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Title: Revisiting Consanguineous Marriages and their Effect on Pregnancy Outcomes in India: Evidences from a Nation-wide Survey

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Revisiting Consanguineous Marriages and Their Effect on Pregnancy Outcomes in India: Evidences from a Nation-Wide Survey

Abstract Supported by the Indian Human Development Survey (IHDS, 2004-2005), this analytic study examines the practice of marriage between collateral relatives and its adverse consequences on pregnancy among Indian married women (age group 15-49). The assessment of occurrence of consanguineous marriages by the states, and the background characteristics of women reveals that the above are more predominant in south India states than in the north India states; women in younger age groups and disadvantageous socioeconomic groups than their counter-groups. However, results of trivariate analysis indicate that within the women of same age and socio-economic standing, the adverse pregnancy outcomes were greater among the women with consanguineous marriage than non-consanguineous marriage. The estimates of Cox regression hazard model reveals that the Relative Risk (RR) of having stillbirth (RR=1.59, p-value < 0.01), abortion (RR = 3.03, p-value < 0.01), miscarriage (RR=1.94, p-value < 0.01) and spontaneous miscarriage (RR=1.70, p-value < 0.01) were higher among consanguineous mothers as compared to non-consanguineous mothers (RR=1.00). Results based on a nationwide survey data fosters that consanguineous marriages are critical predicators of adverse pregnancy outcomes in India. Analytically, this study recommends that educating the people on the negative effects of reproduction because of consanguineous marriages, is critical for avoiding wastage of pregnancy, and related reproductive health problems in India.

Keywords Consanguineous marriages, Stillbirths, Abortions, Miscarriage, Spontaneous miscarriage, Effect.

Introduction

Consanguineous marriage refers to marriage of individuals having a common ancestor or between a man and woman related by blood[1,2,3,4,5,6]. The most common form of consanguineous marriage restrained is between first cousins[7]. However, consanguineous marriage range from cross cousin to more distant relatedness and their prevalence varies by cultural traits followed by a community[8,9]. Globally, one-fifth of the human population around the world lives in communities with a preference for consanguineous marriage and at least 8.5% of children have consanguineous parents[10]. There is a widespread preference in South Asia for marriage between a genealogical or 'classificatory' "mother's brother" and his "elder sister's daughter"[11,12]. Beck[13] has plotted the distribution of this preference as precisely as present knowledge permits, and the resulting map shows that in all the four south India states (Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu), some or all of the population of every administrative district allows marriages of this type.

Previous literature on this subject also displays that minor women, married to their blood relatives, experienced a greater amount of pregnancy wastage and child loss (first child) as compared to those women, married to their distant relatives or non-relatives[14]. Children from such marriages, therefore, are at a greater risk inheriting any harmful condition caused by homozygous recessive genes and consequently suffer autosomal recessive genetic disorders[15,16]. Manifestation of birth defects in the offspring of first cousin parents is substantially greater than in the offspring of non-consanguineous parents and the consanguineous mothers had more stillbirths in comparison with non-consanguineous mothers[17]. Moreover, the researchers also revealed that for every incidence of parental consanguinity, the risk (odds) of birth of a child with congenital heart diseases (CHDs) increases[18]. From an explorative study[19], it is found that stillbirth rates and congenital malformation rates were significantly higher in offspring born to mothers of consanguineous marriage than non-consanguineous marriage, and significantly, decrease in the mean birth weight and head circumference of neonate born to consanguineous parents was noted in the poor, middle, and upper socioeconomic class.Nevertheless, most of the earlier studies in Indian context[20,21,22,23,24,25,26,27'28,29,30,31,32,33,34,35,36,37,38,39], which examined the level of consanguineous marriages and their effect on pregnancy outcomes are either case studies or limited their scope to local level. Therefore, there is an imperative need to assess the variation in level of consanguineous marriages by states and socioeconomic groups from a nation-wide data of India. Conjointly, there is also a need to quantify their effect on adverse pregnancy outcomes across socioeconomic groups by applying advanced statistical models in survival analysis.

Data and Methods

In this study, we have used the India Human Development Survey (2004-05)[40] to assess the levels and patterns of consanguineous marriages and to quantify their effect on adverse pregnancy outcomes. IHDS is the collaborative project of researchers from the University of Maryland and National Council of Applied Economic Research (NCAER), New Delhi. IHDS is a nationally representative, multi-topic survey covering 41,554 households across India. As part of the survey, ever-married women between the ages of 15-49 were asked specific information about marriage practices such as consanguineous marriages. The question asked in this survey was "Are you related to your husband by blood? If so, what is the relationship?" (Options given were that no relation, Uncle, Cousin, Other). Similarly, questions were asked to women concerning history of pregnancy outcome such as Stillbirth, Miscarriage, Spontaneous Abortions, and Induced Abortions etc. However, for the present study, we have used pregnancy information of currently married women in age group 15-49 for five years preceding the date of survey.

Sample Design

Villages and urban blocks (comprising of 150-200 households) formed the primary sampling units (PSUs) from which the households were selected. The urban and rural PSUs' were selected by

separate sample designs each. In order to draw a random sample of urban households, urban areas in a state were listed in the order of their size with number of blocks selected from each urban area allocated, based on Probability Proportional to Sizes (PPS). Once the number of blocks for each urban area was determined, the enumeration blocks were drawn randomly with the help of office of the Registrar General of India (RGI). From this Census Enumeration Blocks (CEB) of about 150-200 households, a complete household listing were conducted and sample of 15 households was selected per block. For sampling purposes, some smaller states were combined with nearby larger states. The rural sample contains about half of the households that were interviewed initially by NCAER in 1993-94 in a survey titled Human Development Profile of India -- HDPI and the other half of the samples were drawn from both districts surveyed in HDPI as well as from the districts situated in the states and territories not covered in HDPI. The original HDPI was a random sample of 33,230 households, located in 16 major states, 195 districts, and 1,765 villages. In states where the 1993-94 survey was conducted and recontact details were available, 13,593 households were randomly selected for re-interview in 2005[41].

Statistical analysis

All the statistical analysis of the study were done by using stata version 10.1 (stata crop LP, College Station, Texas, USA) and Microsoft excel program. The analyses were carried out in two stages: in the first stage, the bivariate and binary logistic regression models were used to estimate the variation in occurrence of consanguineous marriages and types of consanguinity by the state and socio-economic background characteristics of women. In the binary Logit regression, consanguineous marriage (Yes, No) was considered as dependent variable. However, in the second stage, the trivariate estimates were accomplished with pregnancy outcomes as a dependant variable and consanguineous marriage as the primary and other socioeconomic variables as the secondary independent variables. Moreover, Cox proportional hazard regression model was used to estimate the relative risk of adverse pregnancy outcome for women by consanguinity. However, the model was controlled for other relevant covariates such as region (south, north, northeast and west), age of the women (15 – 24, 25 – 34, 35 & above), age at marriage (less than 18, more than 18), place of residence (rural, urban) caste (OBC, SC, ST, other), religion (Hindu, Muslim, other), education (no education, primary, secondary higher) and economic status (poor, middle, rich).

Mathematical procedure for Cox proportional hazard model:

Cox and Oakes (1984)[42] defined the hazard model used in the study. In this model, the pregnancy outcomes such as stillbirths, miscarriages, spontaneous miscarriages and abortions were the outcome variables. The type of marriage (consanguineous/non-consanguineous) is the key predictor variable; however model was controlled for other covariates like region, age of the women, age at marriage, place of residence, caste, education and economic status etc.

The mathematical form of this model is expressed as following:

$$h_i(t) = h_0 exp(\beta_1 x_{i1} + \beta_2 x_{i2} + \cdots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_k x_{ik})$$

where, '*i*' is subscript for observation, and the '*x*'s are covariates(e.g. region, age of the women, age at marriage, place of residence, caste, religion, education level of women, economic status). The quantity $h_0(t)$ is the baseline or underlying hazard function and corresponds to the probability of having adverse pregnancy outcome (stillbirth, miscarriage, spontaneous miscarriage and abortions) when all explanatory variables are zero. The baseline hazard function is analogous to the intercept in ordinary regression (since $\exp^0 = 1$).

The regression coefficients β give the proportional change that can be expected in the hazard of having adverse pregnancy outcome, associated with the changes in the explanatory variable. The Cox proportional regression model assumes that the hazard of having adverse pregnancy outcome at time't' (age of women) of women of consanguineous marriage (z) is proportional to the hazard of the women of non-consanguineous marriage (y) by the same factor ψ at every time t; mathematically expressed as following equation:

$$h_z(t) = \psi h_y(t)$$

Where, h_z and h_y are the hazards (probabilities of having adverse pregnancy outcome) for the two groups of women and ψ is the hazard ratio. If ψ > 1, the hazard of having adverse pregnancy outcome is larger for women of consanguineous marriage compared to those of non-consanguineous marriage, so that non-consanguineous marriage reduces the chance of adverse pregnancy outcome. If ψ <1 or ψ =1, the hazard of having adverse pregnancy outcome are smaller or equal for both women of consanguineous marriage and non-consanguineous marriage. This indicates that consanguineous marriages have not shown any effect (ψ =1) or negatively related to adverse pregnancy outcome.

Results

Percentage of consanguineous marriages in major states

Geographically, India is as heterogeneous as the world in terms of its cultural practices. Greater focus of earlier assessment of consanguinity was confined to south India states. However, in this study we have presented a comparative assessment for all the major states of India. Table 1 displays the state level estimates of consanguinity. Results reveal that women, whose spouses are their blood relatives, are highest in Tamil Nadu (38%) followed by Andhra Pradesh (30%). However, states like Maharashtra and Karnataka also show considerable occurrence of consanguineous marriages i.e., 29% and 28%, respectively. On the contrary, Himachal Pradesh, show the lowest percentage (1%) of women marrying within their blood relatives. In broad-spectrum, the results reveal that the south India states have showed greater occurrence of consanguineous marriages than the north India states.

Percentage of consanguineous marriages by background characteristics

India has the great diversity of social groups and as well as economic class. Assuming the uniformity of consanguinity across these groups can be a great misapprehension. Therefore, present study assessed the socio-economic variations in consanguineous marriages. Table 2 presents the bivariate results of the percentage of women marrying within their blood relatives by different socio-economic background characteristics. The results are upkeep with our proposition of socio-economic variations in consanguinity and thus reveal that the occurrence of consanguineous marriages is not uniform across the socio-economic groups in India. By women's age, results indicate that the highest percentage (20%) of women married within their blood relatives are in age group 15 to 24. Surprisingly, greater proportion of women (18%) from urban areas is married to the men from consanguine relations than rural areas (16%). Women belonging to other backward castes (17%) and Muslim religion (25%) are evident for greater proportion of women got married in their own blood relations in comparison to their counter groups. Evidences also indicate that greater proportion of lower educated women, i.e., not educated or primary educated women are married among their blood relations (18%) than higher educated women (11%). Similarly, by economic status, the highest percentage (17%) of women from poor economic status are married among their own blood relation in comparison to women belonging to middle (16%) and rich economic status (15%).

Type of Consanguinity by background characteristics

The numerous endogamous populations in India have a tradition of practising marriage with their blood relatives i.e. uncle or cousin. The type of consanguinity differs with different background characteristics of women. Table 3 presents the differentials in type of consanguineous marriages by women's background characteristics such as age, age at marriage, place of residence, caste, religion, educational and economic status. However, across all the socioeconomic categories, by types of consanguineous marriages, the cousin marriages are more preferable than other type of consanguineous marriages in India. The highest percentage (65%) of cross-cousin marriages is observed in the Muslim religion; whereas, the highest percentage (33%) of women married to their uncles is observed in SC caste category. However, the women married to their uncles and cousins are found more in rural area (57%, 25% respectively) than urban area (43%, 21% respectively). Similarly, the proportion of women married with uncles and cousins are greater among socio-economically disadvantageous groups such as no education and poor economic status categories than other advantageous socio-economic categories.

Prevalence of pregnancy outcomes by background characteristics

The table 4 explains the negative influence of consanguineous marriages on pregnancy outcomes (stillbirths, abortions, miscarriages, and spontaneous miscarriages) by the background characteristics of women.

Stillbirths

Growing number of studies in public health research fostered socio-economic characteristics are the critical determinants of maternal health and resultant stillbirths. However, results from this study reveal that among the women of same socio-economic standing, the prevalence of stillbirth is high among the women in consanguineous marriages than non-consanguineous marriages. For instance, within the same age group 35 & above, stillbirths are considerably greater among the consanguineous marriages (9 per 100 live births) than women of non-consanguineous marriage (5 per 100 live births). Similarly, among the women with same age at marriage i.e. aged less than 18, stillbirths are greater prevalent in consanguineous mothers (9 per 100 live births) in comparison with non-consanguineous mothers (5 per 100 live births). Within the rural place of residence, the prevalence of stillbirths (9 per 100 live births) in consanguineous mothers is greater in comparison with non-consanguineous mothers (5 per 100 live births). Further, the prevalence of stillbirth in urban areas (7 per 100 live births) in consanguineous mothers is more compared to non-consanguineous mothers (4 per 100 live births). In all the caste groups, prevalence of stillbirths is greater among mothers with consanguineous marriage than non-consanguineous marriage.

In case of Hindu religion, the prevalence of stillbirths is greater among consanguineous mothers (7 per 100 live births) as compared to non-consanguineous mothers (4 per 100 live births). Similar pattern of results are also observed in Muslim religion, i.e. the prevalence of stillbirth in consanguineous mothers (11 per 100 live births) is greater compared to non-consanguineous mothers (7 per 100 live births). Commensurately, the result for all the categories of women's education indicates that the prevalence of stillbirths is greater in consanguineous mothers as compared to non-consanguineous mothers. For instance, in no education category, the prevalence of stillbirths is 9 per 100 live births in consanguineous mothers and only 5 per 100 live births in non-consanguineous mothers. Likewise, among all economic groups, prevalence of stillbirths is higher in consanguineous mothers in comparison with non-consanguineous mothers. In poor economic group, the prevalence of stillbirths is 11 per 100 live births in consanguineous mothers and 6 per 100 live births in non-consanguineous mothers. Overall, the results from table 4 reveal that the prevalence of stillbirths is greater in the women married within their blood relatives.

Abortions

Corresponding to the results of stillbirths, the results for prevalence of abortions also showed greater prevalence among the women in consanguineous marriages compared to non-consanguineous marriages. For example by age, the results indicate that within the age group of 35 & above, abortion rates are high among consanguineous marriages (5 per 100 live births) than non-consanguineous marriages (2 per 100 live births). Similarly, among women with same age at marriage i.e., in less than 18 years, the abortions rates are doubled in consanguineous marriages compared to non-

consanguineous marriages. Inside the rural areas, the prevalence of abortions is 4 per 100 live births in consanguineous group and where as it is only 2 per 100 live births in non-consanguineous group. Similarly, within the urban areas, the prevalence of abortions is 5 per 100 live births in consanguineous marriage but it is only 3 per 100 live births in non-consanguineous marriages. Among the same caste groups, the abortions rates considerably vary by the type of marriage. For instance, in OBC caste group the prevalence of abortions in consanguineous marriage is three times (6per 100 live births) higher in comparison with non-consanguineous group (2per 100 live births). Similarly, in other categories of caste groups, the preponderance rate of abortions considerably varies for consanguineous and non-consanguineous marriages.

By religion, results also indicate that the prevalence of abortions is higher in consanguineous group of the Hindu religion (4 per 100 live births) than in non-consanguineous group (3 per 100 live births). Similarly, the prevalence of abortions is considerably greater in consanguineous group of the Muslim religion (5 per 100 live births) compared to non-consanguineous group (2 per 100 live births). Likewise, among all categories of education, prevalence of abortions is higher in consanguineous group compared to non-consanguineous group. In the primary education category, the prevalence of abortions is twice higher in consanguineous group (7 per 100 live births) than in non-consanguineous group (3 per 100 live births). Similarly, among women in rich economic group, the prevalence of abortions is twice greater in consanguineous group (6 per 100 live births) than in non-consanguineous group (3 per 100 live births).

Miscarriages

Corresponding to prevalence of stillbirths and abortions, the prevalence of miscarriages is also high among the women in consanguineous marriages than non-consanguineous marriages. For instance, within the age group 35 & above, prevalence of miscarriages is greater in consanguineous marriages (14 per 100 live births) than non-consanguineous marriages (10per 100 live births). Similarly, among the women of the same age i.e. aged less than 18, miscarriages have greater occurrence (15 per 100 live births) in consanguineous marriages than women in non-consanguineous marriages (10 per 100 live births). Within the rural place of residence, the prevalence of miscarriages is greater in consanguineous marriages (14 per 100 live births) compared to non-consanguineous group (9 per 100 live births). In addition, the prevalence of miscarriage in urban area is greater in consanguineous group (13 per 100 live births) as compared to non-consanguineous group (10 per 100 live births). Within ST caste group, the prevalence of miscarriage is 14 per 100 live births in consanguineous marriage and 6 per 100 live births in non-consanguineous marriages. Moreover, in other category of caste group, the prevalence of miscarriage considerably varies for consanguineous and non-consanguineous marriages. In the Hindu religion, the prevalence of miscarriages is 12 per 100 live births in consanguineous marriages and 10 per 100 live births in non-consanguineous marriages. Similarly, in the Muslim religion, the prevalence of miscarriage in consanguineous marriage (17 per

100 live births) is considerably greater in comparison with non-consanguineous marriages (9 per 100 live births). By education, results reveal that in no education category, the prevalence of miscarriage is 13 per 100 live births in consanguineous group and only 8 per 100 live births in non-consanguineous group. In addition, results also demonstrate that among all other remaining education categories, prevalence of miscarriage is higher in consanguineous group than non-consanguineous group. In poor economic group, the prevalence of miscarriage is greater in consanguineous group (15 per 100 live births) in comparison with non-consanguineous group (9 per 100 live births).

Spontaneous Miscarriages

To commensurate with the results for all other pregnancy outcomes, the results of the prevalence of spontaneous miscarriages by type of consanguinity reveals that the occurrence of spontaneous miscarriages is also high among women in consanguineous marriages than non-consanguineous marriages. For example, within the same age group 25-34, results indicate that spontaneous miscarriages are considerably greater among the consanguineous marriages (11 per 100 live births) in comparison with women of non-consanguineous marriages (7 per 100 live births). Similarly, among the women of same age at marriage i.e. less than 18, spontaneous miscarriage has high prevalence (10 per 100 live births) in consanguineous marriages compared to women in non-consanguineous marriages (7 per 100 live births). Within the rural place of residence, the prevalence of spontaneous miscarriages is greater in consanguineous groups (9 per 100 live births) compared to non-consanguineous group (6 per 100 live births). However, in OBC caste group the prevalence of spontaneous miscarriage is 11 per 100 live births in consanguineous group and but only 8 per 100 live births in non-consanguineous group.

Similarly, prevalence of spontaneous miscarriage is greater in consanguineous group of the Hindu religion (8 per 100 live births) than in non-consanguineous group (7 per 100 live births). In the Muslim religion, the prevalence of spontaneous miscarriages in consanguineous marriage (11 per 100 live births) is considerably greater than non-consanguineous marriages (7 per 100 live births). Among all the categories of education, prevalence of spontaneous miscarriages is higher in consanguineous group than non-consanguineous group. However, in the secondary education category, the prevalence of spontaneous miscarriage is greater in consanguineous group (12 per 100 live births) than non-consanguineous group (8 per 100 live births). In the poor economic group, the prevalence of spontaneous miscarriages is greater in consanguineous group (12 per 100 live births) compared to non-consanguineous group (6 per 100 live births).

Logit regression estimates of consanguineous marriages by background characteristics

To find the adjusted effects of socioeconomic factors on consanguineous marriages, we have estimated odds ratios from Logit regression analysis. The results of Logit regression model estimates in table 5 confound with the bivariate analyses. The adjusted effects (odds ratios) of Logit regression

model for consanguineous marriages by the background characteristics confirm huge socio-economic variation in occurrence of consanguineous marriages. The prevalence of consanguineous marriages is less likely in North region (OR=0.14, $p < 0.01$, SE=0.12), Northeast and East region (OR=0.19, $p < 0.01$, SE=0.14) as compared to South region (OR=1.00) and these differences are statistically significant. Education is also playing significant role in prevalence of consanguineous marriages. By the educational status of women, results indicate that the prevalence of consanguineous marriages is less likely among women of primary (OR=0.57, $p < 0.01$, SE=0.12), secondary (OR=0.50, $p < 0.01$, SE=0.12) and higher (OR=0.33, $p < 0.01$, SE=0.28) education group as compared to no education group (OR=1.00). The likelihood of prevalence of consanguineous marriages decreases with increase in the educational status of women. Similarly, the prevalence of consanguineous marriages is significantly less in the rich economic group (OR=0.72, $p < 0.01$, SE=0.10) as compared to poor economic group (OR=1.00).

Cox proportional hazard model estimates of adverse pregnancy outcomes by consanguineous marriages and background characteristics

To find the adjusted effect of consanguineous marriages and its effect on pregnancy outcome and to control a kind of censor cases in data, we have used Cox proportional hazard regression model. The results of Cox proportional hazard model estimates in table 6 confound with the trivariate analysis. After controlling for background characteristics, the relative risk of having stillbirth is significantly higher among consanguineous group (RR=1.59, $p< 0.01$, SE=0.16) as compared to non-consanguineous group (RR=1.00). Similarly, the relative risk of miscarriage (RR=1.94, $p<0.01$, SE=0.12) and spontaneous miscarriage is significantly higher among consanguineous group (RR=1.70, $p< 0.01$, SE=0.15) in comparison with non-consanguineous group (RR=1.00). Further, the relative risk of having abortions is three times more (RR=3.03, $p< 0.01$, SE=0.22) for women of consanguineous marriages than women of non-consanguineous marriages and the difference between the above two categories. The relative risk estimates of Cox regression model indicate that consanguineous marriages are critical predictors of adverse pregnancy outcomes in India.

Discussion and Conclusion

Proceeding with many earlier explorative studies at local level, which had talked about the prevalence of consanguineous marriages and its effect on pregnancy outcome, the current research, is an effort to revisit the same with all India level data. The study also brought the methodological advancement in assessment of consanguineous marriages and its effect on pregnancy outcome in comparison with the earlier studies. Overall, the findings of this study foster number of intriguing conclusions and thus provided key insights.

First, the practice of marriages with close relatives was significantly more prevalent in south region than north region of India. This clearly represents the cultural divide in marriage patterns and customs

of north and south India. In addition, within the consanguineous marriages, the cross-cousin marriages are more preferred compared to those with the uncle. Second, the assessments of occurrence of consanguinity by background characteristics in India reveal that they were more prevalent among women in younger age groups and disadvantageous socioeconomic groups rather than their counter groups. Third, the results distinctly reveal that the practice of marriage within the blood relatives was greatly associated with adverse pregnancy outcomes in India. All the adverse pregnancy outcomes, which were assessed in this study show a greater prevalence in the consanguineous mothers compared to non-consanguineous mothers.

Overall, the results updates some of the earlier findings with more comprehensive evidences from nationwide data and re-establish that, till now, consanguineous marriages are critical predictors of adverse pregnancy outcomes in India. Therefore, this study fills all the critical gaps in documenting the evidence on occurrence of consanguineous marriages and its effect on pregnancy outcomes from a nationwide survey data from India. Analytically, this study recommends educating the people on the negative effects of consanguineous marriages that invariably leads to wastage of pregnancy and other related reproductive health problems in India.

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Table 1 Prevalence (per 100) of Consanguinity among major states of India, 2005.

States	Percentage of consanguinity	Sample size of women (N)
Andhra Pradesh	29.6	346
Karnataka	28.1	545
Tamilnadu	38.0	306
Kerala	3.20	261
Punjab	2.90	161
Himachal Pradesh	1.00	155
Haryana	2.30	273
Rajasthan	4.40	201
Chhattisgarh	1.30	206
Madhya Pradesh	5.40	353
Uttar Pradesh	10.4	364
Uttarakhand	1.30	47
Northeast states	3.50	183
West Bengal	8.30	165
Bihar	6.50	187
Jharkhand	12.2	97
Orissa	10.8	353
Assam	1.20	165
Maharashtra	28.5	644
Gujarat	6.30	212
India	16.3	5591

Note: a) All India percentage includes all the states and union territories of India.

b) Northeast states include Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland and Tripura. We have merged Northeast states due to very low samples at state level.

Table 2 Prevalence (per 100) of Consanguinity by background characteristics in India, 2005.

Background characteristics	Percentage of Consanguinity	Sample size of women (N)
Age		
15-24	20.0	-
25-34	17.4	71
35 & above	13.4	693
Age at marriage		
Less than 18	15.6	588
More than 18	16.6	174
Place of residence		
Rural	15.7	446
Urban	17.8	319
Caste		
OBC	17.5	361
SC	17.4	122
ST	11.1	44
Others	10.6	238
Religion		
Hindu	15.0	479
Muslim	25.2	258
Others	9.27	28
Education		
No Education	17.2	445
Primary	17.8	131
Secondary	16.1	167
Higher	10.7	-
Economic Status		
Poor	16.9	274
Middle	16.7	160
Rich	15.5	318

Table 3 Percentage distribution of type of Consanguinity by background characteristics in India, 2005.

Background characteristics	Uncle	Cousin	Other	Sample size of women (N)
Age				
15 – 24	-	-	-	-
25- 34	22.94	58.42	18.65	71
35 & above	23.42	51.16	25.42	693
Age at marriage				
Less than 18	23.90	55.46	20.64	588
More than 18	21.85	41.23	36.93	174
Residence				
Rural	24.84	57.19	17.97	446
Urban	20.81	43.40	35.79	319
Caste				
OBC	22.47	54.25	23.28	361
SC	33.46	50.86	15.68	122
ST	12.95	64.52	22.53	44
Other	19.86	47.26	32.88	238
Religion				
Hindu	26.87	45.38	27.75	479
Muslims	16.49	64.69	18.81	258
Other	24.20	50.42	25.39	28
Education				
No Education	21.68	60.11	18.21	445
Primary	22.75	40.90	36.36	131
Secondary	27.26	38.42	34.32	167
Higher	21.37	50.95	27.67	-
Economic Status				
Poor	25.08	57.10	17.81	274
Middle	22.29	55.86	21.85	160
Rich	22.18	44.99	32.84	318

Table 4 Prevalence (per 100) of stillbirth, abortion, miscarriage and spontaneous miscarriage by background characteristics by Consanguinity in India, 2005.

Background characteristics		Stillbirth Yes (%)	Abortion Yes (%)	Miscarriage Yes (%)	Spontaneous Miscarriage Yes (%)	Sample size of women (N)
Age						
15 - 24	CM	-	-	-	-	-
	Non CM	-	-	-	-	-
25- 34	CM	4.2	2.8	12.7	11.3	71
	Non CM	4.2	1.8	10.4	6.5	336
35 & above	CM	8.7	4.6	13.6	8.7	693
	Non CM	4.8	2.5	9.6	6.7	4486
Age at marriage						
Less than 18	CM	9.0	5.1	14.5	9.5	588
	Non CM	5.5	2.6	10.1	6.9	3441
More than 18	CM	4.0	2.3	10.3	6.9	174
	Non CM	3.0	2.1	8.5	6.3	1382
Place of Residence						
Rural	CM	9.4	4.3	13.9	9.2	446
	Non CM	5.2	1.9	9.2	6.4	2936
Urban	CM	6.6	4.7	12.9	8.5	319
	Non CM	4.1	3.3	10.4	7.2	1890
Caste						
OBC	CM	9.1	5.5	15.8	10.5	361
	Non CM	4.4	2.4	10.6	7.5	1886
SC	CM	-	-	-	-	-
	Non CM	5.3	2.6	8.8	5.3	854
ST	CM	20.5	2.3	13.6	6.8	44
	Non CM	5.5	0.0	5.7	5.0	440
Other	CM	7.6	2.9	12.6	9.7	238
	Non CM	4.7	3.0	10.2	6.9	1646
Religion						
Hindu	CM	6.9	4.0	12.1	8.1	479
	Non CM	4.5	2.5	9.7	6.6	3673
Muslims	CM	11.2	5.4	16.7	10.5	258
	Non CM	6.6	1.7	8.8	6.5	726
Other	CM	-	-	-	-	-
	Non CM	4.0	3.3	10.5	8.0	427
Education						
No Education	CM	9.4	4.0	12.8	8.3	445
	Non CM	5.0	1.8	8.4	5.9	2287
Primary	CM	6.9	6.9	15.3	8.4	131
	Non CM	5.8	3.0	10.2	6.5	912
Secondary	CM	7.2	3.6	15.0	12.0	167
	Non CM	3.7	3.0	10.7	7.7	1255
Higher	CM	-	-	-	-	-
	Non CM	2.3	3.9	13.2	7.2	304
Economic Status						
Poor	CM	11.3	2.9	15.0	12.0	274
	Non CM	5.8	1.8	8.8	6.4	1368
Middle	CM	7.5	3.8	10.6	6.3	160
	Non CM	4.2	3.1	10.8	7.2	873
Rich	CM	6.0	6.3	13.8	7.5	318
	Non CM	4.2	2.6	9.7	6.6	2498

Note: CM: consanguineous marriage

Non CM: non-consanguineous marriage

Table 5 Logit regression model estimations (Odds Ratios) of consanguineous marriage by background characteristics, India, 2005.

Background characteristics	Odds Ratio	95% C.I. for Exp(B) Lower	Upper	SE
Region				
South®	1.00	-	-	-
North & Central	0.14**	0.11	0.17	0.12
Northeast and East	0.19**	0.15	0.25	0.14
West	1.09	0.88	1.36	0.11
Age				
15-24®	1.00	-	-	-
25- 34	0.73	0.05	11.69	1.42
35 & above	0.60	0.04	9.40	1.41
Age at marriage				
Less than 18®	1.00	-	-	-
More than 18	0.87	0.71	1.06	0.10
Place of Residence				
Rural®	1.00	-	-	-
Urban	1.13	0.94	1.37	0.10
Caste				
OBC®	1.00	-	-	-
SC	0.96	0.75	1.23	0.12
ST	0.80	0.55	1.15	0.19
Other	0.78*	0.64	0.96	0.11
Religion				
Hindu®	1.00	-	-	-
Muslims	4.55**	3.66	5.67	0.11
Other	0.65*	0.43	1.00	0.21
Education				
No Education®	1.00	-	-	-
Primary	0.57**	0.45	0.73	0.12
Secondary	0.50**	0.40	0.63	0.12
Higher	0.33**	0.19	0.58	0.28
Economic status				
Poor®	1.00	-	-	-
Middle	0.86	0.68	1.08	0.12
Rich	0.72**	0.59	0.89	0.10

Note: a) ®-Reference Category, Level of significance: * $p < 0.05$, ** $p < 0.01$

b) The regions classification of Indian states has been done according to National Family Health Survey-3 and following are the regional specific states:

South: Andhra Pradesh, Karnataka, Tamilnadu, Kerala, Lakshadweep and Pondicherry.

North & Central: Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Rajasthan, Chandigarh, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Uttarakhand and Delhi.

Northeast and East: Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura, West Bengal, Bihar, Jharkhand and Orissa.

West: Gujarat, Maharashtra, Daman Div, Dadar Nagar Haveli.

Table 6a Cox regression model estimations (Relative Risk) of adverse pregnancy outcomes by consanguineous marriage and background characteristics, India, 2005.

Background Characteristics	Stillbirth				Miscarriage			
	Exp(B)	95.0% CI for Exp(B)		SE	Exp(B)	95.0% CI for Exp(B)		SE
		Lower	Upper			Lower	Upper	
Consanguineous Marriage								
No®	1.00	-	-	-	1.00	-	-	-
Yes	1.59**	1.15	2.18	0.16	1.94**	1.53	2.46	0.12
Region								
South®	1.00	-	-	-	1.00	-	-	-
North & Central	1.34	0.94	1.92	0.18	1.73**	1.34	2.24	0.13
Northeast And East	1.52*	1.04	2.23	0.19	2.19**	1.69	2.84	0.13
West	1.85**	1.26	2.72	0.20	1.24	0.92	1.67	0.15
Age at marriage								
Less than 18®	1.00	-	-	-	1.00	-	-	-
More than 18	0.40**	0.29	0.56	0.17	0.51**	0.42	0.63	0.11
Place of Residence								
Rural®	1.00	-	-	-	1.00	-	-	-
Urban	0.81	0.61	1.08	0.14	0.96	0.79	1.16	0.10
Caste								
OBC®	1.00	-	-	-	1.00	-	-	-
SC	1.05	0.73	1.51	0.18	0.78	0.61	1.02	0.13
ST	1.64*	1.09	2.48	0.21	0.60*	0.41	0.90	0.20
Others	0.94	0.70	1.26	0.15	0.89	0.73	1.09	0.10
Religion								
Hindu®	1.00	-	-	-	1.00	-	-	-
Muslims	1.81**	1.32	2.48	0.16	0.92	0.72	1.18	0.12
Others	0.86	0.50	1.47	0.27	1.25	0.90	1.73	0.17
Education								
No Education®	1.00	-	-	-	1.00	-	-	-
Primary	1.20	0.88	1.63	0.16	1.20	0.95	1.51	0.12
Secondary	1.11	0.78	1.57	0.18	1.52**	1.20	1.91	0.12
Higher	0.75	0.34	1.66	0.41	1.75**	1.21	2.53	0.19
Economic Status								
Poor®	1.00	-	-	-	1.00	-	-	-
Middle	0.68*	0.48	0.95	0.18	1.05	0.82	1.34	0.13
Rich	0.66**	0.49	0.88	0.15	0.87	0.71	1.08	0.11

Note: ®-Reference Category, Level of significance: * $p < 0.05$, ** $p < 0.01$

Table 6b Cox regression model estimations (Relative Risk) of adverse pregnancy outcomes by consanguineous marriage and background characteristics, India, 2005.

Background Characteristics	Spontaneous Miscarriage				Abortion			
	Exp(B)	95.0% CI for Exp(B)		SE	Exp(B)	95.0% CI for Exp(B)		SE
		Lower	Upper			Lower	Upper	
Consanguineous Marriage								
No®	1.00	-	-	-	1.00	-	-	-
Yes	1.70**	1.27	2.27	0.15	3.03**	1.96	4.69	0.22
Region								
South®	1.00	-	-	-	1.00	-	-	-
North & Central	1.61**	1.19	2.17	0.15	1.58	0.97	2.59	0.25
Northeast And East	1.62**	1.18	2.23	0.16	3.03**	1.89	4.85	0.24
West	1.31	0.93	1.86	0.18	0.73	0.40	1.36	0.31
Age at marriage								
Less than 18®	1.00	-	-	-	1.00	-	-	-
More than 18	0.56**	0.44	0.71	0.13	0.42**	0.28	0.62	0.21
Place of Residence								
Rural®	1.00	-	-	-	1.00	-	-	-
Urban	0.99	0.79	1.25	0.12	1.34	0.94	1.90	0.18
Caste								
OBC®	1.00	-	-	-	1.00	-	-	-
SC	0.63**	0.45	0.88	0.17	0.95	0.60	1.51	0.23
ST	0.72	0.46	1.13	0.23	0.06**	0.01	0.41	1.02
Others	0.88	0.69	1.13	0.12	0.98	0.67	1.44	0.20
Religion								
Hindu®	1.00	-	-	-	1.00	-	-	-
Muslims	1.00	0.75	1.34	0.15	0.61*	0.37	0.99	0.25
Others	1.36	0.94	1.99	0.19	2.07*	1.18	3.63	0.29
Education								
No Education®	1.00	-	-	-	1.00	-	-	-
Primary	1.07	0.80	1.43	0.15	1.50	0.97	2.31	0.22
Secondary	1.53**	1.16	2.03	0.14	1.51	0.97	2.35	0.23
Higher	1.29	0.80	2.10	0.25	1.85	0.95	3.61	0.34
Economic Status								
Poor®	1.00	-	-	-	1.00	-	-	-
Middle	0.90	0.67	1.21	0.15	1.64*	1.00	2.69	0.25
Rich	0.75*	0.58	0.96	0.13	1.30	0.83	2.02	0.23

Note: ®-Reference Category, Level of significance: * $p < 0.05$, ** $p < 0.01$