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Original Article

Statistics Section

Identification of Predictors for Late or No Registration of Pregnancy by Selecting an Appropriate Logistic Model after Comparing ANC Visits and Skilled Birth Attendant

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ABSTRACT

Introduction: India is a major contributor to both maternal and neonatal death worldwide. Majority of these fatalities can be averted by adequate utilisation of Antenatal Care (ANC) services. Large scale surveys like National Family Health Survey follow hieratical characters in which subjects within the clusters are often correlated. The ordinary logistic model ignores this correlation and provide compromised estimate of effect size of predictors. Multilevel model that incorporates correlation is the appropriate method.

Aim: To demonstrate the adequacy of multilevel logistic model over ordinary logistic model in hieratical data sets with ANC visits ≥4 and delivery assisted by Skilled Birth Attendant (SBA).

Materials and Methods: This retrospective, cross-sectional study was conducted at the Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India, from October 2021 to March 2022. The data of 174607 women, who delivered the children within five years, obtained using cluster sampling, from country wide survey during 20th January 2015 to 4th December 2016 (India's National Family Health Survey-IV) was used. Firstly, the model adequacy of ordinary and multilevel logistic models was evaluated for ANC ≥4 visits and delivery assisted by SBA, the same data set of fourth round National Family Health Survey by considering the outcomes;. Thereafter, predictors of late or no registration of pregnancy were identified using three level logistic model.

Results: Because of high Variance Partition Coefficients (VPC) at state and district levels, the multilevel model applied on components ANC ≥4 visits and delivery assisted by SBA suggested better accuracy of the multilevel logistic model (-2Log L=189334 for ANC ≥4 visits and 141148 for delivery assisted by SBA) than the ordinary logistic model (-2Log L=220268 for ANC ≥4 visits and 151978 for delivery assisted by SBA). For the late (registration in third trimester of pregnancy) or no registration of pregnancy, each predictor was found significantly associated in which the most important were women's education, child birth order, caste and wealth quintile.

Conclusion: The present study concluded that multilevel logistic model in clustered design data was useful instead of individual level for more precise estimate of effect size of the predictors.

Keywords: Antenatal care, Multilevel modelling, National family health survey, Variance partition coefficient

INTRODUCTION

Maternal and child health remain an intimidating challenge to the healthcare system worldwide. Antenatal Care (ANC) is an opportunity to promote a positive pregnancy experience and improved maternal and child survival [1]. India is the key contributors for both maternal and neonatal death globally. More than 100 maternal deaths per lakh live births and over 23.7 neonatal deaths per 1000 live births occur each year [2,3]. Majority of these deaths can be averted by adequate utilisation of ANC services [2,3]. Several studies had reported by analysing clustered data and reported mother's age at childbirth, parity, unwanted pregnancy, education and exposure to specific health knowledge in explaining the utilisation of ANC services [4-8]. But these studies findings were based on individual level logistic regression model which may be inappropriate for hieratical data structure [9].

Large sample studies usually follow cluster designs which are hieratical in nature i.e., subjects show similarity within the cluster and dissimilarity between the clusters. Clustering effects could be seen at different levels; for example, nation wide sampled mothers showed substantial inter and intrastate disparity in utilisation of ANC services [7]. This disparity could be present even at lower levels of clusters too, such as district levels, block levels and so on [10].

The analysis carried at individual level to identify the predictors of an outcome in clustered data fails to take into account the clustering effect and hence, the findings may not be valid which will influence the correct framing of the policy and programmatic agenda; while multilevel modelling is a statistical technique that extends ordinary logistic regression method by incorporating the existence of inherent correlation within the clusters [11]. Here, the units at lower level (level-1) are individuals who are nested within units at higher level (districts: level-2) and the districts are again nested within units at the next higher level (states: level-3).The main strength of multilevel modelling is its power and flexibility, and ability to model a wide range of scenarios and situations. As with all modelling, the weaknesses lie in the quality of the available data and problems with setting up models correctly to represent the important underlying relationships [12].

In a study by Yusuf B et al., while comparing the ordinary and multilevel logistic models with hierarchal data on violent behaviour among secondary school students in Ibadan, Nigeria, authors recommended the use of multilevel model approach for valid decision [9]. Thus, the past analysis on the National Family Health Survey-IV (NFHS-IV) data set by using ordinary logistic model may not be precise for the estimated effect size of the identified predictors [4,13]. Hence, present study was conducted to demonstrate the adequacy of multilevel logistic model over ordinary logistic model in hieratical datasets with antenatal care (ANC) visits ≥4 and delivery assisted by Skilled Birth Attendant (SBA) as the outcome variables and also to identify the predictors of late or no registration of pregnancy for ANC services using multilevel logistic model.

MATERIALS AND METHODS

This retrospective, cross-sectional study was conducted at the Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India from October 2021 to March 2022. The survey was approved by the International Institute for Population Sciences (IIPS) Ethical Review Board in India and the institutional review boards of the funding agencies and the technical assistance agencies [14].

Inclusion criteria: The outcome variables such as ANC visits ≥4 as suggested by World Health Organisation (WHO) and delivery assisted by SBA i.e., Doctor/Nurse/Lady Health Visitor/Auxiliary Nurse Midwife/other health professionals for the comparison of adequacy of ordinary and multilevel logistic regression models considered were included in the study [15,16].

Exclusion criteria: Data of subjects with the missing information on one or more required variables were excluded from the study.

Sample size: The data of 174607 women given birth within five years from the India's NFHS-IV [16], following the inclusion and exclusion criteria, were subjected to analysis.

Data Collection

The data set used was obtained from India's National Family Health Survey (NFHS-IV) conducted in 2015 to 2016, across 640 districts of 29 states including all seven union territories of India. Respondents were selected following a probability-based cluster sampling procedure in which sampling frames were made on the basis of non overlapping units of geography called Primary Sampling Units (PSUs) i.e., by states and urban and rural areas within each state. At the second stage, a fixed proportion of households were selected using systematic sampling within each PSU [14].

The three levels PSU were:

- Level-1: of 174607 individuals
- Level-2: individuals nested within 640 districts
- Level-3: districts nested within 36 states and union territories

Thereafter, predictors of late or no registration of pregnancy were identified [4,7]. The predictors for the models considered with their categories were current age of women (Age groups: 15-19 years, 20-34 years, 35-49 years), women's education (no education, primary, secondary, higher), child birth order (1st, 2nd, 3rd, 4th, 5th or ≥6), religion (Hindu, Muslim, others), caste {Scheduled Castes (SCs), Scheduled Tribes (STs), Other Backward Caste (OBC), Others}, wealth quintile (poorest, poorer, middle, richer, richest), distance to health facility (no problem, big problem, not a big problem), place of residence (urban, rural) [14]. The analysis was carried by using the ordinary logistic regression model that ignore the hieratical nature of data and thereafter by using the three level mixed effects logistic regression model for ANC visits ≥4 and delivery assisted by SBA to compare the model adequacy [11]. For interpretation, odds ratios (ORs) and 95% confidence intervals (CIs) were reported.

Models

I. Verifying Variance Partition Coefficient (VPC): It explains what proportion of total variance is attributable to variation within groups and between groups and by definition, it is the ratio of variance for a level to the total variance. The VPC at state and district levels were obtained by using the following expressions as [17]:

$$VPC\ at\ state\ level = \frac{\sigma_{s0}^2}{\sigma_{s0}^2 + \sigma_{d0}^2 + (\pi^2/3)}$$

$$VPC\ at\ district\ level = \frac{\sigma_{d0}^2}{\sigma_{s0}^2 + \sigma_{d0}^2 + (\pi^2/3)}$$

Where, σ_{s0}^2=Var(s_{0k}); i.e., variance between states, σ_{d0}^2=Var(d_{0jk}); i.e., variance between district within state and (π^2/3)≈3.29 refers to the standard logistic distribution, i.e., the assumed level-1 variance component.

II. Ordinary logistic model [18]: Let (1-π_j) denote the probability of incidence and no incidence of the binary outcome to the i^{th} individual (i=1,2.....,n) for the outcome with vector of predictors X: ($X_1X_2.....X_p$) the logit function of the ordinary logistic model is expressed as:

$$Logit\ (\pi_j) = \beta_0 + \beta' \mathbf{X}$$

Where, β_0 represents the log odds of random effect associated with the individuals when each predictor equals to zero and β' is the transpose of vector of regression coefficient β_i associated with the predictor measuring the change in log odds of incidence of the outcome.

III. Multilevel mixed effect model [19]: Let π_{ijk} and (1-π_{ijk}) denote the probability of incidence and no incidence of the binary outcome to the individual of the district in state/union territory. For the outcome with vector of predictors X; the logit function of the multilevel mixed effect logistic model is expressed as:

$$Logit\ (\pi_{ijk}) = \beta_0 + \beta' \mathbf{X} + (d_{0jk} + s_{0k})$$

Where, β_0 represents the log odds of random effects associated with the individuals, s_{0k}log odds of random effects associated with state and d_{0jk}log odds of random effects associated with the district conditional on state when each predictor equals to zero.

STATISTICAL ANALYSIS

Data analysis was carried out by using STATA software version 13.0.

RESULTS

Out of the total 174607 women analysed, mostly (87.4%) were in the age group 20-30 years, nearly half (46.5%) with secondary level education followed by 28% with no education. The 2nd and 3rd para women were 51.2%, while 33.3% were of 1st para. In present study, preponderance was of Hindus women (80.7%) and rural (70.6%) and nearly half belonged to OBC caste (45.3%). Out of the total women participants, 51.2% had ≥4 ANC visits and 83.3% deliveries were assisted by SBA; while nearly one of seven women (14.6%) were either late or not registered for ANC services for the pregnancy. The late or no registration for ANC care was higher in women of higher age, higher order child birth, illiterate, rural population and poorest income group [Table/Fig-1].

The VPC at state level (27.84%) and district levels (7.60%) were substantial which cannot be ignored while estimating the predictors. The application of multilevel model proved a better approach for precise estimates (-2Log L=189334) compared to ordinary logistic (-2Log L=2202689). Compared to women of age 15-19 years, ≥4 ANC visit in women of age 20-34 years was statistically same in ordinary logistic model (OR=0.95; 95% CI: 0.90-1.01); but in multilevel modelling it was significantly higher (OR=1.09; 95% CI: 1.02-1.17). In ordinary logistic model, ≥4 ANC visit in ST and other caste category women were statistically higher compared to SC women (OR: 1.24; 95% CI: 1.20-1.29 for ST and OR=1.04; 95% CI: 1.01-1.08 for other caste category). But, in multilevel modelling, it was statistically higher only in women of other caste category (OR=1.11; 95% CI: 1.07-1.16). The vast variation in the estimates between the multilevel and ordinary logistic models for the predictors child birth order, education of the mother and wealth quintile could be seen [Table/Fig-2].

Similarly, [Table/Fig-3] showed variations at state and district level with 39.36% and 8.41%, respectively. Log likelihood values showing multilevel logistic (-2Log L=141148) a better model against ordinary logistic (-2Log L=151978). The ordinary logistic model indicated that the births assisted by SBA were significantly lower in Muslims (OR=0.56; 95% CI: 0.54-0.58) as well as in other religion group (OR=0.84; 95% CI: 0.79-0.90); while in multilevel logistic model, it was significantly lower only in Muslim women (OR=0.71; 95% CI: 0.71-0.77).

Variables	Categories	Total n (%)	≥4 Antenatal visit; n (%)	Skilled birth attendant n (%)	Late/no registration; n (%)
Current age of women (years)	15-19	5819 (3.3)	3170 (54.5)	5026 (86.4)	756 (13)
	20-34	152589 (87.4)	79980 (52.4)	128827 (84.4)	20934 (13.7)
	35-49	16199 (9.3)	6248 (38.6)	11675 (72.1)	3807 (23.5)
Education of women	Illitrate	48842 (28)	13536 (27.7)	33209 (68)	11843 (24.2)
	Primary	23507 (13.5)	10704 (45.5)	18546 (78.9)	3181 (13.5)
	Secondary	81167 (46.5)	49671 (61.2)	73403 (90.4)	7986 (9.8)
	Higher	21091 (12.1)	15487 (73.4)	20370 (96.6)	2487 (11.8)
Child birth order	1st	58072 (33.3)	35999 (62)	53173 (91.6)	6407 (11)
	2nd or 3rd	89469 (51.2)	46577 (52.1)	74917 (83.7)	12114 (13.5)
	4th or 5th	20186 (11.6)	5746 (28.5)	13651 (67.6)	4674 (23.2)
	≥6	6880 (3.9)	1076 (15.6)	3787 (55)	2302 (33.5)
Religion	Hindu	140972 (80.7)	71979 (51.1)	119186 (84.5)	19755 (14)
	Muslim	24708 (14.2)	11604 (47)	18670 (75.6)	4785 (19.4)
	Others	8927 (5.1)	5815 (65.1)	7672 (86)	957 (10.7)
Caste	SC	38535 (22.1)	18850 (48.9)	31753 (82.4)	5092 (13.2)
	ST	18558 (10.6)	8599 (46.3)	13639 (73.5)	2970 (16)
	OBC	79158 (45.3)	38449 (48.6)	66553 (84.1)	12220 (15.4)
	Others	38356 (22)	23500 (61.3)	33583 (87.6)	5215 (13.6)
Wealth quintile	Poorest	41255 (23.6)	10217 (24.8)	27179 (65.9)	9984 (24.2)
	Poorer	36734 (21)	16220 (44.2)	29462 (80.2)	5300 (14.4)
	Middle	34718 (19.9)	19832 (57.1)	30596 (88.1)	3598 (10.4)
	Richer	32967 (18.9)	21768 (66)	30487 (92.5)	3363 (10.2)
	Richest	28933 (16.6)	21361 (73.8)	27804 (96.1)	3252 (11.2)
Distance from health facility	No problem	58400 (33.4)	36205 (62)	51853 (88.8)	6944 (11.9)
	Not big problem	59919 (34.3)	30306 (50.6)	50639 (84.5)	8064 (13.5)
	Big problem	56288 (32.2)	22887 (40.7)	43036 (76.5)	10489 (18.6)
Place of residence	Urban	51404 (29.4)	34338 (66.8)	46864 (91.2)	6579 (12.8)
	Rural	123203 (70.6)	55060 (44.7)	98664 (80.1)	18918 (15.4)
Total n (%)		174607 (100)	89398 (51.2)	145528 (83.3)	25497 (14.6)

[Table/Fig-1]: Distribution of predictor variables in utilising recommended antenatal care visits and deliveries assisted by skilled birth attendant (SBA).

		Ordinary logistic regression model		Multilevel logistic regression model	
	Categories	OR	95% CI	OR	95% CI
Variables	Intercept	0.59*	0.38-0.71	0.87*	0.61-0.98
Current age of women (years)	15-19	1.00	--	1.00	--
	20-34	0.95	0.90-1.01	1.09*	1.02-1.17
	35-49	1.08*	1.01-1.16	1.14*	1.06-1.23
Education of women	No	Ref.	Ref.	Ref.	Ref.
	Primary	1.56*	1.51-1.62	1.25*	1.20-1.30
	Secondary	1.99*	1.93-2.05	1.54*	1.49-1.59
	Higher	2.24*	2.14-2.34	2.16*	2.05-2.27
Child birth order	1st	Ref.	Ref.	Ref.	Ref.
	2nd or 3rd	0.79*	0.77-0.81	0.80*	0.77-0.82
	4th or 5th	0.46*	0.44-0.48	0.63*	0.61-0.66
	≥6	0.27*	0.25-0.29	0.48*	0.45-0.52
Religion	Hindu	Ref.	Ref.	Ref.	Ref.
	Muslim	0.92*	0.89-0.95	0.90*	0.86-0.94
	Others	1.32*	1.25-1.38	0.98	0.93-1.04
Caste	SC	Ref.	Ref.	Ref.	Ref.
	ST	1.24*	1.20-1.29	0.95	0.91-1.01
	OBC	0.82*	0.80-0.84	1.01	0.98-1.05
	Others	1.04*	1.01-1.08	1.11*	1.07-1.16
Wealth quintile	Poorest	Ref.	Ref.	Ref.	Ref.
	Poorer	1.85*	1.79-1.91	1.43*	1.38-1.48
	Middle	2.59*	2.50-2.68	1.82*	1.75-1.90
	Richer	3.12*	3.00-3.24	2.25*	2.18-2.39
	Richest	3.53*	3.38-3.70	3.05*	2.89-3.22
Distance from health facility	No problem	Ref.	Ref.	Ref.	Ref.
	Not big problem	0.85*	0.83-0.87	0.87*	0.85-0.90
	Big problem	0.74*	0.72-0.76	0.78*	0.75-0.80
Place of residence	Urban	Ref.	Ref.	Ref.	Ref.
	Rural	0.76*	0.74-0.78	0.88*	0.85-0.91

[Table/Fig-2]: Associations between selected predictors and number of antenatal visit.
*Significant at α=5%; Variances (95% CI) and VPC (%) of random effects: Level 2 (district): 0.39 (0.34-0.44), 7.60% and Level 3 (state): 1.42 (0.88-2.32), 27.84%.; -2Log-likelihood=2202689 for ordinary logistic regression and 189334 for multilevel logistic regression

		Ordinary logistic regression model		Multilevel logistic regression model	
	Categories	OR	95% CI	OR	95% CI
Variables	Intercept	3.80*	3.41-4.01	6.4*	4.18-6.79
Current age of women (years)	15-19	1.00	--	1.00	--
	20-34	1.09*	1.01-1.19	1.14*	1.05-1.24
	35-49	1.12*	1.02-1.23	1.15*	1.05-1.27
Education of women	No	Ref.	Ref.	Ref.	Ref.
	Primary	1.25*	1.20-1.30	1.20*	1.15-1.25
	Secondary	1.96*	1.89-2.03	1.79*	1.73-1.86
	Higher	3.00*	2.76-3.27	3.03*	2.78-3.30
Child birth order	1st	Ref.	Ref.	Ref.	Ref.
	2nd or 3rd	0.57*	0.55-0.60	0.56*	0.54-0.58
	4th or 5th	0.39*	0.37-0.41	0.42*	0.40-0.44
	≥6	0.30*	0.28-0.32	0.35*	0.33-0.37
Religion	Hindu	Ref.	Ref.	Ref.	Ref.
	Muslim	0.56*	0.54-0.58	0.71*	0.71-0.77
	Others	0.84*	0.79-0.90	0.95	0.88-1.03
Caste	SC	Ref.	Ref.	Ref.	Ref.
	ST	0.75*	0.71-0.78	0.72*	0.68-0.76
	OBC	1.02	0.99-1.06	1.10*	1.06-1.14
	Others	1.05	1.00-1.09	1.11*	1.06-1.17
Wealth quintile	Poorest	Ref.	Ref.	Ref.	Ref.
	Poorer	1.57*	1.52-1.63	1.42*	1.30-1.40
	Middle	2.32*	2.22-2.42	1.96*	1.72-1.88
	Richer	3.14*	2.98-3.32	2.72*	2.33-2.62
	Richest	4.67*	4.33-5.04	4.21*	3.88-4.56
Distance from health facility	No problem	Ref.	Ref.	Ref.	Ref.
	Not big problem	1.03	0.99-1.07	0.95*	0.92-0.99
	Big problem	0.80*	0.77-0.83	0.76*	0.73-0.78
Place of residence	Urban	Ref.	Ref.	Ref.	Ref.
	Rural	0.89*	0.85-0.93	0.89*	0.85-0.93

[Table/Fig-3]: Associations between selected predictors and deliveries assisted by skilled birth attendant (SBA).
*Significant at α=5%; Note: Variances (95% CI) and VPC (%) of random effects: Level 2 (district): 0.53 (0.46-0.60), 8.41% and Level 3 (state):2.48 (1.45-4.23), 39.36%.;-2 Log-likelihood=151978 for Ordinary logistic regression model and 141148 for multilevel logistic regression

The variance partition coefficients for late or no registration for ANC attributed to state and district levels were 12.24% and 7.10%, respectively. Thus, identifying the predictors of late or no registration and the estimates of odds ratio for their different categories; multilevel model will be the robust model. Late or no registration was almost one in seven i.e., 14.6%. The predictors, mother education, child birth order and wealth quintile were major contributor to late or no registration. Compared to illiterate women, the likelihood of late or

no registration was lesser by 15%, 28% and 30% in women with primary, secondary and higher education, respectively. While the likelihood of late or no registration was higher by 1.11, 1.35 and 1.69 times in women of child birth order (1st, 2nd to 3rd, 4th to 5th, ≥6, respectively when compared to women of first order. A negative association of wealth quintile with late or no registration was found; higher the wealth quintile, lower was the likelihood of late or no registration. Rest predictors i.e., age of women, religion, caste, place of residence and distance of health facilities also influenced late or no registration but were minor contributors as compared to other parameters [Table/Fig-4].

Variables	Categories	Multilevel logistic regression model	
		OR	95% CI
	Intercept	0.61*	0.48-0.76
Current age of women (years)	15-19	1.00	--
	20-34	0.88*	0.83-0.94
	35-49	0.97	0.90-1.04
Education of women	No	Ref.	Ref.
	Primary	0.85*	0.82-0.88
	Secondary	0.72*	0.69-0.74
	Higher	0.70*	0.67-0.74
Child birth order	1st	Ref.	Ref.
	2nd or 3rd	1.11*	1.08-1.14
	4th or 5th	1.35*	1.30-1.40
	≥6	1.69*	1.60-1.79
Religion	Hindu	Ref.	Ref.
	Muslim	1.06*	1.02-1.10
	Others	1.01	0.95-1.07
Caste	SC	Ref.	Ref.
	ST	1.13*	1.08-1.18
	OBC	0.94*	0.86-0.97
	Others	0.89*	0.82-0.97
Wealth quintile	Poorest	Ref.	Ref.
	Poorer	0.82*	0.80-0.85
	Middle	0.71*	0.69-0.74
	Richer	0.64*	0.62-0.67
	Richest	0.61*	0.58-0.64
Distance from health facility	No problem	Ref.	--
	Not big problem	0.96*	0.93-0.98
	Big problem	1.11*	1.08-1.14
Place of residence	Urban	Ref.	--
	Rural	1.06*	1.02-1.13

[Table/Fig-4]: Associations between selected predictors and late or no registration of pregnancy: Results from multilevel logistic model.
*Significant at α=5%; Note: Variances (95% CI) and VPC (%) of random effects: Level 2 (district): 0.29 (0.26-0.33), 7.10% and Level 3 (state): 0.50 (0.30-0.83), 12.24%

DISCUSSION

This study first validated the utility of multilevel model compared to the ordinary logistic model on the data of NFHS-IV collected under clustered design. This was validated by -2 Log likelihood values obtained under multilevel and ordinary logistic regression models for the outcomes ANC visits ≥4 and delivery assisted by SBA as mentioned in the result section. Thereafter, the predictors of late or no registration of pregnancy were identified. Multilevel modelling in hieratical structure of data has the advantage wherein the random effects are specified at each level of analysis. With clustered data, observations from the same cluster are generally more similar than observations from different cluster and using ordinary logistic regression model violate the assumption of independence of all observations [19,20].

The data set of NFHS-IV used here for late or no registration showed variations associated with state level as 12.24% and at district level as 7.10%. These variations are quite obvious as women living in the same region (cluster) may share similar characteristics like religious believes, access to health care services and socio-economy conditions; so, justifying the findings using ordinary logistic regression is inappropriate [21]. Singh PK et al., and Wulandari RD et al., had examined the predictors of full antenatal care and found education has positive influence and higher birth order as barrier on utilisation of antenatal care, which is similar to our findings [4,5]. While Akowuah JA et al., used logistic regression approach on Demographic and Health Survey data of rural Mali and showed much of the area-level influences on the use of Maternal and Child Health (MCH) services [8].

Late or no registration of pregnancy is still a major concern in India which is attributed to low education of women, poverty, ignorance of benefit of MCH services and access of MCH services. Still almost one in seven women either do not get registration or register very late. Studies has pointed that the mothers who are late or not registered for ANC services are more likely to give birth to underweight babies of whom survival is poor [22-25]. In fact, state and district level effects for late or no registration of pregnancy are substantial (VPC 12.24 at state level and 7.10 at district level). The late or no registration of pregnancy was found to be associated with all the considered predictors. However, education, child birth order, wealth quintile, distance to health facility, place of residence were the important. As the level of education and wealth quintile was increasing, the likelihood of late or no registration of pregnancy was decreasing; while likelihood of late or no registration of pregnancy was increasing with increasing birth order. Religion as well as caste also had role to play for late or no registration.

Limitation(s)

Firstly, these predictors at individual and household level can identify the pockets with late or no registration for ANC, but cannot establish the causal association and secondly since the data relates to theme assures being self-reported by mothers with a recall period of upto five years, hence subject to recall bias.

CONCLUSION(S)

The hieratical structure of data used here demonstrated variation at state and district levels, thereby large variability in the estimates of various categories of predictors in multilevel model compared to ordinary logistic model was seen and more robust was with multilevel model. Late or no registration was more concentrated in low educated, higher order child birth and in poorer wealth quintile income class. These women are about two third from rural areas, therefore a programmatic drive is needed to enhance the timely registration for ANC to bring improved health of mother and new born.

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