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Factors Associated with use of Modern Contraceptives in EAG States of India: A Hierarchical Model Technique

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Abstract- The main aim of the present study is to find the significant predictors associated with modern contraceptive use in EAG states of India through the Hierarchical model. For this, we develop a model which includes the hierarchical effect present in the data. First, we calculated Intraclass Correlation (ICC), which shows the amount of variation in modern contraceptive use is explained by the district level. Second, this district-level variation was included in the model to obtain precise results. The data used for the study was obtained from National Family Health Survey round four (NFHS-4). The NFHS-4 surveyed a total sample of 699,686 women aged 15-49 years. The survey used a stratified two-stage sampling technique. The selection of PSUs (Primary sample Units) for village areas and Census enumeration blocks (CEBs) in urban areas were selected from the census 2011. The results showed that the odds of using modern contraceptive use were high among families with a high wealth index and the same results were found for all EAG states. The study also reveals that exposure to media, knowledge score of women, and place of residence were significant predictors of modern contraceptive use in EAG states. Akaike Information Criterion was used to compare a simple logistic regression model in which no district level variation was included to model modern contraceptive use and a Hierarchical model which includes district level variation to model modern contraceptive use. As a result, the Hierarchical model was found to be the best fit as compared to a simple logistic regression model.

Keywords- Hierarchical Model, Modern Contraceptive use, Socio-economic and demographic predictors of modern contraceptives

I. INTRODUCTION

India ranks second in the world after China with 1.3 billion people and it is projected that soon will cross China and become the country with the highest population in the entire world. High fertility rates are always a major concern for any country as it always acts as a barrier to access health care services, development, and economic growth of the country. India is still struggling to achieve a TFR of 2.1. As per the NFH-4 India, TFR was witnessed as 2.2.

Family planning services and programs help in controlling the fertility rate as they improve the health of mother and child by acting as a barrier to unintended pregnancies [1]. Family planning through contraceptive use increases the interval between two pregnancies and helps women to make their own decisions on the use of contraception [2, 3]. Despite these benefits, the contraceptive prevalence rate is quite low in India (53%). As Ministry of Health and Family Welfare, based on high fertility rates and poor socio-demographic indicators defined eight states (Bihar, Jharkhand, Madhya Pradesh, Uttarakhand, Odisha, Uttar Pradesh, Chhattisgarh, and Rajasthan) as Empowered Action Group. Among all the EAG states Bihar reported the lowest contraceptive prevalence rate (23%). For other states, the contraceptive prevalence rate is as follows, Jharkhand (37%), Madhya Pradesh (50%), Odisha (45%), Rajasthan (53%), Uttar Pradesh (32%), and Uttarakhand (49%).

Socioeconomic and demographic factors are significant predictors of contraceptive use. A research study in Uttar Pradesh and Bihar stated that son preference was positively associated with contraceptive use. A strong preference for a son acts as an obstacle to family planning programs as the couple continues to have children [4]. Women's education level, types of residence, exposure to media, and age all have a significant effect on contraceptive use [5-11]. Thus an ample amount of literature can be found on determinants of contraceptive use. Most of these studies reference above ignore the hierarchical or nested effect on contraceptive use. The hierarchical effect on contraceptive use is essential for policymaking purposes. Let's understand through a short example, that there might be differences in the socio-demographic profile of women within a state and between states. Ignoring these effects in the analysis may lead to wrong estimates. In the past, many researchers had made considerable progress in developing techniques and

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computer programs for fitting Multilevel linear models with includes normal distributes error term at various level [12-15]. Our interest lies in the model where the response variable is binary as our outcome variable (contraceptive use and non-use) had two binary outcomes (yes or no).
In the context of EAG states the literature is limited thus our study will help to examine the importance of hierarchical effect while analyzing such data with hierarchy or nested structure in the EAG states of India. Our study primarily serves three objectives : (1) to examine district-level variation in contraceptive use in all EAG states, (2) to identify significant factors that are associated with contraceptive use using hierarchical modeling, and (3) to compare both models with no hierarchical effect and one with hierarchical effect.

This study was organized in the following sections. Section I includes the introduction, related work, and specific objectives of the study conducted.
Section II includes related works done in past research. Section III is the description of the variables, structure of Models used in the study, and statistical analysis techniques used for analyzing data. Section IV contains results obtained from the study in form of tables and figures and the discussion based on the results. Section V describes the conclusion of the study with the suggestion for further studies.

II. RELATED WORK

In 1992 a study conducted by Pabley and Goldman used a standard logit model including variations due to sample clustering [16]. Another study conducted in Bangladesh reveals that the hierarchical approach to model contraceptive use is quite helpful in understanding the socioeconomic and demographic factors that are associated with contraceptive use more precisely as compared to previous methods where the hierarchical effect was ignored [17]. Evidence shows that various levels of geographical areas such as districts, states, and blocks had a different impact on the behavior of respondents as different geographical areas have variability in socio-economic characteristics. Thus it becomes quite important to explore the heterogeneity between districts.

III. METHODOLOGY

National Family Health Survey round four (NFHS-4) data was used in the present study.NFHS is a large-scale multi-round survey and a nationally representative source of data on population, health, and nutrition for India and its states. It covers all 29 states and all six union territories for the first time which provides estimates of the most indicators of the district level for all 640 districts of India. The NFHS-4 surveyed a total sample of 699,686 women aged 15-49 years. The survey used a stratified two-stage sampling technique. The selection of PSUs (Primary sample Units) for village areas and Census enumeration blocks (CEBs) in urban areas were selected from the census 2011. The probability proportion to size (PPS) sampling technique was used to select villages from the sampling frame, PSUs were linked to the nearest PSUs where several households were less than 40. For urban areas information on CEBs was obtained from the Office of the Registrar General and Census Commissioner, New Delhi. All the CEBs were then sorted based on the percentage of the Schedule Caste/Schedule Tribe population and PPS sampling was used for the selection of CEBs.

Before initiating the main survey, a complete mapping of all the household and listing operations was complete. Further, if a selected Primary Sample Unit has at least 300 estimated households, it was divided into segments with approximately 100-150 households. Then two segments were randomly selected using a systematic sampling technique using probability proportion to segment size. The data file for NFHS-4 can be obtained from the DHS program website.

Variables

The outcome variable in the study was modern contraceptive use. In the NFHS-4 survey, currently married women were asked which contraceptive method they are currently using. Women whose responses were modern contraceptives were coded as yes and for other methods and no method, the response was coded as no. Details for the method considered to be modern or traditional have been published in previous studies.

The following individual-level socioeconomic and demographic variables were included in the analysis: Age, Education, Religion, wealth status, Total children ever born, exposure to media, and knowledge score. Knowledge score was calculated on the basis that how many modern methods a woman was able to name. There were 7 items in the knowledge score. Women were considered to have high knowledge of modern contraceptives if their score was more than 3 and low if their score was below or equal to 3. Place of residence the only community-level variable was included in the analysis.

Hierarchical Structure of Data

In a situation where lower-level units of data are nested in higher-level units of data then the data is considered to be hierarchy or nested in nature. These types of data are common in educational, clinical, and survey settings. For example, students can be nested in classrooms, or teachers or teachers can be nested within the school. Ignoring these multilevel effects while conducting a research analysis can lead to misleading conclusions. Research shows that ignoring these multilevel effects can impact the estimation of variance and power to detect covariates effect [18-22]. Harvey Goldstein, in his paper, said that real populations have a hierarchical structure[23].In National Family Health Survey the basic unit of analysis is women i.e. level 1. These women are consequently nested within districts representing level 2. The existence of such a hierarchy in data is neither accidental nor ignorable [24].

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Data Analysis

The analysis of the study includes both descriptive statistics and a multi-level logistic regression for analyzing data. Model-building process for the specific objective of the study is shown in table 1.

Table 1: Model building process

Model-1	Model-2	Model-3	Model-4
Empty model: No predictors just random effects for the intercept	An unadjusted logistic regression model	An adjusted logistic regression model	Model-1+level-1 fixed effects
Model-1 gives Intraclass correlation which shows the amount of variation in the outcome variable (Modern contraceptive use) explained by level-2 units(districts)	The outcome gives crude estimates when considering only one independent(predictor) variable	The outcome gives the estimates taking into account all independent variables included in the analysis	Results indicate the relationship between level-1 predictors (socioeconomic and demographic variables of the women) and the dependent variable (Modern contraceptive use) considering the random effect.

Thus our study includes four models and a model-specific mathematical equation is described here.Equation-1 given below is a simple level-1 model with one individual-level predictor where Y_{ij} is the log of odds of using modern contraceptive for women i in district j. β_{oj} represents is the intercept or average log of odds of using a modern contraceptive at district j, X_{ij} is individual-level predictors (age, education, wealth index, knowledge score, residence, Total children ever born, exposure to media, religion), and β_{1j} is the slope related with X_{ij} showing the relationship between women level variable and the log of odd of using a modern contraceptive method.

$$Y_{ij} = \beta_{oj} + \beta_{1j} X_{ij} \quad (1)$$

The second equation given below is a simple level-2 model with one district-level predictor where β_{oo} gives a log of odds of using a modern contraceptive in a typical district, W_j is the district-level predictor but for our analysis, we have not taken any district-level predictor so $\beta_{o1} W_j$ will be equal to zero, β_{1o} is the average effect of individual-level predictors, and μ_{oj} is the level-2 (district) error term representing the effect associated with district j.

$$Y_{ij} = \beta_{oo} + \beta_{1o} X_{ij} + \beta_{o1} W_j + \mu_{oj} \quad (2)$$

So the final equation for a two-level model is given below:

$$Y_{ij} = \beta_{oo} + \beta_{1o}(age)_{ij} + \beta_{2o}(residence)_{ij} + \beta_{3o}(education)_{ij} + \beta_{4o}(religion)_{ij} + \beta_{5o}(total\ children\ ever\ born)_{ij}\beta_{6o}(wealth\ index)_{ij} + \beta_{7o}(exposure\ to\ media)_{ij} + \beta_{8o}(knowledge\ score)_{ij} + \mu_{oj} \quad (3)$$

In our study, we first need to estimate the amount of variability in the chance of using modern contraceptives rather than not using a modern contraceptive that lies within the district of a state. To do we run an Empty model with no predictors from equation 3 and calculate the intraclass correlation coefficient. Below is the equation for calculating ICC:

$$ICC = \frac{var(\mu_{oj})}{var(\mu_{oj}) + (\pi^2/3)}$$

Where $var(\mu_{oj})$ is the district-level variance component. The higher the value of $var(\mu_{oj})$ the larger the variability of the average log of odds between districts. The level-1 variance component is defined as $\pi^2/3 \approx 3.29$ which is standard logistic distribution [25].

IV. RESULTS AND DISCUSSION

A total of 235985 samples of women aged 15-49 who are currently married, fecund, and non-pregnant from all eight EAG states were included in the analysis. Figure 1 below shows the distribution of contraceptive methods used by EAG states.

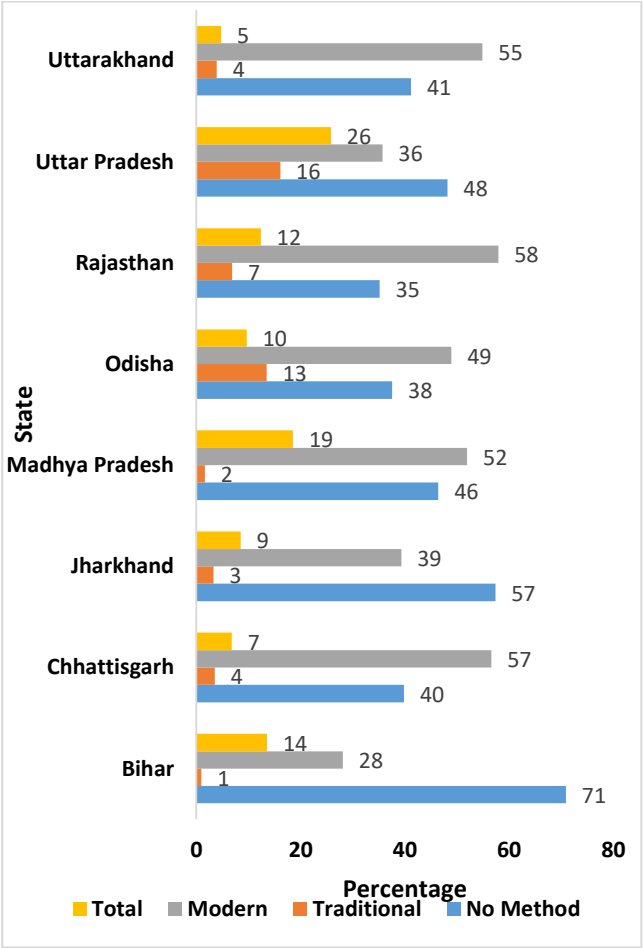

Figure 1: Distribution of modern contraceptive methods by EAG states, NFHS-4

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The highest percentage of modern contraception use was in Rajasthan (58%) followed by Chhattisgarh (57%), Uttarakhand (55%), Madhya Pradesh (52%), Odisha (49%), Jharkhand (39%), Uttar Pradesh (36%) and Bihar (28%). Uttar Pradesh (16%) and Odisha (13%) are the two states where traditional contraceptive use was highest among all EAG states. Table 1 presents the distribution of selected individual characteristics of women by EAG states. Results show that 44% of women belong to the age group 35-49 while the percentage for women aged 25-34 was 38% and 15-24 was 18%. The same trend was observed for all EAG states. The highest percentage of women (56%) with no education belongs to Bihar state. The result in the tables also shows that most of the women from all EAG states are residing in rural areas and are Hindu. In all EAG states, it is found that most of the women belong to a poor wealth family but only for Uttarakhand (50%) almost half of the total women belong to a rich family. As shown in the table women were able to name more than 3 modern contraceptive methods for all EAG states. Table 2 shows the Intraclass Correlation coefficient for all the EAG states of India. ICC explains the amount of variation explained by districts. The ICC for Bihar state was 13% i.e. 13% chance of using contraceptives is explained by between district differences. In Madhya Pradesh and Uttar Pradesh, 11% of the total variation is explained by district variation.

Table 2: Intraclass correlation coefficient

State	Covariance parameter	Estimate	Standard error	Residual	ICC
Bihar	Intercept	0.4898	0.1159	3.29	13%
Chhattisgarh	Intercept	0.1818	0.06258	3.29	5%
Jharkhand	Intercept	0.2168	0.06459	3.29	6%
Madhya Pradesh	Intercept	0.4088	0.08329	3.29	11%
Odisha	Intercept	0.1094	0.0299	3.29	3%
Rajasthan	Intercept	0.1296	0.03314	3.29	4%
Uttar Pradesh	Intercept	0.4115	0.07147	3.29	11%
Uttarakhand	Intercept	0.1531	0.0618	3.29	4%

Table 3: Distribution of selected individual characteristics of women by EAG states (N=235985)

	Bihar		Chhattisgarh		Jharkhand		Madhya Pradesh		Odisha		Rajasthan		Uttar Pradesh		Uttarakhand		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Age																		
15-24	6961	22	2591	16	4293	21	8168	19	3637	16	5793	20	10451	17	1582	14	43476	18
25-34	12076	38	6229	39	7642	38	16296	37	8453	37	11139	38	22982	38	4400	39	89217	38
35-49	12980	41	7204	45	8207	41	19286	44	10673	47	12243	42	27491	45	5208	47	103292	44
Education																		
No Education	17840	56	5945	37	9181	46	19351	44	7827	34	14618	50	28499	47	3001	27	106262	45
Primary	3601	11	3139	20	2493	12	7913	18	3869	17	4456	15	7843	13	1698	15	35012	15
Secondary	9207	29	5857	37	7285	36	13770	31	9793	43	7697	26	18301	30	4756	43	76666	32
Higher	1369	4	1083	7	1183	6	2716	6	1274	6	2404	8	6281	10	1735	16	18045	8
Residence																		
Urban	4024	13	4370	27	4858	24	12377	28	4364	19	7668	26	15761	26	3253	29	56675	24
Rural	27993	87	11654	73	15284	76	31373	72	18399	81	21507	74	45163	74	7937	71	179310	76
Religion																		
Hindu	27690	86	15262	95	14909	74	40264	92	21385	94	26128	90	49887	82	9829	88	205354	87
Muslim	4288	13	411	3	2665	13	3025	7	351	2	2448	8	10794	18	1191	11	25173	11
Other	39	0	351	2	2568	13	461	1	1027	5	599	2	243	0	170	2	5458	2
Total Children Ever Born																		
0-2	12696	40	8334	52	10036	50	21690	50	14078	62	14890	51	25301	42	5873	52	112898	48

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>2	19321	60	7690	48	10106	50	22060	50	8685	38	14285	49	35623	58	5317	48	123087	52
Wealth Status																		
Poor	23214	73	8942	56	13439	67	22607	52	13967	61	11042	38	29704	49	2599	23	125514	53
Middle	4616	14	2522	16	2932	15	7126	16	4311	19	6124	21	11012	18	3028	27	41671	18
Rich	4187	13	4560	28	3771	19	14017	32	4485	20	12009	41	20208	33	5563	50	68800	29
	Bihar		**Chhattisgarh**		**Jharkhand**		**Madhya Pradesh**		**Odisha**		**Rajasthan**		**Uttar Pradesh**		**Uttarakhand**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Exposure to Media																		
No	18787	59	5724	36	10904	54	17035	39	7791	34	11783	40	28365	47	2544	23	102933	44
Yes	13230	41	10300	64	9238	46	26715	61	14972	66	17392	60	32559	53	8646	77	133052	56
Knowledge Score																		
High	24109	75	13976	87	16735	83	37944	87	20374	90	27356	94	57336	94	10718	96	208548	88
Low	7908	25	2048	13	3407	17	5806	13	2389	10	1819	6	3588	6	472	4	27437	12

Table 4 to Table 11 shows the estimated odd ratio through Model-1, Model -3, and Model-4. As the result shows in Table 4 for Bihar married women with age 25-34(Model-4 (OR= 3.3), Model-3 (OR=3.1), Model-1 (OR=5.6)) and 35-49 are more likely to use modern contraceptives as compared to women aged 15-24. The same results with varying odds ratios were obtained for all EAG states and the estimated odd ratio can be seen in the tables given below. The result further reveals that women having secondary education (Model-4 (OR=1.1), Model-3 (OR=1.2)) in Bihar state were more likely to use modern contraceptives as compared to women with no formal education. Results obtained for Chhattisgarh shows women with primary education (Model-4 (OR=1.4), Model-3 (OR=1.3)) are also more likely to use modern contraceptive as compared to women with no formal education. Jharkhand (Model-4 (OR=0.79) ,Model-3 (OR=0.70)),Madhya Pradesh (Model-4 (OR=0.76) ,Model-3 (OR=0.74)) ,Odisha (Model-4 (OR=0.68) ,Model-3 (OR=0.60)) ,Rajasthan (Model-4 (OR=0.68) ,Model-3 (OR=0.60)) and, Uttarakhand (Model-4 (OR=0.74) ,Model-3 (OR=0.84)) results show a very interesting fact that women having higher education are less likely to use modern contraceptive as compared to women with no formal education but for Uttar Pradesh (Model-4 (OR=1.2) ,Model-3 (OR=1.0)) result were just opposite showing women having higher education are more likely to use modern contraceptive as compared to women with no formal education. For Uttarakhand (Model-4 (OR=1.14)) and Bihar (Model-4 (OR=1.18), Model-3 (OR=1.35)) women living in urban areas are more likely to use modern contraceptives compare to women living in rural areas. Hindu women significantly have higher odds of using modern contraceptives compared to Muslim women in all EAG states.

Table 4: Estimated Odds Ration from Model 1, 2, and 3 for Bihar

Bihar												
		Unadjusted OR	95% Confidence Interval		P-Value	Adjusted OR Without Including Leve-2 Variation	95% Confidence Interval		P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval		P-Value
Age	15-24**												
	25-34	5.653***	5.119	6.243	<.0001	3.491***	3.136	3.886	<.0001	3.702***	3.32	4.127	<.0001
	35-49	7.781***	7.054	8.582	<.0001	4.093***	3.661	4.575	<.0001	4.35***	3.884	4.873	<.0001
Education	No Education**												
	Primary	0.97	0.896	1.051	0.9822	1.042	0.953	1.138	0.5446	1.061	0.968	1.164	0.2076

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	Secondary	1.039***	0.983	1.099	0.0064	1.148***	1.067	1.235	0.0076	1.146***	1.062	1.237	0.0005
	Higher	0.877***	0.773	0.995	0.036	1.076	0.923	1.254	0.8513	1.075	0.918	1.258	0.3698
Residence	Urban	1.5***	1.399	1.609	<.0001	1.352***	1.242	1.471	<.0001	1.187***	1.085	1.299	0.0002
	Rural**												
Religion	Hindu	3.257***	2.959	3.584	<.0001	3.633***	3.289	4.013	<.0001	3.756***	3.38	4.174	<.0001
	Muslim**												
	Other	1.341	0.559	3.215	0.5038	1.567	0.637	3.853	0.3281	3.545***	1.388	9.051	0.0082
Total Children Ever Born	0-2**												
	>2	3.666***	3.46	3.885	<.0001	2.696***	2.513	2.892	<.0001	2.79***	2.595	3.001	<.0001
Wealth Status	Poor**												
	Middle	1.324***	1.236	1.417	<.0001	1.177***	1.085	1.275	<.0001	1.163***	1.069	1.265	0.0004
	Rich	1.56***	1.455	1.673	<.0001	1.252***	1.136	1.38	<.0001	1.248***	1.127	1.383	<.0001
Exposure to Media	No**												
	Yes	1.311***	1.248	1.377	<.0001	1.143***	1.074	1.216	<.0001	1.217***	1.141	1.299	<.0001
Knowledge Score	High	1.868***	1.756	1.988	<.0001	1.707***	1.593	1.828	<.0001	1.517***	1.409	1.633	<.0001
	Low**												

*** Reference Category, ***p-value<0.*

Table 5: Estimated Odds Ration from Model 1, 2, and 3 for Chhattisgarh

Chhattisgarh													
		Unadjusted OR	95% Confidence Interval		P-Value	Adjusted OR Without Including Leve-2 Variation	95% Confidence Interval		P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval		P-Value
Age	15-24												
	25-34	4.25	3.83	4.72	<.0001	3.47	3.10	3.88	<.0001	3.51	3.14	3.93	<.0001
	35-49	8.15	7.34	9.05	<.0001	6.10	5.40	6.89	<.0001	5.98	5.29	6.77	<.0001
Education	No Education												
	Primary	1.13	1.04	1.24	<.0001	1.37	1.24	1.52	<.0001	1.28	1.15	1.42	<.0001
	Secondary	0.89	0.82	0.95	0.2854	1.39	1.25	1.54	<.0001	1.30	1.17	1.45	<.0001
	Higher	0.69	0.60	0.78	<.0001	0.92	0.78	1.09	0.3216	0.90	0.76	1.06	0.2128
Residence	Urban	1.15	1.07	1.23	0.0001	0.91	0.83	1.01	0.0625	1.00	0.90	1.10	0.9225
	Rural												
Religion	Hindu	1.48	1.21	1.80	0.0001	2.03	1.63	2.53	<.0001	1.97	1.58	2.46	<.0001
	Muslim												
	Other	0.93	0.70	1.24	0.6077	1.20	0.88	1.65	0.2516	1.20	0.87	1.65	0.2709
Total Children	0-2												

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Ever Born	>2	3.39	3.18	3.62	<.0001	2.66	2.45	2.88	<.0001	2.69	2.48	2.92	<.0001
Wealth Status	Poor												
	Middle	1.48	1.35	1.62	<.0001	1.33	1.19	1.48	<.0001	1.21	1.09	1.35	0.0005
	Rich	1.41	1.31	1.52	<.0001	1.32	1.18	1.47	<.0001	1.23	1.10	1.38	0.0004
Exposure to Media	No												
	Yes	1.55	1.45	1.65	<.0001	1.50	1.38	1.63	<.0001	1.38	1.26	1.50	<.0001
Knowledge Score	High	2.07	1.88	2.27	<.0001	2.15	1.92	2.40	<.0001	1.95	1.73	2.18	<.0001
	Low												

** *Reference Category, ***p-value<0.05*

Table 6: Estimated Odds Ration from Models 1, 2, and 3 for Jharkhand

Jharkhand													
		Unadjusted OR	95% Confidence Interval		P-Value	Adjusted OR Without Including Leve-2 Variation	95% Confidence Interval		P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval		P-Value
Age	15-24**												
	25-34	4.27***	3.88	4.71	<.0001	3.29***	2.96	3.66	<.0001	3.62***	3.25	4.03	<.0001
	35-49	6.18***	5.61	6.80	<.0001	4.27***	3.82	4.77	<.0001	4.84***	4.32	5.43	<.0001
Education	No Education**												
	Primary	1.17***	1.07	1.27	<.0001	1.25***	1.13	1.38	<.0001	1.30***	1.17	1.44	<.0001
	Secondary	0.84***	0.78	0.89	0.0009	1.03	0.94	1.12	0.5277	1.15***	1.05	1.25	0.0021
	Higher	0.71***	0.63	0.81	<.0001	0.70***	0.60	0.82	<.0001	0.79***	0.67	0.93	0.0051
Residence	Urban	1.36***	1.27	1.45	<.0001	1.01	0.92	1.10	0.8859	1.02	0.92	1.12	0.7579
	Rural**												
Religion	Hindu	2.32***	2.11	2.55	<.0001	2.90***	2.63	3.21	<.0001	3.03***	2.74	3.36	<.0001
	Muslim**												
	Other	0.93	0.82	1.05	0.2522	1.23***	1.07	1.41	0.0028	1.75***	1.51	2.03	<.0001
Total Children Ever Born	0-2**												
	>2	2.78***	2.62	2.94	<.0001	2.11***	1.97	2.27	<.0001	2.13***	1.98	2.30	<.0001
Wealth Status	Poor**												
	Middle	1.63***	1.51	1.77	<.0001	1.58***	1.44	1.74	<.0001	1.39***	1.26	1.54	<.0001
	Rich	1.54***	1.43	1.65	<.0001	1.44***	1.29	1.61	<.0001	1.31***	1.17	1.47	<.0001
Exposure to Media	No**												
	Yes	1.28***	1.21	1.36	<.0001	1.16***	1.08	1.25	<.0001	1.13***	1.05	1.22	0.0019
Knowledge Score	High	1.75***	1.62	1.90	<.0001	1.78***	1.63	1.95	<.0001	1.60***	1.46	1.76	<.0001
	Low**												

** *Reference Category, ***p-value<0.05*

Table 7: Estimated Odds Ration from Model 1, 2, and 3 for Madhya Pradesh

Madhya Pradesh													
		Unadjusted OR	95% Confidence Interval		P-Value	Adjusted OR Without Including Leve-2 Variation	95% Confidence Interval		P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval		P-Value
Age	15-24**												
	25-34	4.24***	3.99	4.51	<.0001	3.39***	3.17	3.61	<.0001	3.56***	3.33	3.81	<.0001
	35-49	6.09***	5.74	6.47	<.0001	4.14***	3.86	4.44	<.0001	4.21***	3.92	4.53	<.0001

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Education	No Education**												
	Primary	0.92***	0.88	0.97	<.0001	1.03	0.97	1.09	0.319	0.99	0.93	1.05	0.62
	Secondary	0.61***	0.59	0.64	<.0001	0.87***	0.82	0.92	<.0001	0.80***	0.76	0.86	<.0001
	Higher	0.60***	0.55	0.65	<.0001	0.75***	0.68	0.82	<.0001	0.69***	0.62	0.76	<.0001
Residence	Urban	0.92***	0.88	0.95	<.0001	0.82***	0.78	0.87	<.0001	0.87***	0.82	0.92	<.0001
	Rural**												
Religion	Hindu	1.29***	1.20	1.39	<.0001	1.41***	1.30	1.54	<.0001	1.47***	1.35	1.61	<.0001
	Muslim**												
	Other	1.35***	1.11	1.65	0.0025	1.54***	1.25	1.90	<.0001	1.67***	1.34	2.08	<.0001
Total Children Ever Born	0-2**												
	>2	2.80***	2.69	2.91	<.0001	1.92***	1.84	2.02	<.0001	1.99***	1.90	2.09	<.0001
Wealth Status	Poor**												
	Middle	1.09***	1.03	1.15	0.0017	1.08***	1.02	1.15	0.0109	1.11***	1.04	1.19	0.0011
	Rich	1.02	0.98	1.06	0.4391	1.07***	1.01	1.14	0.026	1.12***	1.05	1.20	0.0007
Exposure to Media	No**												
	Yes	1.14***	1.10	1.19	<.0001	1.24***	1.18	1.30	<.0001	1.15***	1.09	1.21	<.0001
Knowledge Score	High	1.94***	1.83	2.05	<.0001	2.24***	2.10	2.39	<.0001	1.71***	1.59	1.83	<.0001
	Low**												

** *Reference Category*, ****p-value<0.05***

Table 8: Estimated Odds Ration from Model 1, 2, and 3 for Odisha

Odisha													
		Unadjusted OR	95% Confidence Interval		P-Value	Adjusted OR Without Including Leve-2 Variation	95% Confidence Interval		P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval		P-Value
Age	15-24**												
	25-34	2.52***	2.32	2.74	<.0001	2.14***	1.96	2.33	<.0001	2.22***	2.04	2.43	<.0001
	35-49	2.98***	2.75	3.23	<.0001	2.16***	1.97	2.36	<.0001	2.29***	2.08	2.51	<.0001
Education	No Education**												
	Primary	1.08***	1.00	1.17	<.0001	1.02	0.94	1.10	0.6983	1.07	0.98	1.16	0.1249
	Secondary	0.82***	0.78	0.87	0.0045	0.84***	0.78	0.91	<.0001	0.92***	0.85	1.00	0.0491
	Higher	0.67***	0.60	0.76	<.0001	0.61***	0.53	0.70	<.0001	0.69***	0.59	0.80	<.0001
Residence	Urban	1.17***	1.10	1.25	<.0001	1.11***	1.02	1.20	0.0111	1.06	0.98	1.15	0.1621
	Rural**												
Religion	Hindu	1.32***	1.07	1.64	0.0101	1.48***	1.18	1.85	0.0006	1.26***	1.00	1.59	0.0472
	Muslim**												
	Other	1.62***	1.27	2.07	0.0001	1.87***	1.44	2.41	<.0001	1.40***	1.07	1.84	0.0142
Total Children Ever Born	0-2**												
	>2	2.01***	1.90	2.12	<.0001	1.79***	1.68	1.91	<.0001	1.79***	1.68	1.91	<.0001
Wealth Status	Poor**												
	Middle	1.14***	1.06	1.22	0.0002	1.15***	1.07	1.24	0.0003	1.09***	1.01	1.18	0.0288
	Rich	1.12***	1.04	1.19	0.0015	1.16***	1.06	1.27	0.0012	1.08	0.98	1.18	0.111
Exposure to Media	No**												
	Yes	1.33***	1.26	1.41	<.0001	1.38***	1.30	1.47	<.0001	1.38***	1.29	1.47	<.0001
Knowledge Score	High	2.13***	1.95	2.33	<.0001	2.13***	1.93	2.34	<.0001	1.95***	1.77	2.15	<.0001
	Low**												

** *Reference Category*, ****p-value<0.05***

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Table 9: Estimated Odds Ration from Model 1, 2, and 3 for Rajasthan

Rajasthan													
		Unadjusted OR	95% Confidence Interval		P-Value	Adjusted OR Without Including Leve-2 Variation	95% Confidence Interval		P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval		P-Value
Age	15-24**												
	25-34	2.52***	2.32	2.74	<.0001	2.14***	1.96	2.33	<.0001	2.22***	2.04	2.43	<.0001
	35-49	2.98***	2.75	3.23	<.0001	2.16***	1.97	2.36	<.0001	2.29***	2.08	2.51	<.0001
Education	No Education**												
	Primary	1.08***	1.00	1.17	<.0001	1.02	0.94	1.10	0.6983	1.07	0.98	1.16	0.1249
	Secondary	0.82***	0.78	0.87	0.0045	0.84***	0.78	0.91	<.0001	0.92***	0.85	1.00	0.0491
	Higher	0.67***	0.60	0.76	<.0001	0.61***	0.53	0.70	<.0001	0.69***	0.59	0.80	<.0001
Residence	Urban	1.17***	1.10	1.25	<.0001	1.11	1.02	1.20	0.0111	1.06	0.98	1.15	0.1621
	Rural**												
Religion	Hindu	1.32***	1.07	1.64	0.0101	1.48***	1.18	1.85	0.0006	1.26***	1.00	1.59	0.0472
	Muslim**												
	Other	1.62***	1.27	2.07	0.0001	1.87***	1.44	2.41	<.0001	1.40***	1.07	1.84	0.0142
Total Children Ever Born	0-2**												
	>2	2.01***	1.90	2.12	<.0001	1.79***	1.68	1.91	<.0001	1.79***	1.68	1.91	<.0001
Wealth Status	Poor**												
	Middle	1.14***	1.06	1.22	0.0002	1.15***	1.07	1.24	0.0003	1.09***	1.01	1.18	0.0288
	Rich	1.12***	1.04	1.19	0.0015	1.16***	1.06	1.27	0.0012	1.08	0.98	1.18	0.111
Exposure to Media	No**												
	Yes	1.33***	1.26	1.41	<.0001	1.38***	1.30	1.47	<.0001	1.38***	1.29	1.47	<.0001
Knowledge Score	High	2.13***	1.95	2.33	<.0001	2.13***	1.93	2.34	<.0001	1.95***	1.77	2.15	<.0001
	Low**												

*** Reference Category, ***p-value<0.05*

Table 10: Estimated Odds Ration from Model 1, 2, and 3 for Uttarakhand

Uttarakhand										
		Unadjusted OR	95% Confidence Interval	P-Value	Adjusted OR Without Including Leve-2 Vari	95% Confidence Interval	P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval	P-Value

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						ation							
Age	15-24**												
	25-34	3.58***	3.15	4.07	<.001	3.28***	2.87	3.75	<.001	3.22***	2.82	3.69	<.001
	35-49	5.25***	4.63	5.96	<.001	4.31***	3.74	4.98	<.001	4.11***	3.55	4.76	<.001
Education	No Education**												
	Primary	1.31***	1.16	1.47	<.001	1.32***	1.16	1.51	<.001	1.26***	1.10	1.45	0.0007
	Secondary	0.93	0.85	1.02	0.2495	1.11	0.99	1.24	0.0877	0.98	0.87	1.11	0.7926
	Higher	0.71***	0.63	0.80	<.001	0.85***	0.73	0.99	0.0409	0.75***	0.63	0.88	0.0004
Residence	Urban	0.80***	0.74	0.87	<.001	0.91	0.83	1.01	0.0721	1.14***	1.03	1.27	0.0137
	Rural**												
Religion	Hindu	2.64***	2.32	2.99	<.001	2.75***	2.39	3.17	<.001	2.18***	1.88	2.53	<.001
	Muslim**												
	Other	1.99***	1.44	2.76	<.001	2.06***	1.47	2.90	<.001	2.27***	1.61	3.21	<.001
Total Children Ever Born	0-2**												
	>2	1.90***	1.76	2.05	<.001	1.44***	1.31	1.58	<.001	1.49***	1.35	1.65	<.001
Wealth Status	Poor**												
	Middle	0.93	0.84	1.04	0.1972	1.00	0.89	1.12	0.9591	1.03	0.92	1.16	0.604
	Rich	0.85***	0.78	0.94	0.001	0.98	0.87	1.11	0.7266	1.11	0.98	1.26	0.1123
Exposure to Media	No**												
	Yes	1.18***	1.08	1.29	0.0003	1.18***	1.07	1.31	0.0015	1.13***	1.02	1.26	0.0249
Knowledge Score	High	2.35***	1.94	2.85	<.001	2.40***	1.95	2.96	<.001	2.31***	1.86	2.86	<.001
	Low**												

*** Reference Category, ***p-value<0.05*

Table 11: Estimated Odds Ration from Model 1, 2, and 3 for Uttar Pradesh

Uttar Pradesh													
		Unadjusted OR	95% Confidence Interval		P-Value	Adjusted OR Without considering Leve-2 Variation	95% Confidence Interval		P-Value	Adjusted OR Including Leve-2 Variation	95% Confidence Interval		P-Value
Age	15-24**												
	25-34	2.81***	2.65	2.97	<.0001	2.16***	2.03	2.30	<.0001	2.31***	2.17	2.46	<.0001
	35-49	3.31***	3.13	3.50	<.0001	2.22***	2.08	2.37	<.0001	2.40***	2.25	2.57	<.0001
Education	No Education**												

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	Primary	1.08	1.02	1.13	0.8929	1.06	1.00	1.12	0.0594	1.08***	1.02	1.15	0.0061
	Secondary	1.08	1.04	1.12	0.8568	1.02	0.98	1.07	0.3381	1.12***	1.06	1.17	<.0001
	Higher	1.17***	1.11	1.24	<.0001	1.03	0.96	1.10	0.4736	1.21***	1.12	1.30	<.0001
Residence	Urban	1.51***	1.45	1.57	<.0001	1.23***	1.18	1.29	<.0001	1.05	1.00	1.10	0.0711
	Rural**												
Religion	Hindu	1.53***	1.46	1.60	<.0001	1.88***	1.79	1.98	<.0001	1.88***	1.78	1.99	<.0001
	Muslim**												
	Other	2.43***	1.88	3.13	<.0001	2.10***	1.61	2.73	<.0001	1.91***	1.46	2.49	<.0001
Total Children Ever Born	0-2**												
	>2	1.88***	1.82	1.95	<.0001	1.86***	1.77	1.94	<.0001	1.93***	1.85	2.03	<.0001
Wealth Status	Poor**												
	Middle	1.33***	1.27	1.39	<.0001	1.29***	1.23	1.36	<.0001	1.14***	1.08	1.20	<.0001
	Rich	1.77***	1.71	1.84	<.0001	1.61***	1.53	1.70	<.0001	1.29***	1.22	1.36	<.0001
Exposure to Media	No**												
	Yes	1.56***	1.51	1.62	<.0001	1.35***	1.29	1.40	<.0001	1.27***	1.22	1.33	<.0001
Knowledge Score	High	2.71***	2.49	2.96	<.0001	2.09***	1.91	2.29	<.0001	1.64***	1.49	1.81	<.0001
	Low**												

*** Reference Category, ***p-value<0.05*

Women having more than two children ever born has significantly more chance to use modern contraceptives as compared to women with two or less than two children ever born. These findings were the same for all eight states.

Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, and Uttar Pradesh results show that women belonging to middle and rich wealth status families has a higher chance of using modern contraceptive compared to women belonging to poor families however women residing in Odisha and Rajasthan and belonging to middle wealth status family has higher odds of using modern contraceptive as compared to women belonging to poor wealth status family.

Further our results show that in all eight states if a woman is exposed to any kind of media then the chance of using modern contraceptives increases as compared to those who were not exposed to any kind of media. Finally, women with high knowledge scores have significantly higher odds of using modern contraceptives as compared to women with low knowledge scores.

Table 11 shows the AIC (Akaike Information Criterion) for Model-3 and Model-4.AIC is most frequently used to test the model fitting for a given dataset. The lower the value of AIC for a particular model the better model fits the data. As the table shows, AIC is smaller for Model-4 as compared to Model-3 for all EAG states.

Table 12: AIC estimates for Model-3 and Model-4 for all EAG states

State	AIC (Model-3)	AIC (Model-4)
Bihar	33458	31747
Chhattisgarh	18891	18640
Jharkhand	23721	23157
Madhya Pradesh	54708	51684
Odisha	29972	29628
Rajasthan	35239	34588
Uttar Pradesh	74501	71539
Uttarakhand	14240	13940

Family planning is a key to achieving safe motherhood and reducing maternal mortality in developing countries like India. Increasing contraceptive use results in reducing maternal death by 40% [26]. Apart from these benefits contraceptive use can improve maternal health by increasing the gap between two pregnancies as shorter birth interval results in low birth weight, risk of prematurity, and infant death [27, 28].

In this study, we analyzed socioeconomic and demographic determinants of modern contraceptive use among women aged 15-49 who are currently non-pregnant, fecund, and married in the EAG states of India. Age, residence, education, wealth status, exposure to media, the number of children ever born, religion, and,

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knowledge score was found to be significant predictors of modern contraceptive use. Further, the study suggests that the odds of using modern contraceptives among women in the age group 15-24 were low as compared to women in the age group 25-34 and 35-49. This may be due to the reason that at the early age of marries life women would like to raise children. The chance of using contraceptive were almost four times for women aged 35-49 compared to women in the age group15-24 [7].

Our study findings also showed that modern contraceptive use was high among high wealth [29]. Exposure to any kind of media plays a crucial role in increasing modern contraceptive use as it helps women to understand the benefits and risks associated with the non-use of contraceptive methods [30]. Women residing in urban areas have higher odds of using modern contraceptives consistent with previous research [31, 32]. This may be since women living in urban areas have easy access to medical health services as compared to women living in rural areas. Women with high knowledge scores were more likely to use modern contraceptives in all eight states as knowledge score was based on how many modern contraceptives was a woman able to name. Knowing the contraceptive method increases the basket of choice of modern contraceptives and women can select one at their convenience. Total children ever born is also an important determinant of using modern contraceptives. Compared to women with 2 or less than 2 and greater than two children ever born, chances for modern contraceptives use were high among women with 2 or more living children ever born.

V. CONCLUSION

Our study findings conclude that married women who were at their early age (15-24 years) are less likely to use modern contraceptive methods as compared to women with ages 25-49. This may be due to the reason that at an early age women are more likely to get pregnant but the focus should be given to such women to prevent unintended pregnancies. Study reveals that religion plays an important role in using modern contraceptive use, Muslim women were found less likely to use modern contraceptives as compared to Hindu women. Individuals level factors such as wealth index, media exposure, and knowledge score were found to be significant predictors of modern contraceptive use in all EAG states.

Our finding also reveals that district-level variations were present in modern contraceptive use in all EAG states which indicates multilevel models should be used to obtain better estimates when dealing with data that possess nested structure and thus justifies our objective of the study.Model-4 which includes district-level variation gives a more precise estimated odd ratio as compared to model-3 where no district-level variation was considered. Thus the study recommends using the Hierarchical model in such cases where the structure of the data is a hierarchy or nested in nature as it gives better estimates. Also to increase modern contraceptive use in EAG states, interventions such as media exposure to enhance the knowledge of modern contraceptive use should be promoted.

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All authors contributed equally.

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