Consanguineous marriages and their effect on pregnancy outcomes in India

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XXVII IUSSP International Population Conference
Busan, Korea, Republic of
26 August - 31 August, 2013

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Abstract

Purpose— The purpose of this study is to investigate the association between the marriage among the blood relatives and adverse pregnancy outcomes.

Data and Methods— This study uses data from India Human Development Survey (IHDS, 2005). The methods of analyses include bivariate, trivariate and Cox proportional hazard regression models.

Results— The results reveal that the occurrence of consanguineous marriages is more predominant in the states of southern India and among the socioeconomically disadvantageous groups. Moreover, the women in consanguineous union are more likely to have adverse pregnancy outcomes including stillbirths (RR=1.59, p-value < 0.01), abortions (RR = 3.03, p-value < 0.01), miscarriages (RR=1.94, p-value < 0.01) and spontaneous miscarriages (RR=1.70, p-value < 0.01) than non-consanguineous marriage. The consanguineous marriages continue to be a critical predictor of adverse pregnancy outcomes in India.

Implications— In order to avoid wastage of pregnancy and related reproductive health problems in India, it is imperative to initiate awareness creation measures regarding the adverse effect of consanguineous marriages, particularly in those regions where it is still dominantly prevalent.

Originality— For the first time in India, this study comprehensively examined the occurrence of consanguineous marriages and their association with adverse pregnancy outcomes by using advanced statistical analyses and national-wide sample survey data.

Keywords— Consanguineous marriage, Stillbirth, Abortion, Miscarriage, Spontaneous miscarriage, Pregnancy outcome, Cox regression hazard model

1. Introduction

Numerous studies have investigated consanguineous marriage as a 'legal union of male and female of a common ancestor or between a man and woman related by blood' (Centerwall, 1965; Centerwall & Centerwall, 1966; Bittles *et al*., 1985, 1987, 1992; Bittles & Hussain, 2000; Al –Salem & Raishdeh, 1993; Model & Darr, 2002; Tamim *et al*., 2003; Jurdi & Saxena, 2003; Yunis *et al*., 2008). The most common prevailing form of consanguineous marriage is between first cousins (Al–Salem & Raishdeh, 1993). However, consanguineous marriage range from cross cousin to more distant relations and their prevalence varies by cultural traditions followed by a community (Bittles *et al*., 1992; Yunis *et al*., 2008). 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 (Model & Darr,

2002). The prevalence of preference for consanguineous unions is particularly high in South Asian population (Beck, 1972; Chakraborty & Chakravarti, 1977). In Indian context, Hussain and Bittles (2000) analysed the National Family Health Survey (1992-93) and found the prevalence of consanguineous marriage is around 12% but, among Muslims, it is 22%. Beck (1972) 'plotted the distribution of preference for consanguineous marriage thereby demonstrating that four south Indian states including Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu, follow a widespread practice of consanguineous marriage in all their administrative districts'.

The consanguineous marriages have a number of socioeconomic, demographic and health implications. However, this study restricts its scope to only health implication in general and pregnancy outcomes in particular. Previous literature tells us that, women married to their blood relatives experienced a greater amount of pregnancy wastage and child loss as compared to those women married to their distant relatives or nonrelatives. Sadaat (2011), performed an ecological study using data from 63 countries, thereby raising the hypothesis that 'off springs from consanguineous marriages experience higher morbidity and mortality'. Bittles *et al* (1993) demonstrated that neonates born through consanguineous unions had higher mortality rates in Pakistan. Stoltenberg *et al* (1999) linked recurrent stillbirths to first cousin parents in Norwegian population. Children from consanguineous marriages are at a greater risk of inheriting harmful condition caused by homozygous recessive genes and consequently suffer autosomal recessive genetic disorders (McKusick, 1972; AshaBai *et al*., 1981; AshaBai & John, 1982; Sureender *et al*., 1998). The prevalence of still births and birth defects is substantially greater in the offspring of first cousin parents (Stoll *et al*., 1994). Moreover, studies also reveal that the risk of congenital heart diseases is considerably higher among children with parental consanguinity than non-consanguinity (Gowda & Ramachandra, 2006). A study by Kulkarni & Kurian (1990) found 'a significantly higher rate of stillbirths, congenital malformations, low birth weight and head circumference among children born within consanguineous marriage compared to non-consanguineous marriage'.

Most of the earlier studies in the Indian context are can be classified into two categories namely studies based on the national level data and studies based on evidence from local, region levels and case studies. The former comprises of studies focused on the nationally representative surveys data like National Family Health Survey (NFHS-1, 1992-93). Some of these studies have also assessed factor effecting consanguineous marriages (Rao *et al*., 1988; Rao, 1991; IIPS and Macro International, 1992-1993; Audinarayana & Krishnamurthy, 2000; Bittles & Hussain, 2000; Hussain & Bittles, 2000; Hussain *et al*., 2001; Krishnamurthy & Audinarayana, 2001; Padmadas & Nair, 2002; Sureender *et al*., 1998, 2003). However, this data is based on indirect information about the relationship between spouses rather than a direct question on consanguinity, and they are quite old by now. The latter category comprises of studies which focus at local or regional level evidences based on case studies, which examined the factors affecting the consanguineous marriages and their effects on pregnancy outcomes, are limited in scope and hence could not be considered representative of the general

population (Nath *et al.*, 2004). A large proportion of the existing research based on local and national surveys is not relevant to current conditions because India experienced a large scale socioeconomic transformation in the recent past (Dronamraju and Khan, 1963; Centerwall, 1965; Centerwall & Centrewall, 1966; Jhon & Jayabal 1971; Beck, 1972; Rao & Inbaraj, 1977, 1979, 1980; Rao *et al*. 19881; Rao, 1991; Bittles *et al*., 1985, 1987, 1992; Chakraborty & Chakravarti 1977; Devi *et al* 1981, 1987; Reddy, 1985; Kulkarni & Kurian, 1990; George *et al*. 1992; Babu *et al*., 1994; Sureender *et al*., 1998).

The present investigation meets the critical need to update the knowledge and information on consanguineous marriages and its effects on pregnancy outcomes by providing a comprehensive assessment of national level data considering variation in the level of consanguineous marriages by major states and socioeconomic groups across India. In addition, it quantifies consanguineous marriages effect on adverse pregnancy outcomes across socioeconomic groups by applying robust statistical models of survival analysis.

2. Methods

This study used the India Human Development Survey (IHDS; 2004-05) to assess the levels and patterns of consanguineous marriages among Indian states and to quantify their effects on adverse pregnancy outcomes. IHDS is the collaborative project of researchers from the University of Maryland, USA and the National Council of Applied Economic Research (NCAER), New Delhi. IHDS is a nationally representative, multitopic survey covering 41,554 women in India. This study used the marriage history and pregnancy related information of currently married women in the age group 15-49 years during the five years preceding the date of survey. Women between the ages of 15-49 are asked specific questions about marriage history and practices such as consanguineous marriage. The specific questions asked in this survey are "Are you related to your husband by blood? If so, what is the relationship?" (Options given for this question are no relation, Uncle, Cousin, Others). Similarly, questions are asked to women concerning the history of pregnancy outcomes such as stillbirth, miscarriage, spontaneous abortion and induced abortion, etc (Desai *et al.*, 2010).

2.1. Sample Design

Villages and urban blocks (comprising of 150-200 households) formed the primary sampling units (PSUs) from which the households are selected. The urban and rural PSUs are selected by separate sample designs. In order to draw a random sample of urban households, urban areas in a state are listed in the order of their size with the number of blocks selected from each urban area allocated, based on Probability Proportional to Size (PPS). Once the number of blocks for each urban area is determined, the enumeration blocks are 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 are identified, and complete household listing are conducted. Based on this, a sample of 15

households is selected per block. For sampling purpose, some smaller states are combined with nearby larger states. The rural sample contains about half of the households that are interviewed initially by NCAER in 1993-94 in a survey titled Human Development Profile of India -- HDPI (Desai *et al.*, 2010) and the other half of the sample is drawn from both districts surveyed in HDPI as well as from the districts situated in the states and union territories not covered in HDPI. The original HDPI is 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 is conducted and contact details are available, 13,593 households are randomly selected for re-interview in 2005 (Desai *et al*., 2010).

2.2. Statistical analysis

All the statistical analysis of the study are conducted using STATA version 10.1 (stata crop LP, College Station, Texas, USA). The analyses are carried out in two stages. In the first stage, this study estimate bivariate and binary logistic regression models to examine 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-1, No-0) is considered as dependent variable. In the second stage, the trivariate estimates are calculated with pregnancy outcomes as a dependant variable and consanguineous marriage and other socioeconomic variables as the independent variables. Cox proportional hazard regression model is used to calculate the relative risk of adverse pregnancy outcomes for women by consanguinity. The model is controlled for other relevant covariates such as regions in India (south, north, northeast and west) age groups (15 – 24, 25 – 34, 35 & above), age at marriage (less than 18, 18 and above), place of residence (rural, urban), religion (Hindu, Muslim, others), education (no education, primary, secondary, higher) and economic status of households (poor, middle, rich). The wealth index is based on 30 assets and housing characteristics. It is constructed using Principal Components Analysis (PCA) based on households' data. Each of the household assets is assigned a weight (factor score) generated through PCA. The resulting assets scores are standardised in relation to a normal distribution with the mean of zero and standard deviation of one. Then, the values are divided into three equal parts. The castes in modern India can be broadly classified into four classes: Scheduled Castes/Scheduled Tribes, Other Backward Castes (OBCs), and upper castes (Srinivas, 1957).

Calculations for Cox proportional hazard model

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

The mathematical form of this model is expressed as follows:

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

where, '*i*' indicates the number of observations, and the '*x'* stands for a covariate (e.g. region, age of women, age at marriage, place of residence, caste, religion, education level of women, economic status of households). 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 abortion) when all predictor variables are zero. The baseline hazard function is analogous to the intercept in a normal regression expression (since $\exp^o = 1$).

The individual regression coefficients β, give the proportional change that can be expected in the hazard of having adverse pregnancy outcome, associated with the corresponding change in the predictor variable. The Cox proportional regression model assumes that the hazard of having adverse pregnancy outcomes at time 't' (age of women) among women in 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 in the 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 outcomes. If ψ ≤ 1, the hazard of having an adverse pregnancy outcome is smaller or equal for both; this would indicate that consanguineous marriages do not show any effect (ψ =1) or have a negative correlation with adverse pregnancy outcomes.

3. **Results**

India is a heterogeneous state with diverse cultures and traditional practices in the different regions. A majority of the literature on consanguinity in India focuses primarily on the southern states. However, this study presented a comparative assessment representative of all regions. Table 1 shows the state-wise prevalence of consanguineous marriages. Results reveal that the prevalence of consanguineous unions is highest in Tamil Nadu (38%) followed by Andhra Pradesh (30%). 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 to their blood relatives. Overall, the south Indian states display greater occurrence of consanguineous marriages than other regions of India.

Studies in a global context have also identified factors effecting consanguineous marriages. Akrami and Osati (2007) aptly pointed out that social and cultural factor responsible for consanguineous marriages, particularly among Muslims. Assuming the uniformity of consanguinity

across the cultural and economic groups in a country like India, can be a great misapprehension. Therefore, this study assessed consanguineous marriages in India by socioeconomic stratifications. Table 2 shows the percentage of women marrying within their blood relatives by different socioeconomic and demographic characteristics. The results reveal that the occurrence of consanguineous marriages varies drastically across socioeconomic groups in India. The greater proportions of women belonging to Muslim religion (25%) and Other Backward Castes (OBCs) among Hindus (15%) are married to their own blood relations in comparison to others. Analysis also indicates that a larger proportion of less educated women, i.e., not educated or with only primary education (17% and 18%, respectively) are married to their blood relations compared to women with higher education (11%). Similarly, women from poor economic status showed highest prevalence of consanguinity in comparison to women belonging to middle and rich economic status.

However, in Indian cultural ethos, consanguinity is practiced in different forms based on the relationship of spouses. Some endogamous communities have a tradition of practising marriage among cousins while other communities practice marriage between niece and maternal uncle. Table 3 presents the different types of consanguineous marriages stratified by women's background characteristics. Across all the socioeconomic categories, the cousin marriages are more observed than other types of consanguineous marriages in India. The highest percentage (65%) of cross-cousin marriages is evident among Muslims; whereas the highest percentage (33%) of women married to their own uncles is observed in SC caste category. The women married to their uncles and cousins are found more in rural areas than in urban areas. Similarly, the proportion of women married to uncles and cousins are greater among socioeconomically disadvantage groups such as those having no or less education and poor economic status.

To find out the adjusted effects of socioeconomic factors on consanguineous marriages, the odds ratios are estimated using logit regression analysis. The results of logit regression model estimates confound with the findings of bivariate analyses (Table 4). The adjusted effects (odds ratios) of logit regression model for consanguineous marriages by background characteristics confirm the huge socioeconomic variation in the occurrence of consanguineous marriages. The prevalence of consanguineous marriages is less likely in Northern regions (OR=0.14, $p < 0.01$, SE=0.12), Northeast and Eastern regions (OR=0.19, $p < 0.01$, SE=0.14) as compared to the Southern region (OR=1.00) and these differences are statistically significant. Education is playing a significant role in the prevalence of consanguineous marriages. The likelihood of prevalence of consanguineous marriages decreases with the increase in the educational level of women: the prevalence of consanguineous marriages is less likely among women of secondary education (OR=0.50, $p < 0.01$, SE=0.12) and higher education (OR=0.33, $p < 0.01$, SE=0.28) as compared to women with primary education (OR=0.57, $p < 0.01$, SE=0.12) and no education (OR=1.00). Similarly, the prevalence of consanguineous marriages is significantly less among rich (OR=0.72, $p < 0.01$, SE=0.10) as compared to poor women (OR=1.00).

Table 5 explains the adverse effects of consanguineous marriages on pregnancy outcomes such as stillbirths, abortions, miscarriages, and spontaneous miscarriages by the background characteristics of women interviewed in the survey. Growing number of studies in public health research, in India, argued that socioeconomic characteristics such as woman' age, household economic status, caste, religion are the critical determinants of maternal and reproductive health (Pallikadavath, 2004; WHO, 2005; Sines *et al.*, 2007; Subramanian, 2008). However, results from this study reveal that, among the women of similar socioeconomic standing, the prevalence of stillbirth is high among women who had consanguineous marriages than others. For instance, among the women of rural place of residence and belonged to Hindu and Muslim religions, the prevalence of stillbirths is two times higher in consanguineous mothers compared to non-consanguineous mothers. The result for all categories of women's education, caste and economic status, shows that the prevalence of stillbirths is again higher among consanguineous mothers than non-consanguineous mothers. Further, among all education categories, the prevalence of stillbirths is about two times higher for consanguineous mothers in comparison with non-consanguineous mothers. With reference to women of poor economic status, the prevalence of stillbirths is 11 per 100 live births for consanguineous mothers while it is only 6 per 100 live births for non-consanguineous mothers. Overall, the results reveal that the prevalence of stillbirths is greater among women who got married to their blood relatives compared to their counter parts.

Analogous to the results of stillbirths, the results for occurrence of abortion also showed greater prevalence among women who had consanguineous marriages compared to non-consanguineous marriages. For example in rural areas, the prevalence of abortion is 4 per 100 live births in consanguineous group, whereas it is only 2 per 100 live births in non-consanguineous groups. Similarly, in the urban areas, the prevalence of abortion is 5 per 100 live births in consanguineous marriage but it is only 3 per 100 live births in non-consanguineous marriages. Among the caste and religion groups, the abortion rates considerably vary by the type of marriage. Likewise, among all categories of women's education, prevalence of abortion is higher in consanguineous groups compared to non-consanguineous groups. In the primary education category, the prevalence of abortion is twice higher among consanguineous groups (7 per 100 live births) than non-consanguineous groups (3 per 100 live births). Among women belonging to rich economic groups, the prevalence of abortion is twice higher among consanguineous groups (6 per 100 live births) than non-consanguineous groups (3 per 100 live births).

Corresponding to prevalence of stillbirths and abortions, the prevalence of miscarriages is also greater among women in consanguineous marriages than in non-consanguineous marriages. For instance, within the age group of 35 years and above, the prevalence of miscarriages is greater in consanguineous marriages (14 per 100 live births) than non-consanguineous marriages (10 per 100 live births). By rural place of residence, the prevalence of miscarriages is higher in consanguineous marriages (14 per 100 live births) compared to non-consanguineous groups (9 per 100 live births).

Among all the socioeconomic groups such as caste, religion, education and economic status, the prevalence of miscarriage in consanguineous marriage is substantially greater than non-consanguineous marriages. For example, among Muslim women, the prevalence of miscarriage in consanguineous marriages (17 per 100 live births) is considerably greater in comparison with non-consanguineous marriages (9 per 100 live births). With reference to women with no education, the prevalence of miscarriage is 13 per 100 live births for consanguineous groups and it is only 8 per 100 live births for non-consanguineous groups. Among the women belong to poor economic status, the prevalence of miscarriage is greater in consanguineous groups (15 per 100 live births) than in non-consanguineous groups (9 per 100 live births). The prevalence of spontaneous miscarriage also follows a similar pattern.

However, to find out the adjusted effect of consanguineous marriages and its effect on pregnancy outcomes and to control a kind of censor cases in data, Cox proportional hazard regression model is used. The results of Cox proportional hazard model estimates confound with the trivariate analysis (Table 6). After controlling for background characteristics, the relative risk of having stillbirth is significantly higher among consanguineous groups (RR=1.59, $p< 0.01$, SE=0.16) as compared to non-consanguineous groups (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). Further, the relative risk of having the abortion is three times more (RR=3.03, $p< 0.01$, SE=0.22) for women of consanguineous marriages than women of non-consanguineous marriages. The relative risk estimates of Cox regression model indicate that consanguineous marriages are critical predictors of adverse pregnancy outcomes in Indian.

4. Conclusions

Numerous earlier studies at the micro level have focussed on specific states and social groups and described the prevalence of consanguineous marriages and its effects on pregnancy outcomes in India. The current research is a comprehensive effort to revisit the consanguineous marriages and its effects with more recent national level data using robust statistical methods to assess the prevalence and effect of consanguineous marriages on pregnancy outcomes in India. This paper examines the extent of prevalence of consanguineous marriage in India and its impact on adverse pregnancy outcomes among women. The overall prevalence of consanguinity is found to be 16 %. The practice of marriages with close relatives is significantly higher in the southern region than northern region of India. This clearly represents the existing cultural divide in marriage patterns and customs between the north and south of India. Within the consanguineous marriages, the cross-cousin marriages are more preferred compared to those who marry with uncles. The assessment of occurrence of consanguinity by background characteristics reveals that, they are more prevalent among disadvantageous socioeconomic groups. The main factors associated with consanguineous marriage

are women's age, and lower education and poor economic status. However, those belonging to schedule caste, other backward castes and Muslim religion emerged as critical predictors of consanguineous marriage. The findings of this study are in tune with, the findings of numerous other studies which demonstrated a similar inverse relationship of women's education and economic status with consanguineous marriages in diverse populations of India. However, with more comprehensive analysis using recent data, this study re-establishes the fact that socioeconomic and cultural factors playing a critical role in continuation of the tradition of consanguineous marriages in India.

The analysis presented here convincingly demonstrates that there is a significant association between the practice of marriage within blood relatives and adverse pregnancy outcomes in India. All types of adverse pregnancy outcomes, which are assessed in this study, show a greater prevalence among consanguineous mothers compared to non-consanguineous mothers. In a country like India where about one-fifth of all marriages are still between blood relatives, the findings of this study assume importance not only for sociocultural reasons but also to understand the reproductive health outcomes. At the policy level, this study recommends the need for educating people on the health risks associated with consanguineous marriages.

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Table 1 Prevalence (per 100) of consanguineous marriage among major states of India, 2005

States	Percentage of consanguinity	Sample size of women (N)
Andhra Pradesh	29.6	346
Karnataka	28.1	545
Tamil Nadu	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 all Northeast states together due to very low samples at state level.

Table 2 Prevalence (per 100) of consanguineous marriages by background characteristics of women, India, 2005

Background characteristics	Percentage of Consanguinity	Sample size of women (N)
Age		
15-24 years	20.0	-
25-34 years	17.4	71
35 years & above	13.4	693
Age at marriage		
Less than 18 years	15.6	588
18 years and above	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, India, 2005

Background characteristics	Uncle	Cousin	Others	Sample size of women (N)
Age				
15 – 24 years	-	-	-	-
25- 34 years	22.94	58.42	18.65	71
35 years & above	23.42	51.16	25.42	693
Age at marriage				
Less than 18 years	23.90	55.46	20.64	588
18 years and above	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
Others	19.86	47.26	32.88	238
Religion				
Hindu	26.87	45.38	27.75	479
Muslims	16.49	64.69	18.81	258
Others	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 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 years®	1.00	-	-	-
25- 34 years	0.73	0.05	11.69	1.42
35 years & above	0.60	0.04	9.40	1.41
Age at marriage				
Less than 18 years ®	1.00	-	-	-
18 years and above	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
Hosmer and Lemeshow Test				
Chi^2		**37.371****		
-2 Log likelihood		**23466.393**		

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

b) The regional classification of Indian states has been done according to the pattern followed in the National Family Health Survey-3 and following are the regional specific states (IIPS and Macro International, 2007):

South: Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Lakshadweep, and Puducherry.

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 and Diu, Dadra Nagar Haveli.

Table 5 Prevalence (per 100) of stillbirth, abortion, miscarriage and spontaneous miscarriage by background characteristics by Consanguinity, India, 2005

Background characteristics		Stillbirth Yes (%)	Abortion Yes (%)	Miscarriage Yes (%)	Spontaneous Miscarriage Yes (%)	Sample size of women (N)
Age						
15 – 24 years	CM	-	-	-	-	-
	Non CM	-	-	-	-	-
25- 34 years	CM	4.2	2.8	12.7	11.3	71
	Non CM	4.2	1.8	10.4	6.5	336
35 years & 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 years	CM	9.0	5.1	14.5	9.5	588
	Non CM	5.5	2.6	10.1	6.9	3441
18 years and above	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
Others	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
Others	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 6 Cox regression model estimations (Relative Risk) of adverse pregnancy outcomes by consanguineous marriage and background characteristics, India, 2005

Background Characteristics	Stillbirth				Miscarriage				Spontaneous Miscarriage				Abortion			
	Exp(B)	95.0% CI for Exp(B) Lower	Upper	SE	Exp(B)	95.0% CI for Exp(B) Lower	Upper	SE	Exp(B)	95.0% CI for Exp(B) Lower	Upper	SE	Exp(B)	95.0% CI for Exp(B) Lower	Upper	SE
Consanguineous Marriage																
No®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Yes	1.59**	1.15	2.18	0.16	1.94**	1.53	2.46	0.12	1.70**	1.27	2.27	0.15	3.03**	1.96	4.69	0.22
Region																
South®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
North & Central	1.34	0.94	1.92	0.18	1.73**	1.34	2.24	0.13	1.61**	1.19	2.17	0.15	1.58	0.97	2.59	0.25
Northeast And East	1.52*	1.04	2.23	0.19	2.19**	1.69	2.84	0.13	1.62**	1.18	2.23	0.16	3.03**	1.89	4.85	0.24
West	1.85**	1.26	2.72	0.20	1.24	0.92	1.67	0.15	1.31	0.93	1.86	0.18	0.73	0.40	1.36	0.31
Age at marriage																
Less than 18 years®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
18 years and above	0.40**	0.29	0.56	0.17	0.51**	0.42	0.63	0.11	0.56**	0.44	0.71	0.13	0.42**	0.28	0.62	0.21
Place of Residence																
Rural®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Urban	0.81	0.61	1.08	0.14	0.96	0.79	1.16	0.10	0.99	0.79	1.25	0.12	1.34	0.94	1.90	0.18
Caste																
OBC®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
SC	1.05	0.73	1.51	0.18	0.78	0.61	1.02	0.13	0.63**	0.45	0.88	0.17	0.95	0.60	1.51	0.23
ST	1.64*	1.09	2.48	0.21	0.60*	0.41	0.90	0.20	0.72	0.46	1.13	0.23	0.06**	0.01	0.41	1.02
Others	0.94	0.70	1.26	0.15	0.89	0.73	1.09	0.10	0.88	0.69	1.13	0.12	0.98	0.67	1.44	0.20
Religion																
Hindu®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Muslims	1.81**	1.32	2.48	0.16	0.92	0.72	1.18	0.12	1.00	0.75	1.34	0.15	0.61*	0.37	0.99	0.25
Others	0.86	0.50	1.47	0.27	1.25	0.90	1.73	0.17	1.36	0.94	1.99	0.19	2.07*	1.18	3.63	0.29
Education																
No Education®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Primary	1.20	0.88	1.63	0.16	1.20	0.95	1.51	0.12	1.07	0.80	1.43	0.15	1.50	0.97	2.31	0.22
Secondary	1.11	0.78	1.57	0.18	1.52**	1.20	1.91	0.12	1.53**	1.16	2.03	0.14	1.51	0.97	2.35	0.23
Higher	0.75	0.34	1.66	0.41	1.75**	1.21	2.53	0.19	1.29	0.80	2.10	0.25	1.85	0.95	3.61	0.34
Economic Status																
Poor®	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Middle	0.68*	0.48	0.95	0.18	1.05	0.82	1.34	0.13	0.90	0.67	1.21	0.15	1.64*	1.00	2.69	0.25
Rich	0.66**	0.49	0.88	0.15	0.87	0.71	1.08	0.11	0.75*	0.58	0.96	0.13	1.30	0.83	2.02	0.23
Hosmer and Lemeshow Test		**23.257****				**45.23****				**33.45****				**16.45****		

Chi^2				
-2 Log likelihood	**62431.45**	**4453.23**	**3980.34**	**2456.90**

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