

**SOCIAL DETERMINANTS OF CHILD IMMUNIZATION IN THE
STATES OF RAJASTHAN, ODISHA AND MADHYA PRADESH
(INDIA): SPECIAL FOCUS ON SOCIAL GROUPS**

**Synopsis of the doctoral dissertation
submitted by**

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INTRODUCTION

Over the last three decades, immunization is the major focus of child survival programme and widely believed to be “the most cost-effective route to child’s better health” (WHO, 2004). However, immunization coverage remains very low in many developing countries, including India, a matter of considerable concern to governments. On the other hand, the fourth Millennium Development Goals (UN, 2007) emphasises hundred per cent of full immunization coverage among children aged 12-23 months. However, 23.5 million of the world’s children were not immunized with DPT3 and of these 8.7 million children are from India (UNICEF, 2008). According to UNICEF estimates, India has one of the lowest routine immunization rates in the world (UNICEF 2007), and this is because of large inter-provincial disparity (NFHS, 2007). If this inequality is conceptualized as a “measure of difference” in access or outcomes based on social or economic exposures such as wealth, education level and location of residence, then it could be termed as social determinants, which are the best predictors of health service access and health outcomes for populations. Recent systematic reviews addressing the reasons for under- or non-vaccination of children from low- and middle-income countries (Rainey *et al.*, 2011) and in India (Mathew, 2012; Nayar, 2007) also suggests social determinants may have a substantial impact on routine childhood vaccination.

Previous research studies identified numerous socio-economic and demographic factors at individual level as being associated with uptake of childhood immunization. Whilst much is known about systemic barriers viz., vaccine supply, distribution, costs, and provider skills (Casey, Thiede and Klingner, 2001); individual-level factors (poor understanding of immunization, suspicions, myths, and rumours); low maternal education (Luman *et al.*, 2003; Chhabra *et al.*, 2007); maternal employment and working outside the home; younger maternal age (Luman *et al.*, 2003); delivering away from a health facility and not possessing an immunization card (Suarez *et al.*, 2007) that determine immunization uptake. On the other hand, social group affiliation in India is considered broadly a proxy for socio-economic status (Nayar, 2007). Scheduled Caste (SC) and Scheduled Tribes (ST) and in some cases the Other Backward Castes (OBC) are considered as socially disadvantaged groups and such groups have a higher probability of living under adverse conditions (Nayar, 2007) and coverage of immunization among their children is observed to be low (IIPS, 1995; IIPS & ORC Macro 2002; IIPS & ORC Macro 2007). According to the third National Family Health Survey (NFHS, 2007), coverage of immunization at national level is significantly low among

Scheduled Castes and Tribes children (42% and 33%, respectively) as compared to children belongs to 'other caste' (54%).

Some researchers argue that the health and health behaviour are influenced by more intermediary health determinants such as education, occupation and other dimensions of socio-economic position (Galobardes *et al.*, 2006; Krieger *et al.*, 1997) rather than social group disparities (Dressler *et al.*, 2005). However, there is a necessity to recognize the contingency of the relations between social group affiliation and particular health outcomes (Smith, 2000) by controlling inequalities between social groups (Voko, *et al.*, 2009). If significant social group differences in child immunization remain even after controlling socio-economic characteristics, then it can be concluded that socio-economic position partially mediates the association between social affiliation and immunization uptake. This calls for an assessment of the effect of caste/tribe on intake of child immunization after controlling for the other socioeconomic and demographic factors. Understanding the effect of social determinants on routine immunization is important for the development of modalities to address them with the purpose of optimizing vaccination coverage, particularly among weaker sections of the society. With this background, this study attempts to examine the role of social determinants particularly, social group affiliation on the coverage of child immunization using the data from third National Family Health Survey (NFHS-3) in the three Empowered Action Group (EAG) states (*viz.*, Odisha, Rajasthan and Madhya Pradesh), where level of vaccination is low and child mortality (4q_1) is highest among 28 states of India.

OBJECTIVES

The principle objective of the study is to understand role of social determinants, particularly social group affiliation on child vaccination laying emphasis on Scheduled Castes/Tribes in the three EAG states of India. The specific objectives are as follows:

- To examine the differentials in coverage of different vaccines and patterns of partial vaccination (drop-out, left-out and missed-out of vaccinations) across social groups;
- To understand the effect of social determinants on child immunization, particularly the role of caste/tribe sequentially controlling for other risk factors;
- To understand whether social group affiliation and programme factors interact with each other in predicting child immunization; and

- To understand the effect of social determinants, particularly the role of caste/tribe and coverage of immunization on Vitamin A supplementation coverage, sequentially controlling for other risk factors.

CONCEPTUAL FRAMEWORK

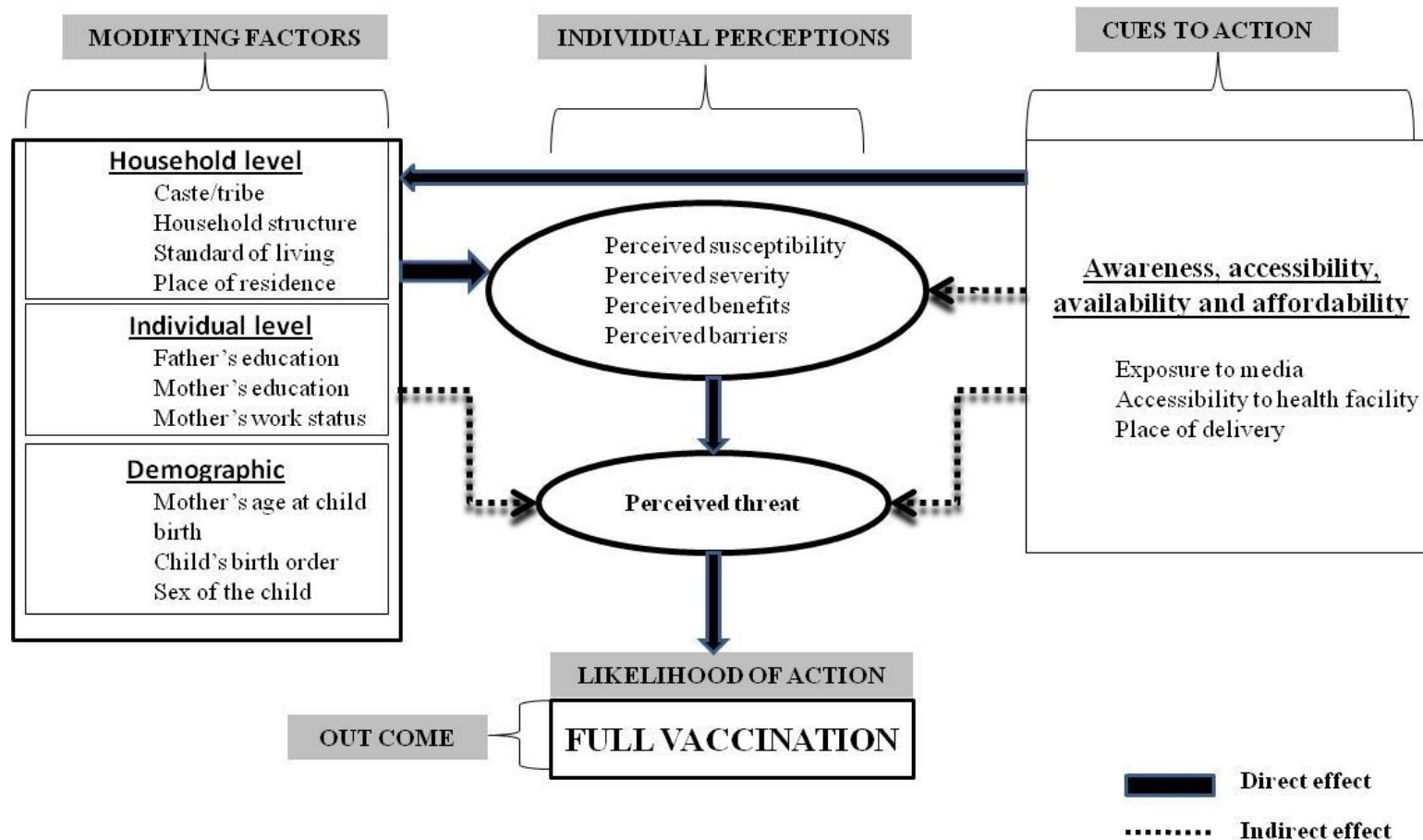
This study has been conceptualized based on two major conceptual models - health belief model (Rosenstock, 1990) and Tanahashi model for health services coverage (Tanahashi, 1978) to address the inequities in child immunization coverage between different social groups in the selected States of India. Both of the models primarily contain three aspects of health services coverage - modifying factors; individual perception and cues to action (related to coverage, availability, accessibility, acceptability and contact). Schematically both conceptual models are presented in Figure 1 and detailed description is given in the following lines.

The health belief model provides a set of constructs for identifying and understanding the multiple factors that influence the demand and delivery of a vaccine. It is an influential and widely used theoretical model initially developed by the U.S. Public Health Service (Rosenstock, 1974; Janz, Champion and Strecher, 2002). The key components of the model are: first, the perception of threat, which is conceived as two components: perceived severity and susceptibility to an adverse outcome; second, perceived outcome expectations, which are examined as perceived benefits and perceived barriers to performing a protective behaviour; and third, modifiers, which influence the individual's response to the model, such as socio-demographic factors and cultural beliefs. Modifiers are demographic, social or psychological in nature, that is likely to influence the health outcome resulting from some action. In this study, we have included social group affiliation as a principal factor and other socio-economic status, viz. level of education, or general health-related behaviours as other modifiers. The fourth component of this model is likelihood of the behavioural outcome. An important tenet of the health belief model is the idea of perceived threat, which is the combination of an individual's perception of severity of a health problem and that individual's perceived susceptibility of being affected by a potential health risk. Health beliefs and behaviour is the perception of outcome expectations — what a person feels will be the result of some action — considered as either perceived benefits or perceived barriers to achieving a desired outcome. Perceived outcomes of expectations are what persons feel to gain benefits from behavioural change or feel a negative impact of barriers from such behavioural change. The fifth construct of the model is cues to action. These factors promptly influence a person

to initiate the completion of a recommended behaviour change or action. It is a facilitative mechanisms and contexts for introducing a protective behaviour (Figure -1).

In health belief model, however, it was not determined what the cues to actions variables are. Therefore, at this point Tanahashi health service coverage model concept introduced, which expresses the extent of interaction between the health service and the people for whom it is intended. This model distinguished between four different levels of healthcare coverage, summarized as: (i) availability, (ii) accessibility, (iii) acceptability, and (iv) contact coverage.

Figure 1: Conceptual framework



Source: Rosenstock, 1990 and Tanahashi, 1978

HYPOTHESES

Two hypotheses ‘characteristics hypotheses’ and ‘interaction hypotheses’ used to elucidate pathways and mechanisms of influence household social affiliation (caste/tribe) on intake of child immunization. Specifically,

- Scheduled Tribe and Scheduled Caste children are least likely to be fully immunized. However, the caste/tribe affiliation by itself has little or no independent influence on child immunization rather it is the difference in the socio-economic and demographic composition of caste/tribe groups that largely accounts for observed differences in child immunization. (Characteristics hypotheses)’
- Social exclusion because of social group affiliation could be reduced through effective awareness generation and higher access to health facility among marginalized sections. (Interaction hypotheses)

METHODOLOGY

Data and study variables

The third National Family Health Survey (NFHS-3), a large-scale survey conducted in 2005-06, carried out by the Ministry of Health and Family Welfare (MOHFW), New Delhi and co-ordinated by International Institute of Population Sciences (IIPS), Mumbai provides the principal data for the study. NFHS-3 collected information from a nationally representative sample of 1,09,041 households, 1,24,385 women age 15–49, and 74,369 men aged 15–54 in all 29 states covering 99 per cent of India’s population (IIPS, Mumbai and ORC Macro, 2005. NFHS-3: India). Data used for the presented study confined to three major states (Madhya Pradesh, Odisha and Rajasthan) of India, because of their diversity in terms of social group composition, different ecological back drop and poor health status of children (infant and child mortality rates are highest in Odisha and Madhya Pradesh) and coverage of EPI vaccines lowest to medium.

Information on children collected in the NFHS-3 survey for those who had taken birth during five years preceding the survey from de-facto women aged 15–49 years used for the analysis. The sample excludes children whose mothers have died as well as those whose mothers are younger than 15 years or older than 49 years at the time of survey. According to the World Health Organization guidelines, children are considered fully immunized if they

receive 1 BCG vaccine injection to protect against tuberculosis; 3 doses each of diphtheria, pertussis, and tetanus (DPT) and polio vaccines; and 1 measles vaccine by age 12 months. To address the objectives, the current study focused on the children aged 12 to 59 months and restricted for the living children only, due to the lack of immunization information for children who died. Children who have not completed their first birth day had excluded from the study sample, because these children may not have received all the recommended doses. Valid data on immunization were available for 5,405 children (Rajasthan-1,519, Odisha-1,366 and Madhya Pradesh-2520) in the three study states, out of a total of 5887 children who had taken birth during five years preceding the survey.

The NFHS-3 data provides information on caste/tribe and most of the women belonged to one of the four castes, namely, Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Class (OBC), and those who are neither SC nor ST nor OBC and are designated as 'others'. From this information, different categories of caste groups are considered for the analyses. In addition to the caste/tribe, following other socio-economic (residence, household structure, household standard of living, father's education, mother's education, mother's work status) and demographic characteristics, (mother's age at the time of child's birth, birth order and sex of the child) were used as independent variables. Besides socio-economic and demographic characteristics, three proxy variables (exposure to electronic media, place of delivery and access of health facility to mother) were used as cues to action indicators, from the available NFHS data. Since the NFHS data does not provide direct indicator for perceptions, the outcome of perception may be determined from changes in outcome. Using the available data on women's constrains to access health facility in the NFHS-3, a composite index on mother's access to health facility (with three categories low, medium and high access) was constructed using the principal component analysis.

Statement 1. Methods and models adopted for analysis of data on immunization among children aged 12-59 months in three selected states (Rajasthan, Odisha and Madhya Pradesh) of India, using third National Family Health Survey (NFHS-3), 2005-06

Analysis of data: Methods and models		Variables used			
Model-1:	Caste/tribe	Effect of 4 categories of caste/tribe (SC, ST, OBC and OC)* Effect of 3 categories of caste/tribe (SC/ST, OBC and OC) Effect of 2 categories of caste/tribe (SC/ST and Others)			
Model-2:	Model 1+ Programme variables (Cues to action)	Caste, access to health facility, place of delivery, exposure to media			
Model-3:	Model 1 + Modifying variables (Other socio-demographic characteristics)	Caste, residence, household structure, household standard of living, father's education, mother's education, mother's work status, mother's age at the time of child's birth, birth order, sex of the child			
Model-4:	Model 1 + Model 2 + Model 3	Caste, residence, household structure, standard of living, father's education, mother's education, mother's work status, mother's age at child's birth, birth order of the child, sex of the child, mother's access to health facility, exposure to media, and place of delivery of the index child			
Dependant variables	Categories	Models/variables used	Caste/tribe	Techniques employed	Chapter
Women's access to health facility (Composite index) [Unit of analysis: Women aged 15-49]	Three categories of access - Low, medium and high (No Vs. High access; Medium Vs. High access)	Woman's constrains to access health facility and social determinants of access	4 categories	Principal component analysis, Reliability analysis, and Multinomial logistic regression	4
Vaccination card	Yes/No	Social determinants	4 categories	Logistic regression analysis	5
Coverage of vaccines	% specific vaccinations % dropout vaccinations % missed out vaccinations	Source of vaccination data and Caste/tribe	4 categories	Descriptive statistics	
Specific vaccinations	Received DPT-3: Yes/No Received Measles: Yes/No	Model 1, 2, 3 & 4 Model 1, 2, 3 & 4	4 categories	Logistic regression analysis	6
Immunization status**	No vaccination Vs. Complete; Partial vaccination Vs. Complete)	Model 1, 2, 3 & 4	3 categories	Multinomial logistic regression analysis	
Interaction effects of caste/tribe with program variables on immunization	Caste/tribe by exposure to media Caste/tribe by place of delivery Caste/tribe by access to health facility	Model 1, 2, 3 & 4 Model 1, 2, 3 & 4 Model 1, 2, 3 & 4	2 categories	Logistic regression analysis	7
Vitamin A Supplementation	Received - Yes/No	Model 5, 2, 3 & 4	3 categories	Logistic regression analysis	6
Analysis across:	Child's age: 12-23, 24-35, 35-47 months and caste/tribe	Model 4		Logistic and multinomial logistic regression analyses	Appendix

Notes: *Scheduled Castes (SC) and Scheduled Tribes (ST) are identified by the Government of India as socially and economically backward and needing protection from social injustice and exploitation. Other Backward Class is a diverse collection of intermediate castes that were considered low in the traditional caste hierarchy but are clearly above SC. 'Other caste' is thus a default residual group that enjoys higher status in the caste hierarchy.

**a). *Full Immunization*: Received all 6 doses of vaccinations (BCG + 3 doses of DPT + 3 doses of Polio + Measles); (b). *Partial Immunization*: Received at least any one of the vaccination; (c). *No Immunization*: did not receive any one of the vaccination

Analysis of data

The conceptual framework calls for examining the effect of caste/tribe after controlling the other socioeconomic and demographic factors on child immunization. For this purpose, both bi-variate and multivariate analyses along with reliability tests have been carried out. Dependent variables which have dichotomy in nature are analyzed with binary logistic regression, whereas dependent variables, which have more than two categories analyzed with multinomial logistic regression. Detailed information on methods adopted for analysis of data is presented in Statement-1. First, the gross differentials in source of vaccination data, coverage of specific vaccination, dropout during multiple doses of vaccines, left out during vaccination, missed out for only one vaccine, coverage of DPT-3, measles, vaccination status,, coverage of vitamin A supplement across the four caste/tribe groups are examined through bivariate analysis. Later, to examine the net effects of caste/tribe on dependent variables, different multivariate techniques (logistic and multinomial logistic regression analyses) were adopted with four models (Models 1-4), as mentioned in the Statement 1. Briefly, Model-1 assess the effect caste/tribe only; Model-2 contains caste/tribe (Model-1) along with three programme variables (cues to action); Model -3 caste/tribe (Model-1) along with other modifying variables (socio-demographic variables) and finally Model-4 contains all the variables from the three previous models (Model 1 + Model 2 + Model 3). Finally, to examine whether the social affiliation interacts with program characteristics, the interaction effects of caste/tribe with and three program variables on child immunization assessed. As the emphasis is on caste factor, findings are discussed in detail on the net effect of caste and other socio-economic, demographic and program factors on the dependent variables. Other explanatory variables have been used only to substantiate the findings or to develop the model, and are not discussed in detail.

Organization of thesis

The thesis is organized into eight chapters. Chapter -1 (Introduction) provides an introduction to the topic of research justifying the need for the study and also describes the background of the study. An exhaustive review of literature is furnished on various social determinants affecting routine immunization programmes in low, middle and high income countries, along with the relationship between caste/tribe and child immunization in Chapter - 2. The research questions, objective of the study, conceptual framework, hypothesis, sources of data, research plan, statistical methods used are described in Chapter-3 on Methodology.

Results from the analyses based on NFHS-3 data in the study states are provided in Chapters 4–7. Chapter-4 focuses on characteristics of study population in the three study States - Rajasthan, Odisha and Madhya Pradesh. This chapter has been distributed into two sections. Section 1 presents background characteristics (socio-economic and demographic characteristics) of mothers and children born during the five years preceding the survey. Section 2 presents programme (cues to action) characteristics of mothers, and an analysis on social determinants of mother's access to health facility.

Fifth chapter (gross differentials of child immunization coverage across social groups) presents differentials of immunization coverage across social groups with a comparative viewpoint between children of four social groups. This chapter also focuses on the coverage of specific vaccine by source of vaccination coverage data and causes of partial immunization and differentials across the social groups. In this chapter, social determinants of vaccination card coverage are also addressed.

Sixth chapter describes on the role of social determinants, particularly the caste/tribe on specific vaccines viz., third dose of DPT (DPT-3), measles vaccinations, immunization status (no/partial/full) and Vitamin A supplementation, in the three study states with four models, for each of the outcome variables. Finally, results from analyses of interaction effects between household's social group affiliation with programme variables (exposure to media, place of delivery and access of health facility to mother) on coverage of immunization are presented in the seventh chapter (Interaction effects of social groups with programme variables on child immunization)

The eighth chapter summarises all the findings from the study and gives a precise picture about child immunization coverage among children of scheduled caste/tribes in the selected study states of India along with limitations of the study and further research problems concerning the issue.

Overview of the study findings

The principal objective of the study is to understand how underlying socioeconomic disadvantage among social groups may influence the uptake of child vaccinations in the three EAG states (Madhya Pradesh, Odisha and Rajasthan) of India using the NFHS-3 data. A

summary of results from the analyses are presented in Statement-2 and discussed briefly in the following lines.

Among the three study States, the coverage of vaccines was highest in Odisha and lowest in Rajasthan. A striking disparity was observed between the scheduled caste/tribe and other caste groups, regarding the utilization of immunization services. Across the social groups, the coverage of specific as well as full immunization is lowest among children of STs. The result of this study confirms dropping out during vaccination as the main reason of this disparity, and this behaviour is also prevalent among SC/STs as compared to non-SC/STs. In the state of Rajasthan, dropping out during DPT vaccination (DPT1-DPT3) is observed to be 6.5%, 11.4% and 8.0% more among SCs, STs and OBCs, respectively than OCs. While in the state of Odisha, dropping out during polio vaccination (Polio1-Polio3) is 6.8% and 7.4% more among SCs and STs, respectively than OCs. In the state of Madhya Pradesh, left-out during BCG-measles vaccination is observed to be more for SCs, STs and OBCs by 11.7%, 16.7% and 5.7%, respectively than OCs. The result also shows that 11%, 17% and 12% of children had missed only one dose of vaccines in the states of Rajasthan, Odisha and Madhya Pradesh, respectively. If they had not missed this one dose, the coverage of fully immunized children in these states may have increased to 38% in Rajasthan, 64% in Odisha and 58% in Madhya Pradesh.

Significant gross differentials are observed between the social groups in the uptake of third dose of DPT – 38 to 40 percent point difference observed between STs and OCs children in the state of Rajasthan, Odisha and Madhya Pradesh. After controlling for other socio-economic, demographic and programme variables also, the differences persist across the social groups. For instance, the odds of uptake of third dose of DPT had changed for STs from 0.13 in Model-1 to 0.31 in Model-4, in the state of Rajasthan. While in the state of Odisha, it changed for STs from 0.37 to 0.67 between Models 1-4; and from 0.21 to 0.65 in Model 1-4 in the state of Madhya Pradesh, respectively.

Statement 2: A summary of the findings from bivariate and multivariate analyses on child immunization

Summary of findings on gross and net effects of caste/tribes on child immunization among children aged 12-59 months, Rajasthan, Odisha and Madhya Pradesh

Outcome variables	State	Gross differentials (in comparison to 'OC - Other caste')	
Coverage of vaccination - Full immunization (%Total)	Rajasthan	Less among SC, ST and OBC by 13.4, 37.4 and 20.2%, respectively (Total OC=44.8%)	
	Odisha	Less by 20.4% among ST children and the difference between OC and SC, OBC are small. (Total OC=50.1%)	
	Madhya Pradesh	Less among SC, ST and OBC by 17.8, 34.8 and 12.1%, respectively. (Total OC=62.1%)	
Drop-out between: DPT1-DPT3	Rajasthan	More among SC, ST and OBC by 6.5, 11.4 and 8%, respectively (total drop outs among OC=18.4%)	
	Odisha	More among SC, ST and OBC by 9.6, 6.5 and 6.2%, respectively (OC=9.1%)	
	Madhya Pradesh	More among SC, ST and OBC by 4.8, 7.9 and 3.0%, respectively (OC=16.5%)	
Drop-out between: Polio-1 and Polio-3	Rajasthan	Polio1-Polio-3 are small	
	Odisha	More among SC and ST by 6.8% and 7.4%, respectively (OC=17.0%)	
	Madhya Pradesh	More among SC and ST by 4.6% and 4.2%, respectively. (OC=5.6%)	
Left-out between: BCG-Measles	Rajasthan	Left out rates are more for SC, ST and OBC by 4.3, 19.6 and 7.1%, respectively. (Total OC=14.7%)	
	Odisha	Left out rates are more for SC and ST by 1.6, 6.1%, respectively (OC=11.5%)	
	Madhya Pradesh	Left out rates are more for SC, ST and OBC by 11.7, 16.7 and 5.7%, respectively. (OC=11.8%)	
Missed-out one dose of vaccination (%)	Rajasthan	5% of SC and 3% of OBC children missed one vaccine more	
	Odisha	Differences in comparison to 'Other caste' are small	
	Madhya Pradesh	Differences in comparison to 'Other caste' are small	
If not missed-out one dose of vaccination, total immunization (%)	Rajasthan	Increases by SC-13.5, ST-8.9, OBC-11.2, OC-8.5%, respectively	
	Odisha	Increases by SC-18.7, ST-14.7, OBC-16.5, OC-19.7%, respectively	
	Madhya Pradesh	Increases by SC-13.0, ST-10.6, OBC-11.9, OC-12.9%, respectively	
Outcome variables and categories	States	Gross differentials	Net effect of caste/tribe & changes in Models 1-4 (Ref: Other caste)
Third dose of DPT (DPT-3) vaccination - Yes/No [Logistic regression analysis]	Rajasthan	Less by SC-12.5%, ST-39.4%, OBC-18.9% (Total OC= 51.5%)	Net effect of caste changed for ST from 0.13 to 0.31(OR=odds ratio's in Models 1-4); 0.45-0.61 for OBC (M 1-2); OR=0.60 for SC (M-1); OR changed for ST from 0.37 to 0.67 (M1-3) OR changed for ST from 0.21 to 0.65 (Models 1-4); 0.49-0.70 for SC (M 1-2); OR=0.57 for OBC (M-1)
	Odisha	Less by ST-23.2%, SC and OBC are small (OC=69.7%)	
	Madhya Pradesh	Less by SC-16.4, ST-37.5, OBC-13.1% (Total OC=69.8%)	
Measles vaccination - Yes/No [Logistic regression analysis]	Rajasthan	Less by SC-12.6, ST-39.5 and OBC-15.7% (OC = 58.1%)	OR changed for ST from 0.16 to 0.35 (Models 1-4); 0.53-0.69 for OBC (M 1-2); OR=0.60 for SC (M-1); OR changed for ST from 0.41 to 0.66 (Models 1-3) OR increased for ST from 0.21 to 0.55 (Models 1-4); 0.46-0.63 for SC; OR=0.50-0.67 for OBC (Models 1-2)
	Odisha	Less by ST-20.9% (Total OC=70.0%)	
	Madhya Pradesh	Less by SC-16.0, ST-35.6, OBC-14.0% (Total OC=77.7%)	
Coverage of Vitamin A Supplementation - Yes/No [Logistic regression analysis]	Rajasthan	Less by 11.2%, 30.7% and 14.9% among SC, ST, OBC (Total OC=48.2%); non-immunized by 59% (fully immunized = 77.4%)	OR for ST 0.565 (M-1) and OR changed for non-immunized from 0.004 to 0.007; 0.084 to 0.106 for partially immunized (Models 1-4)
	Odisha	Less by SC-2.1%;ST-12.5%;OBC-5.7% (OC= 71.8); Non-immunized 22.2% and immunized= 78.4%)	
	Madhya Pradesh	Coverage less by SC-21.2%, ST-31.3%, OBC-12.0%; non-immunized 55.6% (OC=64.1% & immunized78%)	

Statement 2: A summary of the findings from bivariate and multivariate analyses on child immunization

Summary of findings on gross and net effects of caste/tribes on child immunization among children aged 12-59 months, Rajasthan, Odisha and Madhya Pradesh

Outcome variables	State	Gross differentials (In comparison to 'Other caste')	Net effect of caste/tribe & changes in Models 1-4 (Ref: Other caste)
Immunization status: <i>No vaccination</i> (No Vs. Full)	Rajasthan	Not immunized more: SC/ST-6.5% & OBC-3.6%; Fully immunized less: SC/ST-23.6% and OBC-20.2%	OR for No immunization changed for SC/ST from 4.42 to 2.65 (M1-2); 2.90-2.07 for OBC (in Models 1-2)
	Odisha	Not immunized more: SC/ST-3.5%; Fully immunized less among SC/STs by 12.9%	OR changed for OBC from 0.51 to 0.41 (M1-4); 1.65 for SC/ST (M 1)
	Madhya Pradesh	Not immunized more: SC/ST-4.3% and OBC-3%; Fully immunized less: SC/ST-27.3% and OBC-12%	OR changed 3.85 and 2.22 for SC/ST and OBC, respectively (M-1)
<i>Partial vaccination</i> (Partial Vs. Full)	Rajasthan	More among SC/ST and OBCs by 17%	OR for changed for SC/ST from 2.84 to 1.92; 2.44-1.84 for OBC (M 1-2)
	Odisha	Partial vaccination more among SC/ST by 9.5%	OR=1.73 for SC/ST
	Madhya Pradesh	Partial vaccination more SC/ST-23% & OBC 9.1%	OR changed for SC/ST from 2.99 to 1.81 (M1-2); 1.57 for OBC (M 1)
		Gross differentials	Net differences (in comparison to 'Non-SC/ST & High program')
Interaction effects of Caste/tribe with program variables on immunization	Rajasthan	Coverage of full immunization among SC/STs with poor, medium, high access less by 35.5%, 31.6%, and 13.6%, respectively; (coverage among Non-SC/STs with high access to health facility= 48.9%)	OR changed from 0.16 to 0.43 and 0.22 to 0.52 for SC/STs with poor/medium access; among non-SC/STs with poor/medium access, from 0.26 to 0.53 and 0.26 to 0.37 (Models 1-4); and for SC/STs with high access, OR =0.57 (M 1)
	Odisha	SC/STs with poor/medium/high access to health facility coverage less by 18.4%, 19.5 and 10.1%, respectively (% in Non-SC/ST with high access 54.5)	OR changed from 0.47 to 0.61 and 0.45 to 0.59 for SC/STs with poor/medium access (M 1-2); and for SC/STs with high access, OR =0.67 (M 1)
	Madhya Pradesh	SC/STs with poor/medium/high access to health facility coverage less by 31.1, 30.5 and 17.4%, respectively; (% in Non-SC/STs with high access 62.4)	OR changed for SC/STs with poor/medium/high access from 0.27 to 0.74, 0.28 to 0.70 and 0.49 to 0.75, respectively; among non-SC/STs with poor/medium access, from 0.45 to 0.73, and 0.64 to 0.79 (M 1-2)
<i>Caste/tribe and place of delivery (POD) on coverage of full immunization</i>	Rajasthan	SC/ST and non-SC/STs with non-institutional PODs were less immunized by 34% each; 23% less among SC/STs with institutional POD (non-SC/STs institutional 52.5%)	OR changed from 0.21 to 0.49 for SC/STs and from 0.21 to 0.61 for Non-SC/STs with Non-institutions POD (Models 1-4); and among SC/ST's with institutional POD, OR from 0.38 to 0.46 (M 1-2)
	Odisha	Less among SC/ST (23.3%) and non-SC/ST (7.8%) with non-institutional PODs; less by 4.4% among SC/STs with institutional POD (% non-SC/STs with institutional 57.5)	OR changed for SC/STs with non-institutional POD from 0.39 to 0.74 (Models 1-4); and Non-SC/STs and Non-institutional POD, OR=0.74 (M1)
	Madhya Pradesh	Less among non-institutional SC/ST (42.3%) and non-SC/ST (30.3%); 18.2% among SC/STs with institutional POD (% non-SC/STs with institutional delivery 18.2%)	OR changed for Non-institutional SC/STs from 0.16 to 0.47; Non-SC/STs from 0.27 to 0.58; and among institutional SC/ST's 0.47 to 0.63 (Models 1-4)
<i>Caste/tribe and exposure to media on coverage of full immunization</i>	Rajasthan	Less by about 31% each among SC/STs and non-SC/STs who were not exposed to media; 15% among SC/STs exposed (% in exposed Non-SC/STs=45.9%)	OR changed from 0.21 to 0.66 for SC/STs and from 0.20 to 0.50 for Non-SC/STs those were not exposed to media (Models 1-4); and among exposed SC/ST's, OR from 0.54 to 0.61 (M 1-2)
	Odisha	Less among unexposed SC/ST (28%) and non-SC/ST (8.6%); 11% among exposed SC/STs (% in exposed non-SC/STs=55.6%)	OR changed for SC/STs from 0.30 to 0.57 (Models 1-4); and Non-SC/STs OR = 0.71 (M 1) among not exposed to media; and among exposed SC/ST's from 0.64 to 0.73 (M 1-2)
	Madhya Pradesh	Less among SC/ST (39%) and non-SC/ST (30.5%) who were not exposed; 21% among exposed SC/STs (coverage among exposed Non-SC/STs=65.4%)	OR changed among not exposed SC/STs from 0.19 to 0.57; Non-SC/STs from 0.28 to 0.66; among exposed SC/ST's 0.42 to 0.72 (Models 1-4)

Similar results are observed for separate analysis on measles uptake of vaccination. The proportion of children who were not immunized or partially immunized were more among the children of SCs/STs (3.5% to 6.5% of children were not immunized and 12.9% - 23.6% fully immunized in the study states). Results from the multinomial logistic regression also show SCs and STs are significantly less likely to be fully immunized than that of other caste group children. Large differentials are observed between the OCs and SCs/STs and the changes in the net effect of social group affiliation even after controlling for other factors (Models 1-4).

With an eye to assess the effect of interaction between principal modifying factor and cues to action factors, an interaction analyses has been carried out using multivariate (logistic regression) analyses. The bivariate analysis shows clear distinction between SCs/STs and non-SCs/STs when observed with programme variables across the states. Exposure to electronic media, institutional deliveries and access to health facility were lower among mothers of SC/ST groups compared to mothers of non-SC/ST groups. However, the caste/tribe interaction with programme variables on the coverage of full immunization show a positive association with mother's exposure to (electronic) media, institutional delivery and higher access to health facility. Irrespective of caste/tribe affiliation, higher coverage of full immunization is observed among children of mothers who were exposed to electronic media, institutional delivery and having medium/higher access to health facility. However, the magnitude of differences is much lower for SCs/STs than non-SCs/STs children. For example, in the state of Rajasthan, the coverage of full immunization among SCs/STs with poor, medium and high access is less by 35.5%, 31.6%, and 13.6% points, respectively as compared to Non-SCs/STs with high access of health facility (49%). Similar results are observed from the multivariate analyses. The probability of full immunization coverage among children increases irrespective of social group affiliation, if the mothers were exposed to media or had an institutional delivery or had higher access to health facility.

In summary, results clearly show a strong effect of social group affiliation on the coverage of child immunization. Scheduled caste/tribes are significantly less likely to be fully immunized than the 'other' caste children in the three study states. However, results from multivariate analyses show that the caste/tribe affiliation *per se* does not operate independently on child immunization and it interacts with other socio-economic and

demographic and programme factors. This supports the characteristics hypothesis that posits that the observed social group differences in uptake of child immunization are largely due to the differences in demographic, social and economic composition of the social groups. Second, there is a clear evidence of learning by doing among 'scheduled caste' and scheduled tribe' mothers and also observed learning by doing is associated with availability, accessibility, affordability and awareness about child vaccination across the social groups. Although the scheduled caste/tribe children were significantly less likely to be fully immunized, mothers who have higher exposure to mass media or institutional delivery or access of health facility were found to be more likely to immunize their children. From the analyses, clear evidence of good exposure to mass media; institutional delivery and higher accessibility of health facility have favouritism in the demand for immunization services, particularly among SC's and ST's. Therefore, dissemination of information on maternal and child health care through these medium helps to increase parents consciousness about the availability health care services and increase demand for vaccine, without changing the service delivery.

Following three limitations have to be taken into account when interpreting results of this study. First, the vaccination status of children did not take into account valid or invalid doses (e.g. doses beyond the appropriate vaccination age for a given dose); secondly, the vaccination status was ascertained as documented in the health cards of the children and by caregivers recall, which may introduce some bias (over-estimating vaccination in some cases and under-estimating vaccination in others). Finally, a large number of variables and models have been used which may increase the number of occasions where, in spite of no true underlying relations observed odd ratios became statistically significant.

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