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Multilevel Modeling of District, Community and Individual Correlates to Public Health Facility Utilization for MCH Care

INTRODUCTION

The staggered economy and huge population demand have had great repercussions on India's health system. With the exception of few southern regions, and a few urban areas, there is a marked shortage of equipment and qualified personnel for meeting the need of maternal care. The country had an estimated 61 allopathic doctors per 1,00,000 population and of the total available doctors 52 percent were from southern states of Andhra Pradesh, Goa, Karnataka, Travancore-Cochin, Maharashtra and Tamilnadu and MCI Delhi contributed only 5 percent Medical Council of India, 2007). The national coverage for institutional births in India is only 47 percent and only 50 percent of pregnant women had three and more ante-natal Care (ANC). An estimated 71 percent of births in the country take place at home, especially in rural areas (DLHS 2007-08). The lack of obstetric services is alarming and this is compounded with shortfalls in essential medicines, inadequate financing, the lack of essential and supplies, and the poor connectivity of health facilities.

During the last 40 years, Andersen's Health Care Utilization Behavior model has been adapted to consider more system-level measures, focusing on the availability, accessibility and organization of services (Aday & Andersen, 1974). Further, studies have found that besides predisposing, enabling and need factors, the external program and provider-related factors also affect healthcare utilization (Aday & Awe 1997, Aday *et. al.* 2004). Phillips *et al*. (1998) found that studies that included environmental variables measured only urban/rural location, or region may have been imprecise proxies for more specific measures such as supply of services but not the actual measures.

Keeping this in mind the appropriate behavioral model for maternal health care utilization adopted for this study has included predisposing factors, enabling factors, need factors and environmental variables (Andersen 1995) so as to address the associated obstacles through different approaches. Environmental variables in this study include healthcare infrastructure characteristics, external environment factors, and community- level enabling variables.

Healthcare infrastructure characteristics include maternal care programs, available resources at health facility and their adequacy of health care facilities such as manpower, instruments and drugs supply which influence the accessibility and utilization. External environmental factors reflect the type of road, distance to health facility and location of village/district etc. and community-level enabling variables include attributes of the community where women resides which enable them to utilize facility for delivery. For example, women with higher education levels in the community (Andersen & Davidson 1996).

Hence, there is a need to examine the influence of household or individual characteristics, village and district level covariates on the utilization for the maternal care which incorporates the physical access to health services, health program and infrastructure availability at health facility as well. In view of the fact that the outcome delivery care is a key goal of the Safe Motherhood Program (SMP) that reflects the recommendations of the World Health Organization (WHO) for the detection and treatment of maternal health conditions and complications (WHO 1994) to reduce the maternal mortality (WHO 2004), this chapter will examine the community effect (between and within) on institutional delivery with multilevel modeling in order to link the MDG goals to improve the institutional birth

This study aims to focus on some research questions. First, what is the influence of health program measures and its adequacy (adjusting for predisposing, enabling, and need factors) on the use of health care services in EAG states? Secondly, this study analysis hopes to improve the understanding on how women's health-care-seeking behavior is shaped by the availability of health services program and community behavior so as to inform the development of strategies to improve the provision and use of maternal healthcare at district and community level.

LITERARURES

In the case of aggregate variables, the same determinant can have a different meaning and effect on the community than on the individual level, which has to be considered. Community-level variables are often proxies for a variety of factors, and thus "mixed bag" variables as described above, which means it is difficult to disentangle what the actual determinants are and how they act. Another study found that socio-economic and

demographic factors are stronger predictors of health care utilization than the availability and accessibility of health services (Marmot *et. al.* 1998, Kandel *et. al.* 2004). Existing studies have found that people living in the poorest neighborhoods are least likely to receive adequate care (Pearl *et. al.* 2001, Collins & Schulte 2003, Magadi *et. al.* 2003). With respect to the community effect on health facility utilization, earlier studies have found that people living in the poorest neighborhoods are least likely to receive adequate care (Pearl *et. al.* 2001, Collins & Schulte 2003, Magadi *et. al.* 2003).

Among these covariates, environmental variables are often measured at the aggregate level such as at state, district or village while other variables in the model are measured at the individual level. Therefore, other analytical techniques which take different levels into account are contextual, multilevel or hierarchical models and they may be used to specify the relationships among variables at different levels (Bryk & Raudenbush 1992, Gatsonis *et. al.* 1993, Iversen 1991). From a public health and programmatic perspective, it is important to analyze contextual factors affecting the use of health services at the community, institutional and policy levels. Since the effect of community level versus individual-level determinants of care-seeking is quite challenging, identifying the determinants for institutional delivery at individual level, village level and districts level may be different from determinants of expenditure on delivery. There are many ways in which community characteristics can affect the probability of a woman delivering with skilled attendance. These comprise intrinsically group level attributes such as the urban or rural nature of the community, community attitudes and norms concerning childbirth and characteristics of surrounding health facilities, including accessibility and quality. Furthermore, there are aggregate variables, such as the level of poverty or education in the community. The inclusion of contextual variables at different level may have implications to operationalize the improved results. We therefore included contextual variables, focusing on individual level, village and district level variation in the utilization which could facilitate the measurement and modeling complex relationships between variables.

Understanding community level factors in the study of maternal health care is important because individuals are nested within households and households are embedded in communities hence individual decisions can also be influenced by the characteristics of the

communities in which they live (Mackian *et. al.* 2003). Writing on the utilization of primary health care services, Rahman (2000) has demonstrated that a woman's decision to attend a particular health care facility is as a result of personal need, social factors and the location of services. More importantly, ecological perspectives suggest multiple levels of influence of physical and social environmental conditions on health behavior (Stokols 1996). Existing studies particularly in India have identified important predictors of maternal health care utilization, but their focus is mainly on individual demographic and household socioeconomic determinants. Nevertheless, some literature includes community characteristics that can influence service utilization for maternal care services, but are not related to health program and infrastructures.

Data and Methods

Sample size

The household and facility data from the DLHS III (2007-08), has been used for this study. Data has been obtained from the merged data file of women, village and facility and therefore the analysis is based on 55,043 births in the five years period preceding the survey of rural women from 5687 villages, 263 districts of EAG states.

Methodology

Most contextual studies based on individual level data have followed the multilevel analytical approach using the usual random coefficient multilevel models or alternating logistic regression (Leyland *et. al.* 2001, Preisser *et. al.* 2003). In the multilevel analytical approach, measures of association between contextual factors and health have their standard errors corrected for the non-independence of people within areas (Snijders & Bosker 1999). Furthermore, as Merlo (2001, 2005) has emphasized, multilevel models provide measures of variation based on random effects (such as area level variance or the variance partition coefficient) that inform us on the distribution of health outcomes across areas.

Multilevel-logit Model: Three level

Maternal care indicators, particularly institutional delivery has been considered in this study as outcome variable. Bivariate analysis is carried out with outcome variable by EAG states before processing the multilevel modeling. Delivery care is represented by a dichotomous variable coded as 1 for the institutional birth uptake and 0 otherwise.

Multilevel logistic regression was used for model delivery care outcome adjusting for environmental, district, neighborhood effects and socio-demographic background of mothers (Rasbash *et. al.* 2000 & 2001).This model accounts hierarchical structure of the data included by clustering of births to mother within villages (primary sampling unit), and villages within districts. Factors hypothesized to explain differences among individual births were modeled at level 1; and explanatory factors for between-neighborhood and between-district variation at level 2 and 3 respectively.

The multilevel logit-model used in the analysis is of the following form:

$$logit(\pi_{ijk}) = \log(\frac{\pi_{ijk}}{1-\pi_{ijk}})$$

$$= \beta_{0jk} + \beta_{ijk}I_{ijk} + \beta_{jk}P_{jk} + \beta_k D_k + \varepsilon_{ijk}$$

And $$\beta_{0jk} = \beta_0 + \upsilon_{0k} + u_{0jk}$$

where *i, j* and *k* indicates the levels 1, 2 and 3 respectively; π_{ijk} is the probability of uptake of maternal care of interest for the *i* th birth, in the *j*th village of *k*th district; and error term ε_{ijk} is assumed to follow normal distribution.. Further I, P, and Dare the vector of mother (individual), village (PSU) and district level covariates respectively. While, υ_{0k} and u_{0jk} are random intercept of "between district" and "between villages" variance respectively which follow a Normal Distribution with mean zero and their covariance matrix for three-level model. The variation described by between-district and between-village is measured through proportion of total residual variance attributed to each level called Variance Partition Coefficient (VPC).

For the maternal care outcome, two versions of the multilevel model were considered to examine the effect and significance of individual, village and district level factor on the maternal care of interest. In each version of the model, the neighborhood-level random intercept represents the extent to which outcomes vary between neighborhoods after adjusting for confounders at different levels. Other factors have not been considered in the model including those which could not be readily quantified in a large-scale survey, such as neighborhood variations in beliefs about delivery care. The results from these models are presented in the form of odds ratios.

Variables description

Based on the Anderson's framework of health service utilization, variables from three-level model were identified as predisposing, enabling, need and environmental factors. The following are the variables chosen at each level and Table 1 explains the description of each variable in model. MLwin 2.11 version was used to get results from multilevel modeling.

Individual-level: Children's mother's socio-demographic characteristics like the level of education; age at birth; caste, childcare burden; working status; husband education; information received on ANC/institutional birth; relative socio-economic status (household wealth quintile), JSY received, at least 3 ANC received; and child birth order. Also, delivery complications and any pregnancy loss in last five years have been considered as need factors of the Anderson's framework. All individual-level variables were coded categorically.

Neighborhood-level (villages or PSU) variables: In this study primary sampling units (PSUs) which are sampled villages are considered as neighborhood and that could be divided into two parts, one is accessibility and availability of the health center from the village; and the other is related to health program variables in the village or near to village. Accessibility and availability variables are all weather road connectivity to health center and distance to the nearest public hospital. Program variables are: concentration of population educated to secondary or higher level, ANM availability and skilled health attendant facilitating ANC available in village, improved status of HSC/PHC/CHC health facility adequacy indices (physical infrastructure, health personnel, essential drugs and equipments, instruments at PHC and HSC level). All variables are coded categorically.

District level variables: Few variables are chosen at the district level which may have more influence on outcome variable like percent urban population, percent proportion of households belonging to the lowest wealth quintile (household assets based) and the average number of deliveries at HSC and PHC.

Results and Discussion

Characteristics of the sample

Table 1 shows descriptive statistics of district, village and individual levels correlates of institutional delivery included in the regression. Neighborhood-level (village) variables capture the ability of potential users to physically be able to reach health services. In the districts of EAG states, on an average, only 14 percent of the population belongs to urban and 28 percent of households belong to lowest wealth quintile. About a 7 percent concentration of people are educated to secondary or higher level in the village. While looking into the program factors and utilization among them, there is a shortage of skilled ANMs as only 30 percent of them have been trained in maternal and child health care including delivery. Sixty five percent of villages have functional PHCs and about 86 percent are connected by all-weather roads to the nearest health center. 54 percent of villages observed a good improvement in HSC/PHC/CHC services in past few years. However only 5 percent said the improvement was very good. Progressively, 50 percent PHC have more 3/4th health personnel availability, 73 percent PHCs are well adequate with essential drugs while on the other hand only 33 percent of PHCs and 37 percent of HSCs are well equipped (upper 3rd adequacy quintile) with essential equipments/instruments/laboratory services required for maternal care and physical infrastructure respectively.

Nearly 49 percent women were up to 25 years of age at the time of births, 37 percent belonged to SC/ST caste followed by 48 percent from OBC caste. 40 percent of women had the birth of second order, and majority of women, about three in every four, already had one other child below five years of age. Unfortunately, 65 percent women were non-educated while 22 percent had more than 5 years of schooling. Their husbands had better education levels. Even though 34 percent were non-educated, 58 percent had more than 5 years of education. Working and non-working women equally share the proportion in the population.

Further, little information on maternal health programs was considered to see differentiation in the utilization pattern. Government programs on delivery care successfully reached women either through media, health personnel or some other sources. About 2/3rd women had been informed about delivery care and about one in four had utilized at least 3ANCs (as suggested under RCH the program for better maternal care). Only 10 percent women benefited from JSY (incentives for the delivery) who delivered especially in a health institution.

Bivariate results

Table 2 describes the percentage of delivery care of women by indicators of physical accessibility and adequacy indices of health services in the village or community. States like Uttaranchal, Rajasthan, Orissa and Madhya Pradesh which showed the highest, i.e. more than 50 percent institutional births among women had gone for at least 3 ANC visits while least progress was observed in Jharkhand (29%) and Chhattisgarh (19%). Accessibility to health center definitely played a very important role in the utilization of services and this has been estimated to have a negative association. The propensity for delivery care significantly decreases as distance from women's place to a public health center increases, especially increased more with 30 kilometers or more distance in all the states. Minimum utilization was observed significantly in states Jharkhand and Chhattisgarh followed by Uttaranchal and UP.

Role of ASHAs in the village is more prevalent for the utilization when compared with ANMs residing in the village. This could be because the ASHAs have the responsibility of interacting more with the women in the village. Similarly, drugs adequacy and physical infrastructure availability does not make a difference in the states for utilization except for Orissa and Madhya Pradesh while adequate laboratory services/equipments required for delivery care has shown more the utilization in improving states including Uttaranchal and Bihar. However, adequate physical infrastructure at HSCs attracts more women for the utilization in the states of Uttaranchal, Bihar and Orissa. Maximum utilization and delivery at HSC/PHC/CHC was observed in same improving states.

Multilevel-logit results

Multilevel model was performed to see the effect on utilization due to "between village" and "between district" level variations. In three-level model, Model 1 includes mother (or women inter-changeable[1]) characteristics assuming as predisposing, enabling and need factors; model 2 is done with program variables assuming as environmental and community factors and model 3 (full model) includes all the three level variables in the multilevel analysis (Table 3).The random intercept model indicates that almost 55 percent of the district level and 45 percent of village level variation was accounted for the individual characteristics in the model and this variation moderately increased at district level, once external characteristics, namely accessibility of health centers, availability and adequacy of community (village) health program variables factors were included in the model; conversely village level variation increased.

*Individual effect Model 1 (predisposing, enabling and need factors):*Except for caste, working status of women and primary level of education (less than 5 years of schooling), effect of all individual characteristics is significant at each level of hierarchy. Increasing age at birth increases the utilization of health institution for birth since the risk of complications during delivery increases as the age of a woman increases. Non-SC/ST caste has a higher likelihood of institutional utilization while increasing birth order and child care burden has decreased the likelihood to have institutional birth. Between districts and between villages variation for service utilization was found to be 10 percent and 12 percent respectively.

Village-level effect model 2 (program variables): village level includes external environment and community health program variables (Table 3). Here an external environment resembles the accessibility and availability of the health center. Health program (NRHM) has ground level inclusion of health personnel's involvement in the community, functional and infrastructure available to public health center. Accessible and nearer public health centers significantly increased the odds for utilization in presence of all controlled variables. As the distance increases, utilization decreases and there is a 50 percent less likelihood of having an institutional delivery once the distance to public health center increases to 10kms or more. Additionally, the presence of skilled ANMs in the village, functional PHC and observed improvement in HSC/PHC/CHC (in last one year) have had a positive influence and

[1] *Since one child correspond to women so women is unit of analysis and so women characteristics is taken.*

significantly lead to a higher probability of utilization compared to their counterpart. Infrastructure adequacy has a different impact on the utilization and a weaker association was found with most of the infrastructure indicators. Though, adequacy (upper 3rd quintile) of essential equipments/laboratory services at PHC required for maternal care only showed a significant effect on the utilization and effectively, increasing number of delivery at primary health care (PHC and HSC) has shown a higher likelihood of institutional delivery which could be a good indicator of improving rural health programs."Between districts" variation was found to be 15 percent while "between villages" variation was observed as 10 percent only while considered the program variables in the three-level model.

Full model (model 3):

Full model includes all the variables at three level and similar results were obtained as in model 1 and 2. There were only a few changes in the values of odds in analogous manner with respect to enabling, need and accessibility factors while most of the community program variables weaken its influence. Only improved public health facilities and to a certain extent adequate equipments/laboratory services at PHC, have an ability to positively influence the use of delivery care. On the other hand, district variables like percent of relative neighborhood poverty, percent neighborhood higher education (12th standard and more) and percent urban have a great influence on the utilization. Higher education has shown a 74 percent increase in the utilization by increasing one percent change in higher educated population percentage in village. A significant increase has also been observed in institutional delivery if women belong to a more urbanized district and less utilization if women belong to poorest (lowest WQ) districts. Among whole variation, inter district variation was found to be more (14 percent) as compared to a 11 percent variation for "between villages" for the service utilization, once controls for all the three-level covariates in the model were applied.

Figure 5.1 showcases the full model residual map (three level logit-model) with the confidence interval range (at 5%) and **figure 5.2** showcases the normal probability plot for the outcome variable institutional delivery by districts of EAG states. Values were identified in the MLwin plot for the districts and lowest was identified for district Bilaspur from

Chhattisgarh state and district Baran from Rajasthan state which have the maximum residual value score.

Conclusions

The main purpose of the multilevel model is to examine the inter-district and inter-village variation of utilization services for institutional births. First part of the analysis from bivariate result for utilization by states demonstrates that not only improving states Rajasthan, Orissa and Madhya Pradesh have improved in utilization but satisfactory more prevalence of utilization was also found importantly in Bihar and Uttaranchal. Easy and throughout year connectivity of village to the nearest health center was significantly more associated with institutional births. Percentage of births to women living far (more than 30 kilometers) from a hospital was found be extremely less compared to nearer ones. A higher number of women opted for institutional births, especially those who had three or more ANC visits, who had information on delivery care and had received the JSY incentives for the institutional delivery. Hence, this explains how accessible government health center and health program have been significant in reaching end users which encourages delivery care utilization. This study support despite the predisposing and enabling covariates; accessibility and delivery care program factors are also stronger predictors of delivery care utilization (Marmot 1998, Kandel 2004).

Doctor's availability and other health personnel at PHC have not created much difference in 3the utilization. The percentage of institutional delivery was found be slightly higher with the adequacy of other infrastructure (more than 60% adequate)like adequacy for drugs, physical infrastructure and for adequate laboratory services/equipments in the improving states of Orissa, Madhya Pradesh and Rajasthan, in addition to Uttaranchal and Bihar. This finding may be due to the fact that many rural health centers are poorly staffed, offer a limited range of services, and typically lack the special equipment, supplies, and medicine needed to provide delivery care and findings are similar to the study of PAHO (2002).

Three-level multilevel model explains the variation in utilization by "between village" and "between district" after controlling individual, village and district level covariates. The random intercept model indicates that almost 55 percent of the district level and 45 percent

of village level variation was accounted for the individual characteristics in the model and this variation is moderately increased at district level once external characteristics namely accessibility of health centers, availability and adequacy of community (village) health program variables factors included in the model, while village level variation increased by few percentages. Except for caste, working status of women and primary level of education (less than 5 years of schooling), effect of all individual characteristics is significantly effect at each level of hierarchy. Working women are probably more engaged in labor or agricultural work and their work does not allow them to go to facility for delivery because of the time and work pressure involved. Government maternal health care programs effectively influenced the awareness for delivery care and ante-natal care (ANC) for the institutional births.

Accessible and nearer public health center significantly increased the odds for utilization in presence of controlled all the variables. is a major factor to discourage the utilization, a rapid decline of more than 50 percent observed in utilization was found once distance to public health center increases from 10km and more. Available adequate infrastructure at primary health care (HSC/PHC) has not captured its strong influence in the model may be because of non-inclusion of upper level public health center (CHC and DH), however at some extent it explains the effect of skilled ANM in village, observed improvement in any public health center (in last one year) to increase the probability of utilization. Adequacy of essential equipments/laboratory services at PHC required for maternal care only somewhat shows an impact on the delivery care compared to inadequate facility. Effectively, more number of deliveries at primary health unit (HSC and PHC) is associated with the more institutional births that could be a good indication of improving rural health programs.

Relative neighborhood poverty at district level, percent community higher education (12^{th} and above years of schooling) and percent urban has great influence on the utilization. More urbanized district encouraged and economically poorest districts discouraged women for institutional births. Results support the findings of the study done by Pearl (2001), Collins and Schulte (2003) and another by Magadi (2003).Inter district variation was found to be higher than inter villages variation for the utilization once controls were put in place for all the three level variables in the model.

This study explores the community and district variation including health program and accessibility factors. It suggests that apart from women characteristics which hinder the utilization, barriers of accessibility and inadequate infrastructure of services have considerably reduced the institutional births. Therefore, an attempt to increase maternal care-seeking behavior in rural India will require resources to be targeted at the most inadequate health centers, particularly essential equipments/laboratory services at PHC, for delivery care and encouraging pre-natal care strategy of integrating with referral unit, monitoring and proper communication to strengthen the existing program effectively and enhance the utilization in all states uniformly those not yet reached. Increasing the proportion of women care in health facilities and the number of skilled health providers (ANM) during pregnancy and childbirth is critically important for improving the health of mothers and new born babies. Study suggests that the mere availability of health facilities is necessary but not sufficient condition to promote use if the quality of service is inadequate and inaccessible considering the inter-districts variation for the program implementation.

Table 1:Unweighted summary statistics of variables used in modeling maternal health care					
Predisposing factors:		**Scale**	**Level**	**Mean**	**SE**
Age at birth	<25 years	Categorical	Individual	0.49	0.002
	25-29 years			0.29	0.002
	30 and above years			0.22	0.002
Caste	SC/ST	Categorical	Individual	0.37	0.002
	OBC			0.48	0.002
	Others			0.14	0.001
Birth order	One	Categorical	Individual	0.25	0.002
	2-3			0.40	0.002
	3 and more			0.35	0.002
Child care burden (additional child <5 years old)	No another child	Categorical	Individual	0.03	0.001
	One another child			0.71	0.002
	2+ children			0.27	0.002
Working women	No	Categorical	Individual	0.51	0.002
	Yes			0.49	0.002
Enabling factors:					
Education	No education	Categorical	Individual	0.65	0.002
	<5 years			0.07	0.001
	5-9 years			0.21	0.002
	10 and above			0.07	0.001
Husband education	No education	Categorical	Individual	0.34	0.002
	<5 years			0.08	0.001
	5-9 years			0.35	0.002
	10 and above			0.23	0.002
Information on institutional delivery	No	Categorical	Individual	0.31	0.002
	Yes			0.69	0.002
JSY received	No	Categorical	Individual	0.91	0.001
	Yes			0.09	0.001
3 and more ANC	No	Categorical	Individual	0.73	0.002
	Yes			0.27	0.002
Wealth quintile	Poorest	Categorical	Individual	0.36	0.002
	Second			0.29	0.002
	Middle			0.18	0.002
	Fourth			0.12	0.001
	Richest			0.05	0.001
% household with higher education in village	12th and above education	Ratio	Village/PSU	0.07	0.073
% urban by dist		Ratio	District	0.146	0.104
% poorest household by dist		Ratio	District	0.278	0.157

Cont… Table 1					
Need factors:					
Pregnancy loss in last 5 years	No	Categorical	Individual	0.92	0.001
	Yes			0.08	0.001
Problem during delivery	No	Categorical	Individual	0.29	0.002
	Yes			0.71	0.002
Environmental factors					
A) external environment factors:					
Public health center accessible throughout the yr	No	Categorical	Village/PSU	0.14	0.002
	Yes			0.86	0.002
Private health center accessible throughout the yr	No	Categorical	Village/PSU	0.15	0.002
	Yes			0.85	0.002
Distance to public health center providing delivery care	<10 km	Categorical	Village/PSU	0.68	0.002
	10-30km			0.30	0.002
	30+ km			0.02	0.001
B) community health program variables:					
ANM in village (<5km)	No	Categorical	Village/PSU	0.36	0.002
	Yes			0.64	0.002
Skilled ANM (skill attendant)	No	Categorical	Village/PSU	0.70	0.002
	Yes			0.30	0.002
Functional PHC	No	Categorical	Village/PSU	0.35	0.002
	Yes			0.65	0.002
Improved public health facility (SC/PHC/CHC)	Not good	Categorical	Village/PSU	0.40	0.002
	Good			0.54	0.002
	Very good			0.05	0.001
Manpower adequacy at PHC	<60 % (3rd quintile)	Categorical	Village/PSU	0.50	0.002
	>60 % (3rd quintile)			0.50	0.002
Drug adequacy at PHC	<60 % (3rd quintile)	Categorical	Village/PSU	0.27	0.002
	>60 % (3rd quintile)			0.73	0.002
Equipments/lab services adequacy at PHC	<60 % (3rd quintile)			0.67	0.002
	>60 % (3rd quintile)			0.33	0.002
Infrastructure adequacy at HSC	<60 % (3rd quintile)	Categorical	Village/PSU	0.63	0.002
	>60 % (3rd quintile)			0.37	0.002
Average number of delivery at SC/PHC by district		Ratio	District	37.6	52.4

Table 2: Percent institutional delivery in presence of health program variables in EAG states									
Program variables		**Uttaranchal**	**Rajasthan**	**UP**	**Bihar**	**Jharkhand**	**Orissa**	**Chhattisgarh**	**MP**
A) delivery program									
ANC visit*	No or <3	15.6	33.0	17.8	22.5	7.1	24.7	7.1	32.2
	3+	52.0	65.9	37.8	42.8	28.7	53.4	18.8	59.3
Information on institutional delivery*	No	16.1	29.5	13.2	17.6	8.1	18.2	6.0	25.3
	Yes	29.7	43.1	25.7	34.6	17.4	42.4	14.4	44.0
JSY program in village*[@]	No	22.3	45.4	19.4	24.9	12.1	31.7	9.0	31.1
	Yes	28.6	40.4	23.5	28.8	14.0	45.3	13.7	40.9
B) Accessibility and proximity to health services:									
Nearest public Health center providing delivery care*	<5km	29.4	46.8	23.9	33.0	18.3	41.0	16.7	39.5
	5-15km	24.7	41.4	20.6	26.7	12.8	38.9	13.9	43.2
	15-29km	21.1	32.6	17.5	19.5	11.3	30.3	6.5	39.1
	30km & above	11.0	17.0	15.5	22.8	8.6	19.1	4.6	18.5
Accessible public HC throughout the year*	No	10.3	33.7	15.2	21.4	10.7	33.1	11.1	34.8
	Yes	29.0	40.8	22.1	30.0	13.3	40.3	13.0	40.9
Accessible private HC throughout the year*	No	13.6	36.0	14.9	21.5	12.0	30.8	10.7	35.2
	Yes	28.6	40.8	22.2	29.9	13.2	40.6	13.2	41.0
C) program under state program to encourage service utilization:									
ASHA in village*	No	26.7	39.1	20.7	26.5	13.2	36.6	12.4	38.3
	Yes	25.7	42.1	23.2	29.1	12.6	43.3	13.2	41.8
ANM residing in village*	Outside &>5 km	27.2	43.5	21.0	27.3	11.9	43.8	12.9	41.7
	residing <5 km	26.1	39.3	22.4	27.8	13.5	38.9	12.5	38.3
Skill ANM*	No	26.0	39.8	21.4	26.8	13.1	38.3	12.2	39.2
	Yes	27.3	45.2	23.1	29.3	13.1	53.3	14.1	41.8
Doctor available at PHC*	No	20.1	37.1	21.2	24.3	5.7	45.1	12.1	39.5
	Yes	28.0	42.5	21.9	27.8	13.4	38.1	13.0	39.6
Manpower adequacy at PHC*	<60 % (3rd quintile)	28.2	39.1	22.1	28.2	10.9	45.1	12.3	38.0
	>60 % (3rd quintile)	14.4	44.0	21.3	27.1	13.3	36.2	14.2	42.7

Cont….. Table 2									
Drugs adequacy at PHC*	<60 % (3rd quintile)	24.4	40.1	21.3	29.7	16.1	34.1	12.2	37.3
	>60 % (3rd quintile)	26.8	40.8	22.0	26.8	12.4	51.7	12.8	42.3
Physical infrastructure adequacy at PHC*	<60 % (3rd quintile)	35.3	36.1	22.1	31.1	11.5	42.7	12.4	42.1
	>60 % (3rd quintile)	25.0	41.1	22.0	27.6	13.9	53.1	13.8	41.3
Essential instruments & laboratory services adequacy at PHC*	<60 % (3rd quintile)	26.2	40.0	21.8	27.2	12.6	39.7	13.0	37.6
	>60 % (3rd quintile)	29.0	45.5	21.7	33.0	13.5	40.7	11.6	42.3
Infrastructure adequacy at HSC*	<60 % (3rd quintile)	21.9	42.3	21.7	27.3	12.6	38.1	10.5	39.2
	>60 % (3rd quintile)	28.4	40.0	21.9	36.7	14.1	44.8	13.2	40.0
Number of deliveries at HSC & PHC in district*	Less than mean	26.4	39.9	22.1	26.3	13.0	39.5	12.4	40.0
	More than mean	26.4	46.0	20.0	28.2	13.5	41.8	16.2	39.1
Note: Tests of independence are based on Pearson Chi-square test; *p<0.05; @: based on JSY beneficiary in last one year									

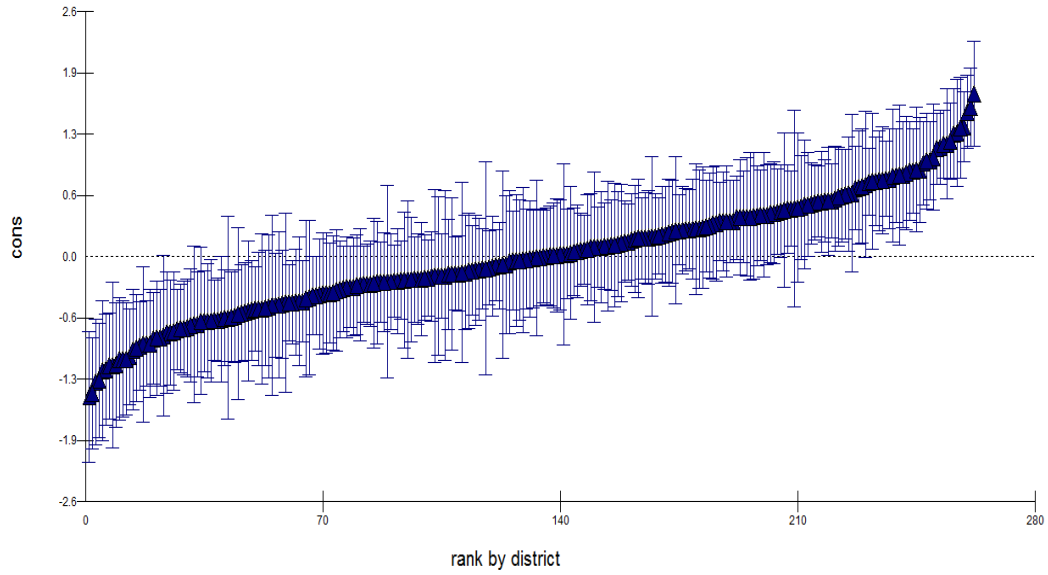

Fig 5.1: Residual plot for the district of EAG states (Multilevel-Logit Model)

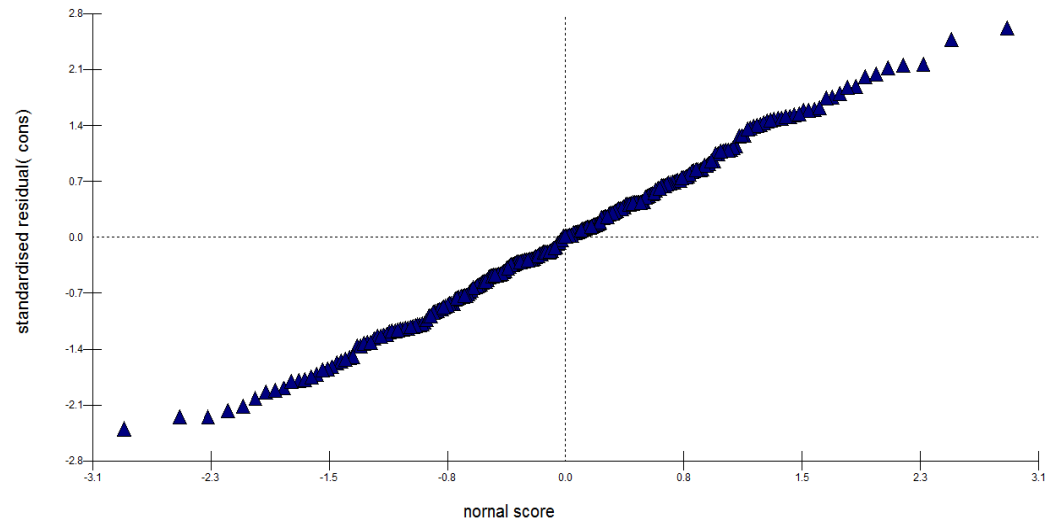

Fig 5.2: Normal plot for standardized residuals and normal scores

Table 3: Three level model: Multilevel weighted logistic regression estimates for institutional births, EAG states, 2007-2008							
		Model 1		Model 2		Model 3	
		odds	CI	odds	CI	odds	CI
Enabling factors:							
Information on institutional delivery	No[@]						
	Yes	1.71***	(1.79-1.63)			1.70***	(1.78-1.62)
3 and more ANC	No[@]						
	Yes	2.43***	(2.49-2.37)			2.43***	(2.49-2.36)
Wealth quintile	Poorest[@]						
	Second	1.31***	(1.39-1.23)			1.30***	(1.38-1.22)
	Middle	1.57***	(1.66-1.48)			1.53***	(1.62-1.43)
	Fourth	2.08***	(2.19-1.97)			2.00***	(2.11-1.89)
	Richest	3.59***	(3.74-3.44)			3.37***	(3.52-3.22)
% household with higher education						74.59***	(75.0-74.16)
% urban by district						2.20***	(3.08-1.32)
% poorest household by district						0.41***	(1.08-(-0.268))
Need factors:							
Pregnancy loss in last 5 years	No[@]						
	Yes	1.57***	(1.68-1.45)			1.55***	(1.67-1.43)
Problem during delivery	No[@]						
	Yes	1.60***	(1.67-1.53)			1.61***	(1.68-1.54)
Environmental factors							
A) external environment factors:							
Public health accessible	No[@]						
	Yes			1.02	(1.17-0.87)	1.04	(1.23-0.84)
Private health center accessible	No[@]						
	Yes			1.09	(1.25-0.93)	1.08	(1.26-8.89)
Distance to public health center providing delivery care	<10 km[@]						
	10-30km			0.69***	(0.74-0.64)	0.86***	(0.94-0.77)
	30+ km			0.52***	0.64-0.40)	0.68***	(0.98-0.38)
B) community health program variables:							
ANM in village (<5km)	No[@]						
	Yes			1.01	(1.07-0.95)	1.00	(1.07-0.92)
Skilled ANM (skill attendant)	No[@]						
	Yes			1.12**	(1.17-1.07)	1.07*	(1.15-0.99)

Cont….. Table 3							
Functional PHC	Yes[@]						
	No			0.90***	(0.96-0.84)	1.03*	(1.12-0.94)
Improved public health facility (SC/PHC/CHC)	Not good[@]						
	Good			1.16***	(1.23-1.09)	1.02	(1.09-0.94)
	Very good			1.21***	(1.35-1.07)	1.10*	(1.26-0.94)
Manpower adequacy at PHC	Less than 60 % [@]						
	More than 60 %			1.00	(1.05-0.95)	1.00	(1.09-0.90)
Drug adequacy at PHC	Less than 60 % [@]						
	More than 60 %			0.85***	(0.92-0.79)	0.89	(0.98-0.79)
Equipments/lab services adequacy at PHC	Less than 60 % [@]						
	More than 60 %			1.24***	(1.32-1.16)	1.09**	(1-19-0.98)
Infrastructure adequacy at HSC	Less than 60 % [@]						
	More than 60 %			1.14	(1.21-1.07)	0.94	(1.02-0.85)
Average number of delivery at SC/PHC by district (log)				1.18***	(1.22-1.14)	1.31**	(1.35-1.26)
Fixed Part							
Cons		0.047***	(0.047-.047)	0.209***	(0.39-0.04)	0.054***	(0.47-(-0.362))
Random part							
District level variance		0.543	(0.655-0.431)	0.681	(0.813-0.549)	0.471	(0.571-0.371)
Village level variance		0.449	(0.507-0.391)	0.479	(0.523-0.435)	0.449	(0.507-0.391)
Variance partition coefficient (VPC)							
Between district		0.105		0.153		0.142	
Between PSU		0.127		0.108		0.107	
-2*log likelihood:		**13076.6**		**12787.0**		**12681.0**	

Note: controlling for other predisposing (age at birth, caste, birth order, child care burden, working status) and enabling factors (women's education, spouse education) @: reference category; SE: standard error; *p<0.1, **p<0.05, ***p<0.01

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