namely, i. Bavla – a rural block with a population of 115,733, and ii. Behrampura and Vasna – urban wards with populations of 159,181 and 153,558 respectively[11]. Written informed consent was obtained from the parents/guardians of the child.

Study Participants: The target population was children aged 0-72 months whose family resided in the study area for past 1 year. Parents or guardians were interviewed. A census sampling method was used. All households within the study area were surveyed. Participants who were not available at the time of the survey and those unwilling to participate in the study; about 5%, were excluded.

Data Collection and Procedure: A detailed questionnaire was developed to collect sociodemographic information and information on the immunization status of sampled children. The immunization status questionnaire was developed after reviewing a survey questionnaire of the SAGE working group[7]. A modified BG Prasad scale was used to classify the socioeconomic status of the participants based on per capita income[12]. Details for vaccines were obtained through oral history given by mothers or caregivers. All primary vaccines are administered before one year of age, hence, it was assumed that children aged 12 months and above represented a meaningful sample for the assessment of immunization coverage. Moreover, existing datasets such as the NFHS also report immunization rates for children above 12 months.

The National Immunization Schedule was used as a rubric to classify the immunization status of children for all primary immunizations, by age[13]. i. Fully immunized: birth doses- BCG, OPV, and Hepatitis B; 6, 10, 14 weeks- Pentavalent (consists of DPT, Hepatitis B, and Hemophilus influenza type b); and 9 months- Measles. ii. Partially immunized: Child received at least one vaccines but not all. iii. Unimmunized: Child did not receive any vaccine.

Online software Open Data Kit (ODK) was used for data collection. The tool was translated into Gujarati, the local language. Local health workers and field investigators facilitated data collection. All data collected was transferred to Microsoft Excel.

Bias: A large number of respondents were unable to present the immunization card on request, at the time of data collection. Due to this, the dates of immunization were unavailable for some children. Thus, using dates as a measure of immunization status would have shown an abnormally low immunization coverage.

Therefore, we based the immunization status of each child on the responses of the study participants. It should however be noted that relying on respondent memory introduces the possibility of recall bias. Thus, in case of positive responses for particular vaccines, we assumed that it was given at the correct time.

Data Analysis: Data from Microsoft Excel was imported to STATA MP 14.2 for analysis. Immunization status was the outcome of interest, created by aggregating the responses for each of the primary immunizations mentioned above. Descriptive statistics were used to calculate mean, frequency, and percentage of study variables. Multiple response analysis was done for multiple response sets. To determine the association of various factor variables with immunization status, bivariate analyses were performed for each independent variable using logistic regression. Variables that were found to be statistically significant at p-value <0.05 were included in the multivariate model.

Results and discussion

The total number of households surveyed in rural and urban were 3, 289 & 3, 399 respectively.

Table-1 depicts the socio-demographic characteristics of included children and their parents. A total of 9, 466 children aged 0-72 months were considered from rural (n=4, 908) and urban (n=4, 558) areas. The mean age in rural areas was 28.90 months and 26.90 months in urban areas. The sex distribution in both areas was 51% male and 48% female. More than half the respondents belonged to nuclear families and the majority of them were middle class. A large proportion of mothers had elementary school education in rural and urban areas (52.65% & 48.99% respectively). In the present study, immunization status was considered for children between the ages of 12-72 months. Children below 12 months were excluded as they were not old enough to receive all vaccines included in primary immunization.

As indicated in Table-1, the overall proportion of fully immunized children in rural and urban areas were 86.40% and 89.22% respectively. Specific immunization coverage for birth doses of BCG, Polio and Hepatitis B were almost similar (≈98%) in both areas. Likewise, pentavalent and measles coverage was 93.22% and 87.60% in rural areas and 95.74% & 90.27% urban areas.

The outcomes were grouped by rural and urban residence (Table-2). The odds of being partial/unimmunized were 1.30 times higher for children living in rural areas than in urban areas.

We categorized the reasons for not receiving any immunization or partial immunization into two, namely, vaccine hesitancy and health system issues. Table-3 shows the reasons chosen by respondents for not vaccinating their children. It should be noted that several respondents cited more than one reason for non-immunization. For example, 65.36% of respondents in rural areas failed to immunize their children due to fear of side effects from vaccines. Some parents whose children were fully immunized also reported vaccine hesitancy. Vaccine hesitancy was found to be significantly associated with low coverage of immunization.

The association between each independent variable and immunization status was assessed one by one as shown in Table-4. Children from nuclear families in a rural area had significantly higher odds of being partially or unimmunized (OR:1.36; CI:1.09-1.71) than those in joint families. Caste, an important social classifier in India, was also a strong predictor of immunization status.

Table-1: Socio demographic Characteristics of Children in the age group of 0-72 months.

	Rural	Urban
Characteristics	(n=4908)	(n=4558)
Child's Age in Months Mean	28.90	26.90
Gender n (%)		
Male	2,539 (51.73)	2,331 (51.14)
Female	2369 (48.27)	2227 (48.86)
Caste		
SC	625 (12.73)	1880 (41.25)
OBC	4218 (85.94)	2136 (46.86)
ST	7 (0.14)	43 (0.94)
General	58 (1.18)	499 (10.95)
Type of House		
Kutcha/ No house	18 (0.37)	36 (0.79)
Kutcha-Pucca	2397 (48.84)	1500 (32.91)
Pucca	2493 (50.79)	3022 (66.30)
Type of Family		
Joint	1224 (24.94)	1336 (29.31)
Nuclear	3684 (75.06)	3222 (70.69)
Maternal Education Status		
No Schooling	1645 (33.52)	1065 (23.37)
Elementary (1st-8th)	2584 (52.65)	2233 (48.99)
High School (9th-12th)	635 (12.94)	1106 (24.27)
Graduation	44 (0.90)	154 (3.38)
Mode of Income		
Daily Wage	4028 (82.07)	3262 (71.57)
Salaried (Monthly wage)	558 (11.37)	1290 (28.30)
Others (Food for labor, livestock dependent)	322 (6.56)	6 (0.13)
Mean Per Capita Income	2600.36	2872.72
Socioeconomic Status		
Upper Class	114 (2.32)	103 (2.26)
Upper Middle Class	1113 (22.68)	1314 (28.83)
Middle Class	2006 (40.87)	2180 (47.83)
Lower Middle Class	1498 (30.52)	911 (19.99)
Lower Class	177 (3.61)	50 (1.10)
Immunization status	(n=3896)	(n=3545)
Fully immunized	3366 (86.40)	3163 (89.22)
Partially or Unimmunized	530 (13.60)	382 (10.78)

Table-2: Impact of Study Setting on Immunization Status.

Taluka	OR (95% CI)	p-value
Urban	Ref	0.000
Rural	1.303 (1.133-1.500)	

OR- crude odds ratio; Ref- Reference.

Table-3: Reasons for Not Vaccinating (children aged ≥12 and ≤72 months).

Reasons[#]	Rural (n= 534)	Urban (n= 376)	
a). Vaccine Hesitancy	Frequency (%)	Frequency (%)	p-value
Child too young for immunization	92 (17.23)	13 (3.46)	0.000
Unaware of need for immunization	17 (3.18)	21 (5.59)	0.07
Place of immunization unknown	22 (4.12)	3 (0.80%)	0.003
Time of immunization unknown	64 (11.99)	7 (1.86)	0.000
Fear of side effects	349 (65.36)	130 (34.57)	0.000
No faith in immunization	186 (34.83)	65 (17.29)	0.000
Place of immunization too far to go	4 (0.75)	7 (1.86)	0.13
Time of immunization inconvenient	3 (0.56)	7 (1.86)	0.06
Family problems, including busyness & illness of mother	23 (4.31)	57 (15.16)	0.000
Child not brought	13 (2.43)	83 (22.07)	0.000
Child ill brought	5 (0.94)	97 (25.80)	0.000
Others (Out of town, cost etc.)	10 (1.87)	8 (2.13)	0.78
b). Health System Issues	n= 3	n= 6	
ANM absent	0	2 (33.33)	0.25
Vaccine not available	2 (66.67)	1 (16.67)	0.13
Long waiting time	1 (33.33)	3 (50.00)	0.63

([#]) Multiple Response Analysis.

We found that children whose mothers had elementary and high school education were less likely to be partially or unimmunized in both rural and urban areas compared to those mothers who never attended school. On the other hand, in urban areas, odds of being partially or /unimmunized were lower (OR:0.48; CI:0.25-0.89) for children whose mothers were graduates. Similarly, children whose parents were daily wage earners (OR:1.5; CI:1.12-2.18), and depended on livestock or worked for food (OR: 2.20; CI:1.40-3.46) were more likely to be partially or unimmunized in rural areas. However, in urban area it was not significant, found to be that children whose parents were daily wage earners more likely to be immunized. Similarly, no statistically significant association was observed between socioeconomic status and immunization status, but results revealed that children belonging to different classes in rural areas are at risk of being partial/unimmunized and on the contrary children from urban areas did not show any risk.

Table-4: Bivariate Analysis of Predictors affecting Immunization Status in Rural and Urban Areas.

	Variables	Rural	Urban
		OR (95% CI) p-value	OR (95% CI) p-value
Gender	Male	Ref	Ref
	Female	1.130 (0.941-1.358) 0.18	1.002 (0.810-1.239) 0.98
Type of Family	Joint	Ref	Ref
	Nuclear	1.368 (1.094-1.711) 0.006	1.112 (0.875-1.413) 0.38
Caste	SC	Ref	Ref
	OBC	2.623 (1.811-3.798) 0.000	1.547 (1.228-1.948) 0.000
	ST	6.062 (1.131-32.483) 0.03	1.431 (0.495-4.135) 0.5
	General	1.943 (0.716-5.268) 0.19	1.029 (0.698-1.515) 0.8
Maternal Education Status	No Schooling	Ref	Ref
	Elementary (1st-8th)	0.517 (0.427-0.626) 0.000	0.487 (0.384-0.617) 0.000
	High School (9th-12th)	0.295 (0.201-0.433) 0.000	0.263 (0.187-0.369) 0.000
	Graduation	0.145 (0.196-1.069) 0.05	0.483 (0.259-0.899) 0.02
Mode of Income	Salaried (Monthly wage)	Ref	Ref
	Daily Wages	1.562 (1.120-2.180) 0.009	0.950 (0.753-1.200) 0.6
	Others (food for labor, livestock dependent)	2.206 (1.405-3.463) 0.001	2.000 (0.221-18.055) 0.5
Socioeconomic Status	Upper Class	Ref	Ref
	Upper Middle Class	1.016 (0.508-2.032) 0.9	0.797 (0.385-1.650) 0.5
	Middle Class	1.166 (0.595-2.288) 0.6	0.923 (0.452-1.881) 0.8
	Lower Middle Class	1.502 (0.765-2.950) 0.2	0.990 (0.476-2.058) 0.9
	Lower Class	1.836 (0.846-3.986) 0.1	0.603 (0.153-2.368) 0.4
Immunization Card	Yes	Ref	Ref
	No	1.837 (1.407-2.396) 0.000	3.860 (2.596-5.738) 0.000
Place of Immunization	Public Institution	Ref	Ref
	Private Institution	3.635 (2.600-5.082) 0.000	4.164 (3.068-5.653) 0.000
Immunization Facilitated By	Family and NGO	Ref	Ref
	Doctor	0.352 (0.220-0.563) 0.000	2.899 (1.778- 4.728) 0.000
	Community Health Worker	0.290 (0.200-0.421) 0.000	0.900 (0.681-1.188) 0.4

OR- crude odds ratio; Ref- Reference

Table-5: Multivariate Analysis of Predictors affecting Immunization Status in Rural and Urban Areas.

	Variables	Rural	Urban
		AOR (95% CI)	AOR (95% CI)
Type of Family	Joint	Ref	Ref
	Nuclear	1.297 (1.032-1.631) 0.02	1.063 (0.825-1.371) 0.6
Caste	SC	Ref	Ref
	OBC	2.239 (1.535-3.266) 0.000	1.455 (1.142-1.855) 0.002
	ST	5.108 (0.826-31.559) 0.07	1.371 (0.430-4.368) 0.5
	General	1.679 (0.576-4.892) 0.3	1.031 (0.695-1.529) 1.0
Maternal Education Status	No Schooling	Ref	Ref
	Elementary (1st-8th)	0.504 (0.414-0.614) 0.000	0.537 (0.420-0.687) 0.000
	High School (9th-12th)	0.303 (0.203-0.450) 0.000	0.296 (0.208-0.420) 0.000
	Graduation	0.151 (0.019-1.197) 0.07	0.499 (0.253-0.982) 0.04
Mode of Income	Salaried (Monthly wage)	Ref	Ref
	Daily Wages	1.309 (0.932-1.839) 0.1	0.869 (0.676-1.118) 0.2
	Others (food for labor, livestock dependent)	1.627 (1.019-2.597) 0.04	1.350 (0.104-17.425) 0.8
Immunization Card	Yes	Ref	Ref
	No	1.627 (1.239-2.137) 0.000	3.394 (2.254-5.111) 0.000
Place of Immunization	Public Institution	Ref	Ref
	Private Institution	2.976 (2.026-4.371) 0.000	3.615 (2.635-4.958) 0.000
Immunization Facilitated By	Family and NGO	Ref	Ref
	Doctor	0.441 (0.277-0.703) 0.001	2.779 (1.685-4.583) 0.000
	Community Health Worker	0.450 (0.305-0.665) 0.000	0.937 (0.701-0.210) 0.6

AOR-adjusted odds ratio; Ref- Reference

Additionally, immunization card, place of immunization, and immunization facilitator were found to be statistically significant determinants of immunization status in both rural and urban areas. Strangely, when immunization was facilitated by a doctor in urban areas, odds of a child being partially or unimmunized were 2.89 (CI:1.77- 4.72) times higher.

To assess the combined effect of all predictor variables, adjusted odds ratios were obtained using multivariate analysis (table 5). In the full model, family type, maternal education, mode of income, having an immunization card, place of immunization, and immunization facilitator, were found to be statistically significant.

Children living in a nuclear family in rural areas had 1.29 (CI:1.03-1.63) times higher odds of being partially or unimmunized compared with children from joint families. Children belonging to Other Backward Castes (OBC) in rural

and urban areas had 2.23 (CI:1.53-3.26) and 1.45 (CI:1.14-1.85) times higher odds of being partially or unimmunized compared to those general category families. It was seen that maternal education protected a child from being partially or unimmunized. In the same way, mode of income was a determinant of the immunization status of children.

We found place of immunization to be highly predictive of immunization status. Children vaccinated in a private institution had 2.97 (CI:2.02-4.37) and 3.61 (CI: (2.63-4.95) times greater odds of being partially or unimmunized in both rural and urban areas respectively. Interestingly, in the rural setting, unavailability of immunization cards was responsible for 1.62 (CI: 1.23-2.13) times higher odds of being partially or unimmunized, whereas in urban areas these odds were 3.39 (CI:2.25-5.11) times higher. It was found that, compared to the family or an NGO, when immunization was facilitated by a doctor, the odds of a child being partially or unimmunized were 2.77 (CI:1.68-4.58) times higher for urban residence, whereas in rural areas, a child whose immunization was facilitated by either a doctor, (OR:0.44; CI:0.27-0.70) or community health worker (OR:0.45; CI:0.30-0.66) was more likely to be fully immunized.

Discussion: Immunization coverage is a complex process and requires strategies to achieve to fulfil the immunization gaps. The Indian context is governed by myriad factors including variations in geographical region, income, parental education, determinants of social class, and family characteristics[5]. In our study, the percentage of partially or unimmunized children in rural and urban areas was 13.60% & 10.78% respectively. A comparative review of NFHS-3 & NFHS-4 identified a very marginal rural-urban gap in some of the regions in India[14]. According to NFHS- 4, in the state of Gujarat, 50% children aged 12-23 months received basic immunization whereas most children were at least partially immunized, and 9% were unimmunized[9]. Basic immunization coverage did not vary by urban-rural residence[9]. Caste is an indicator of social discrimination and also contributes to a lack of access to health facilities[15]. This was confirmed by our findings, where children belonging to lower castes were less likely to be fully immunized. Immunization coverage was low in children whose parents were dependent on livestock or worked for food. Literature also reports that low income negatively affects immunization status[16].

The issues that have emerged in this study can be classified as demand side (vaccine hesitancy) and supply side (health systems). A very small number of respondents reported issues related to the health system indicating that resources are available to meet the needs of immunization coverage. On the other hand, the most common reasons behind vaccine hesitancy were, fear of side effects, and no faith in immunization, in both rural and urban areas. Although rare, adverse reactions/events occurring as a result of due immunization might affect parental perception towards vaccines. In similar studies conducted in different parts of India, parental concerns regarding side effects and lack of faith in the vaccine were considered as the main reasons for non-immunization of the children[5,17,18].

In considering the component factors of vaccine hesitancy, lack of information about place and time of immunization in the rural areas and in urban areas family problems including a busy schedule, illness of mother and child, and a child not being brought to a health facility or other immunization center were significantly associated with low immunization. Previous studies have highlighted the same issues in the uptake of immunization[18-22]. A possible explanation could be low literacy and less knowledge about the benefits of immunization. Literature shows that maternal education is an important and major determinant of immunization coverage because it facilitates understanding of the importance of complete immunization[15,20-23]. Moreover, it can be assumed that in urban areas, lack of time or the possibility of wage loss might discourage parents from taking a child for immunization. Thirdly, rural-urban migration is increasing which could be an important issue as an adaptation to a new socio-cultural environment resulting in inadequate immunization of children.

We found that children were better immunized at government than private hospitals. In India, immunization services are provided free of cost at public health facilities. However, private facilities charge for vaccines and services; which is associated with greater odds of a child being partially or unimmunized. Our findings are concordant with other studies conducted in India[15,17]. Some parents prefer private facilities due to convenient timings. It is important to take into account if immunization programs can be rescheduled to accommodate the working hours of parents[24]. Similarly, chances of immunization increase in joint families due to the presence of additional caregivers[17]. Likewise, the availability and proper maintenance of immunization cards could also serve as a reminder for immunization and allow parents or caregivers to adhere to the schedule. Not having an immunization card was also found in a similar study conducted in Gujarat[19]. Interestingly, service providers in urban areas had little influence on children being immunized. Our finding is similar with a study conducted in Bihar and Uttar Pradesh[25]. This could be ascribed to providers' inability to provide clear information, and counsel parents about immunization schedules, affecting both knowledge and motivation[26].

Recommendations: Going forward it will be necessary for immunization programs to move from a vertical to a more inclusive approach. It will be essential to address social determinants that affect not only childhood but health across the course of life. i. Community-based behavior change programs should be widely publicized to provide a better understanding of the benefits of complete and timely immunization and allay fears[23]. Providers should improve communication, acknowledge vaccine related fears, and counsel families to overcome common misconceptions and contextual barriers during routine immunization campaigns and as part of routine healthcare

services, including antenatal care for pregnant women. ii. Future research can be designed around the dangers of vaccine preventable diseases, rather than touting the benefits of immunization, thereby acting on the loss aversion of the human psyche. iii. Evidence-based strategies to strengthen the social and cultural determinants should be added to the National Vaccine Policy of India. An efficient and effective disease surveillance system with a strong political will can be established in resource-limited areas.

Limitations/Strengths: This research study is a large community-based study that provides an insight into the social and cultural factors associated with incomplete immunization of children in rural and urban areas. Due to the census sampling method, findings are generalizable. However, the poor availability of immunization cards which caused the researchers to rely on oral history could have led to an inaccurate estimate of childhood immunization status.

Conclusion

This study reveals the effects of sociodemographic factors on the immunization status of children in the Ahmedabad district. Our results suggest that vaccine hesitancy is a major contributor in the suboptimal uptake of immunization. To address sociodemographic issues and vaccine hesitancy, policy-makers should focus on optimizing the timing and proper dissemination of information in both rural and urban areas in order to improve the immunization status of children in the state of Gujarat and in India.

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