Demography India
Vol. 49, No. 2 (2020), pp. 1-22 ISSN 0970-454X

Role of Social Network in Contraceptive Use by Indian Women: Evidence from NFHS

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Abstract: Social network plays a crucial role in determining individual's usage of contraceptive in societies that rely on traditional kinship networks for economic and social mobility. Using NFHS 2005-2006 and 2015-2016 data the impact of local caste- and religion-based network on an Indian woman's decision to use modern contraceptive is estimated after controlling for other covariates such as age, education, working status, son preference, partner's education and women autonomy. The mediating or attenuating role of one-to-one interaction of public health worker with local women's decision-making process is investigated. Relying on multilevel modeling approach, the results indicate that there is a positive same-caste and same-religion effect; if a higher proportion of women belonging to certain ethnic community choose modern contraceptive methods, the odds of an individual women (belonging to the same ethnic community) choosing modern contraceptive methods goes up. The paper highlights the mechanisms that influence private health decisions and provides recommendations to harness those mechanisms to achieve programmatic goals of encouraging usage of safe and modern contraceptive methods.

Keywords: Contraception, Social Network, Public Health Worker, Caste, Religion, Multilevel Modeling.

Introduction and Review of Literature

India has actively pursued population policy since 1965, which comprises of encouraging usage of contraceptives and limiting family size. Contraceptive use is not uniform among all social groups as there are differences between caste groups and religious groups (Pasupuleti, et al., 2017; Muttreja and Singh, 2018). Even though previous work has analyzed the inter-caste differences in contraceptive use among married women, the focus has been on son preference, women autonomy, role of family members (especially mother-in-law) and access to health care services. These being crucial factors, it will be a shortcoming not to look at the role that social networks play in providing information on contraceptives to women (Godley, 2001; Yee and Simon, 2010). The objective of this paper is to investigate the role of caste-based and religion-based social networks in contraceptive usage by women and whether individual outreach by public health workers have the desired effect.

Work done by Ramesh (2008), Narzary (2009), Gautam (2010) on Indian women's contraceptive usage, have shown that factors such as age, education, number of living children, preference for sons, place of residence, caste, knowledge of contraceptive, economic status of household and mass media exposure significantly influence a woman's usage of contraceptive. Opinions of family members, friends and community can matter. It is important to understand the mechanisms through which social network influences health behavior in general. These mechanisms are social support, social engagement, access to resources, social influence and social learning (Berkman et al., 2000; Lowe and Moore, 2014). Social support is the support received by

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an individual or a group because they are part of a community and it can take many forms - informational, emotional, appraisal and instrumental. Social engagement refers to engaging in various community level activities. Social network can facilitate an individual's pursuits by providing access to various resources and influence individual choice due to the social and institutional power that resides in the network. Social learning is a process by which a behavioral change takes place in an individual due to the exchange and evaluation of new information received via the person's social network.

Social networks can perpetuate conservative cultural viewpoints through interpersonal communication and can be a medium of diffusion of information on contraception (Godley, 2001). A patriarchal structure combined with co-existence of extended family members leads to fertility decisions of a young couple being influenced by views held by family members. Anukriti et al. (2020), Kumar, Bordone and Muttarak (2016), Char, Saavala and Kulmala. (2010), Barua et al. (2013) and Kadir et al. (2003) find evidence of strong influence of mother-in-law on young married women's reproductive health and choices. Godley (2001) investigated the role of kinship network (adult sibling relationships) on contraceptive choices of recently married young women from 51 villages in rural Thailand. Controlling for factors such as age, education, distance to health center and household access to television, Godley (2001) found that household and village level kinship ties (measured by number of siblings in household, in village and outside village) do have differential influence the type of contraceptive being used. Qualitative study done by Yee and Simon (2010) on 30 women who have given birth recently found that opinion of partners, mothers and friends had great influence on contraceptive choices.

Ali, Amialchuk and Dwyer (2011) analyzed impact of peer effects on adolescent's usage of contraceptive during their first sexual intercourse based on data from National Longitudinal Study of Adolescent Health survey (1994 wave) conducted on U.S. adolescents and their parents. Controlling for individual, family characteristics and school-level fixed effects, the empirical results showed that a 10 percent increase in the percentage of classmates who use contraception increases the likelihood of a respondent's contraception use by approximately 5 percent. Montgomery et al. (2001) examined the influence of informal social networks on contraceptive behavior of women in South Ghana using longitudinal survey data on reproductive behavior and social interaction from six communities. The study results showed that an increase in the number of network partners is associated with statistically significant and substantively large increases in use of modern contraception and an even larger effect was found if the network partner was herself a user of modern contraceptive methods. Dynes et al. (2012) highlighted social perception as a driving factor when it comes to family planning among a sample of married men and women in Ethiopia and Kenya. The results revealed that difference in perception of community norms determine the direction of contraceptive use. Therefore, there is empirical evidence in the literature that have analyzed contraceptive behavior in other countries that suggests that social networks do play an influential role in an individual's contraceptive usage.

Indian Context

India's caste system is a traditional institution using the philosophy of division of labor. It is a system of social stratification which divides population into groups- Brahmin (priests), Kshatriyas (warriors and rulers), Vaishyas (merchants and farmers) and Shudras (domestic help, laborers and artisans). Caste provides a network through which one can further one's professional

and social standing, within the limitations of one's caste. There is evidence of men's use of caste network for economic mobility. Historical trends and patterns of presence of caste clusters in private enterprise has been documented by Damodaran (2008) which provide evidence to the fact that entrepreneurial class in India have used caste identities to further their fortunes in independent India. Upper caste households are more likely to have connections in government, medical and educational institutions than lower caste households, the hierarchical order of caste persists in the household's connections in important institutions (Vanneman et al., (2006)). As Indian women have not historically participated in labor force and their labor force participation rate is low[2], there is no documented evidence that women have used caste-based or religion-based social network in the same fashion that men have. Even though caste system may or may not have benefitted women in terms of their labor market outcomes, it would be interesting to see if caste-based and religion-based social network is proving beneficial to Indian women by encouraging contraceptive use.

The field of economics have generally ignored the welfare impact of network formation by females. Seminal work done by Munshi and Rosenzweig (2006 and 2009), Damodaran (2008) have focused on the economic advantages of caste networks (e.g. job recommendations, financial support during income shocks) which are generally utilized by men. By focusing on health behaviors along caste-lines and religion-lines, this paper makes an important contribution to the literature on the association between female social network and private health behavior. Studies analyzing the influence of community factors on private health behavior did not consider residential segregation by caste and religion (McNay, et. al., 2003; Moursund and Kravdal, 2003; Rajan, 2015) and thereby failed to capture the mechanisms through which a woman's social network is influencing her health choices. In a way, this paper also contributes to the nascent literature on residential segregation in India (Vithayathil, Singh and Pradhan, 2019; Sidhwani, 2015). Inferences are drawn based on two waves of a nationally representative health survey (separated by ten years), to capture dismantling or tightening of traditional kinship networks in a developing country that also witnessed a surge in economic opportunities. Finally, the analysis sheds light on a rarely explored aspect of public health delivery services in India – efficiency. Other than the work done by Anand and Fan (2016) and Banerjee, Deaton and Duflo (2004), there is hardly any documentation or analysis of the quality of public health delivery services.

The results indicate that caste and religion-based networks are strong determinants of contraceptive choice made by women, while interaction with health workers do not have the desired impact after controlling for other factors and this is achieved after to overcoming some of the shortcomings in the literature described in the above paragraph. Rest of the paper is organized as follows; motivation describe the two major research questions analyzed followed by data and methodology sections that contains details on datasets and empirical methods used. Results and discussion section lay out and discusses the results of empirical analysis. The final section on conclusions and policy recommendations summarizes the main results and provides policy recommendations.

[2] Chatterjee, Desai and Vanneman (2014) document the downward trend of female labor participation rate from 2004-2005, especially for women from rural areas. Their results are based on data from various rounds of National Sample Survey Organization and two rounds of India Human Development Survey.

Motivation

The first research question that the paper has investigated is the association between social network and usage of modern contraceptive. The correlation between percentage of women using contraceptive in the social network of a woman and usage of contraceptive is investigated by controlling for individual level and state level variables. The social network of a respondent is the number of women residing in her neighborhood which is the primary sampling unit. As the analysis in this paper is focused on social network oriented around caste and religion, caste-wise and religion-wise distribution of contraceptive usage among all women in a primary sampling unit is included as an explanatory variable in the regression model which helped in teasing out the impact of the specific social network on an individual woman's usage of modern contraceptive methods. The second research question is regarding the role of public health worker(s) when it comes to usage of modern contraceptive. Had they been successful in diffusing the message of importance of contraceptive usage to women? Previous research has highlighted the role of family members in influencing a woman's decision to use contraceptive. Work done by Munshi and Myaux (2006) and Rajan (2015) have shown that prevalence of contraceptive usage among women is determined by their exposure to the concept of family planning. Rajan (2015) using cross-section data found a positive association between individual woman's contraceptive usage and prevalence of contraceptive usage and knowledge among older women. Munshi and Myaux (2006) used village level panel data to tease out the impact of diffusion of family planning message on individual contraceptive usage. Along with family members, health worker(s) can contribute to the decision-making process by providing information and guidance on available contraceptive choices. The intensity of interaction with public health workers is measured by the number of times the respondent met a public health worker in the previous three months, this metric is included in the empirical model.

Data

Data from third and fourth wave of National Family Health Survey[3], NFHS 2005-2006 (NFHS-3) and NFHS 2015-2016 (NFHS-4) have been used for the present study. The National Family Health Survey is one of the most comprehensive and nationally representative health surveys on Indian population and therefore a valuable resource for researchers and policymakers alike. The ten-year gap between the third and fourth survey cycle of National Family Health Survey (when the time gap between previous survey cycles had been around six to seven years) is deeply concerning, as there is lack of health data on a population that is witnessing rapid transformation in terms of available economic opportunities. NFHS-3 (NFHS-4) survey captured health-related information on 109,041 (568,200) households and interviewed men of ages 15-54 and women of ages 15-49 across 29 states (and 6 union territories). The study sample consists of 80,308 (475,933) ever married women with at least one child. The coverage of NFHS-4 is five times than that of NFHS-3. NFHS-4 consists of district identifiers which enables generation of estimates and metrics at the district level, something that was not possible with NFHS-3.

[3] Indian Institute of Population Sciences and ORC Macro. National Family Health Survey. International Institute of Population Sciences, Mumbai. Available from: http://www.rchiips.org/nfhs/

Table 1: Percent distribution of ever-married woman with at least one child by characteristics

Characteristics	2005-06	2015-16
Current Usage of Modern Contraceptive Methods	52.9	51.9
Age		
15-19	3.4	1.3
20-24	15.7	12.4
25-29	20.1	19.6
30-34	18.8	18.6
35-39	17.2	17.9
40-44	14.2	15.4
44-49	10.7	14.8
Education		
None	49.2	35.5
Primary	15.4	14.9
Secondary	30.0	40.8
Higher	5.4	8.8
Religion		
Hindu	81.3	81.4
Muslim	13.2	13.1
Christian	2.3	2.3
Other	3.3	3.2
Caste		
Scheduled Caste	19.4	21.1
Scheduled Tribe	8.4	9.6
Other Backward Caste	40.5	45.3
Forward Caste	31.0	24.0
Number of Girl Children		
0	24.2	27.9
1	39.7	42.3
2	21.5	19.5
3	9.2	6.9
4+	5.3	3.5
Number of Boy Children		
0	17.2	18.2
1	40.0	45.6
2	29.1	27.7
3	9.4	6.3
4+	4.3	2.2
Employed	45.2	88.4
Currently Working or Worked sometimes in last 12 months	56.2	61.9
Exposure to Family Planning Ads		
Husband's Education	27.7	8.0
None	16.3	21.7
Primary	44.0	39.7
Secondary	12.0	30.0
Higher		
Household's wealth quintile	18.9	18.4
Poorest	19.9	19.8
Poorer	20.2	20.6
Middle	20.3	21.0
Richer	20.7	20.2
Richest		
Number of Times Met Public Health Worker	87.3	74.3
0	4.8	2.9
1	2.8	4.2
2	52.9	51.9

Characteristics	2005-06	2015-16
3	2.5	3.4
4+	2.6	15.2
Decision Regarding Contraception		
Self or Jointly With Husband	54.0	50.9
Location		
Rural	69.0	66.4
Analytical Sample	**80308**	**475933**

Sources: NFHS-3 and NFHS-4; Note: Weighted Percentages

The survey cycles of NFHS are not repeated cross-sectional surveys; the datasets do not contain either individual or household level identifiers which will enable a researcher to track a person or a household from 2005-2006, ten years later. It also discourages pooling of samples. The survey cycles are separate cross-sectional surveys which provide time-variant snapshots of health of Indian population. It is not known what percentage of households and survey respondents were captured in both the survey cycles. The analytical strategy pursued in this paper applies the same functional form and model on the two stand-alone datasets with the purpose of investigating the change in relationships between covariates and outcome of interest from 2005 to 2016. In my review of the literature other than Rajan (2015), studies that investigated the influence of social networks relied on one NFHS survey cycle[4]. Table 1 provides descriptive statistics of the study sample. It shows the percentage distribution of ever married women who have at least one child, by age groups, education levels, husband's education levels, caste groups, religion, number of living children and wealth status of family.

Methodology

To examine the impact of community on contraceptive use of women, the following mixed effects logistic multilevel model (3-level) is estimated using STATA's xtmelogit procedure. A simple logistic model with PSU (primary sampling unit) fixed effects would have been enough. Existence of PSU identifiers enables pooling of surveys and one can include PSU fixed effects in the model to control for any unexplained variation at PSU level. But this is not possible with NFHS as PSU level identifiers are non-existent. The analytical strategy of multilevel modeling considers clustering of observations. Survey respondents in NFHS are clustered in primary sampling units which are in turn clustered in states[5]. Regression models that do not consider the fact that errors are correlated across individuals in a cluster greatly overstate the significance of covariates included in the model. The xtmelogit procedure allows for many levels of nested clusters and calculates robust standard error (of regression coefficients) that considers cluster level correlation.

$$C_{ijs} = \alpha_{js} + \beta X_{ijs} + \lambda CUSC_{js} + \mu State_s + E \text{ where } E = e^{ijs} + e^{js} + e^{s}$$

C_{ijsy} is a binary variable denoting contraceptive usage of individual "i" in primary sampling unit "j" in state "s". X_{ijs} are respondent level covariates described above. State dummies are included in the empirical model to control for different economic conditions that persist among Indian states and for state government's family planning initiatives. The λ coefficients will capture the influence of caste-based or religion-based network on contraceptive use, but the estimate will

[4] McNay, et al. (2003), Moursund and Kravdal (2003) used NFHS-1 and NFHS-2 respectively.

[5] As NFHS-3 dataset does not have district level identifiers, it was not possible to estimate a 4-level model.

be biased if the respondent is self-selecting herself to a caste because she identifies with its group behavior more relative to other caste groups. There is evidence that Indian men and women follow the endogamous rules of marriage laid down by the caste system; one is married into the same caste that they are born into instead of selecting a partner from another caste group[6]. The rules of communication set down by the patriarchal society, residential segregation and endogamous rules of marriage ensures that inter-caste interaction at a social level is minimum. Therefore, it is expected that the bias in the coefficients due to selection effects will be minimal. The empirical model is run on subgroups of study sample – a) Hindu and belonging to specific caste groups (Scheduled Caste, Scheduled Tribe, Other Backward Caste and General Caste/Forward Caste) b) Muslim c) Christian and d) Other Religion. If analytical strategy involved running the empirical model on the full study sample and including dummy variables to denote the caste and religion affiliation, it would not have been able to capture the differing marginal relationships between covariates and modern contraceptive usage across caste groups and religion groups. By running the model on mutually exclusive subgroups, it is possible to estimate the same-community and cross-community impacts.

Variables used in Empirical Model

Outcome Variable

The outcome variable is binary variable depicting current usage of modern contraceptive method. Modern contraceptive method includes pill, IUD (intra uterine device), injections, diaphragm, condom, female sterilization, male sterilization, Implants, female condom, foam/jelly and lactational amenorrhea. As this is a cross-sectional analysis involving variables containing information on a respondent's status in the time period of 2005-2006 and 2015-2016, it is imperative that "current contraceptive usage" is investigated.

Covariates

The empirical analysis controls for individual characteristics such as age (second order polynomial to capture nonlinearities), education (set of four binary variables depicting different levels of education with no education as reference group), working status, partner's education, standard of living and media exposure to family planning advertisements. Other covariates include percentage of children who are girls which acts as an indicator of son preference and autonomy regarding contraceptive decision making. The variable on contraceptive decision making is a binary variable that takes the value of one if decision making regarding contraceptive usage is done by the woman solely or in collaboration with husband/partner; and zero if decisions on contraceptive usage is taken by some other family member. Questions on influence of specific family members on contraceptive usage were asked of respondents in NFHS 1998-1999 (NFHS-2) survey cycle but not in NFHS-3 or NFHS-4, therefore it was not possible to control for influence of specific familial relationships (such as mother-in-law).

[6] India Human Development Survey 2004-2005 found that 95 % of females in their sample, married within their own caste (Desai and Dubey, 2011).

NFHS asks survey respondents about their level of interaction with a public health worker[7] in the previous three months and place of interaction (home, Anganwadi[8], ICDS center[9]). To answer the second research question, a variable on the number of times a woman in the study sample met a public health worker is included in the empirical specification. The model also contains this variable's quadratic form to capture nonlinear relationship of "interaction with health worker" with usage of modern contraceptive methods. This variable and its quadratic form will capture how much influence public health workers have on an individual woman's choice but also how efficient that influence is. Given that this paper is about ethnicity based social network's impact on a specific health outcome of women, it would have been prudent to explore that angle even in case of public health workers. It was not possible to pursue that aspect as NFHS lacks ethnicity data of health workers.

Not only interpersonal exchange and community norms, but mass media campaigns can bring about a positive change in reproductive behavior as found in a study by Valente & Saba (1998) on Bolivian men and women. There is suggestive evidence from Musalia's (2005) work on Kenyan men and women in two districts of the country with opposite economic prospects that harsher economic conditions can alter conservative views of kin networks towards contraceptive use thereby denoting an interaction effect. The variable on media exposure to family planning ads takes the value of one if the respondent has read about/ listened to/ seen family planning advertisements in the last few months.

Defining Social Network

Montgomery et al. (2001) examined the effects of the knowledge, attitudes, and behaviors of other persons on an individual's likelihood of making certain choices using survey data that had specific items on respondent's conversations with their network partners on modern contraceptives. The authors defined contraceptive preferences of social network to be the total number of network partners' approval and usage of contraceptive methods. Pathak, et. al. (2014) and Anukriti, et. al. (2020) did a field survey of young married women in rural Jaunpur district of Uttar Pradesh for their analysis on the influence of specific familial relationships and social network on fertility patterns and contraceptive usage. Their surveys mapped the social network of women with whom they discussed fertility and reproductive issues. Even though localized field surveys provide researchers the advantage to ask specific questions, due to their small sample sizes[10] the results are not generalizable. NFHS does not contain questionnaire items to either map a woman's social network or conversations with her social network. To overcome this limitation, inspiration is drawn from the work done by McNay et al. (2003), Moursund and Kravdal (2003);

[7] Public health worker encompasses anganwadi workers (AWW), accredited social health activist (ASHA), auxiliary nurse midwife (ANM), multipurpose worker (MPW) from sub-health center (SHC), lady health visitor (LHV) from Family Welfare Planning Center. Role and primary functions of each health worker differ but they do form a team to provide various maternal and child health services. AWW workers are primarily involved in women and children health and work through anganwadi centers (AWC), ASHAs are local women trained to act as health educators and promoters in their communities while ANMs are paramedics providing family planning and immunization services. A MPW provides general assistance to ANMs and a LHV supervises all ANMs in her area.

[8] Anganwadi is a government sponsored child-care and mother-care center in India.

[9] Integrated Child Development Services (ICDS) is a family welfare programme targeted at children below 6 years of age and their mothers providing services such as immunization, supplementary nutrition, health checkup and preschool education along with being the source of information on health and nutrition. The services are provided through Anganwadi centres.

[10] Pathak et al. (2014) and Anukriti et al. (2020) had sample sizes of 567 and 671 respectively.

and Rajan (2015) to investigate the impact of community level factors on contraceptive choices and other health outcomes for Indian women using various rounds of NFHS. Aggregating of respondent data to the lowest geographic unit was used to proxy for community preferences or social network. Moursund and Kravdal (2003) used PSU-level statistics on infrastructure development, family planning initiatives and access to public services. Rajan (2015) defined community norms to be the proportion of women using sterilization method in PSU, and McNay, et al. (2003) calculated the same metric at the district level.

Even though information is not directly available from NFHS, one can make an educated guess from the social dynamics prevalent in India and assume that women are interacting with other females from the same caste and/or religion. Vithayathil and Singh (2012) found high level of caste-based residential segregation in Indian cities and it trumped residential segregation by socioeconomic status. Gayer and Jaffrelot (2012) in their ethnographic study of Muslim communities across 11 cities in India found that residential segregation across religious lines have attenuated in the last 25 years. To estimate the impact of social network on contraceptive use, information is required on caste and religion of people who provided family planning advice to respondent. Data is not available on gender or caste/religion of friends, neighbors and public health worker; therefore, it is a challenge to determine the social network of the respondent. Family members including in-law relations belong to the same caste of the respondent as inter-caste and inter-religion marriage rates are very low in India (Das et al., 2011). One cannot draw the same conclusion about neighbors, friends and health workers. Due to lack of direct information in NFHS – III and NFHS - IV, a proxy variable CUSC is calculated, that is depicting the percentage of women using modern contraceptive methods, in the primary sampling unit (PSU) that the respondent is residing in. NFHS's primary sampling units are census blocks in urban areas and villages in rural areas, my assumption that PSU form the community/neighborhood of a woman is not far-fetched. This variable is calculated for each caste group and religious group within each PSU, which will capture both own-community and cross-community effect in the empirical model. Table 2 provides details on average number of women in PSUs in 2005-2006 and 2015-2016 by their caste and religious affiliation.

Table 2: Women by Religion/Caste Groups in Primary Sampling Units (mean)

Religion and Caste	**2005-06**	**2015-16**
Religion		
Hindu	16.2	12.6
Muslim	2.9	2.1
Christian	1.7	1.2
Other	1.2	0.8
Caste		
Scheduled Caste	3.3	2.7
Scheduled Tribe	1.3	1.6
Other Backward Caste	5.9	5.5
Forward Caste	5.5	2.5
All Women	22.0	16.7
Number of PSUs	3850	28518

Sources: NFHS-3 and NFHS-4

Results and Discussion

Tables 3 and 4 present the results of mixed effects logistic regression for various Hindu caste and non-Hindu religious subgroups, and for years 2005-2006 and 2015-2016. As the binary outcome is modeled as logistic CDF, the estimated coefficients in Tables 3 and 4 do not reflect the constant increase or decrease in probability with a unit change in covariates. It is possible to determine the marginal effect from a mixed effects logistic regression model through the margins command in STATA which calculates the slope/marginal effect of the probability of using modern contraceptive method for each observation in the model and reports the average of the slope/marginal effect. The change in average of the slope/marginal effect as the covariate of interest takes on different values while the rest of the covariates are fixed at their mean value is plotted. The conditional slope/marginal effects for covariates of interest are graphed in Figures A.1 to D and being slope of logit function, it can take values greater than one and lesser than zero.

Decision-Making, Income Status, Exposure to Media and Educational Levels

The variable depicting women and/or partner centric contraceptive decision making is the biggest determining factor (z-stat for this variable is highest) for all ethnic and religious subgroups. Also, there is no dramatic shift in this relationship over ten years and we see this strong association even after controlling for social network variables. Pathak (2015) found similar result from fieldwork in a rural district in Uttar Pradesh, where the effect of mother-in-law dissipates after husband's preferences and social network characteristics are controlled for. The direction of the coefficients for various levels of household wealth are in the expected direction (when the variables are significant), as women belonging to households with less resources do have less money to buy contraceptives. But this relationship between wealth and contraceptive usage is significantly negative for Muslim women. Being employed does improve the chances of using modern contraceptives across all the subgroups, while media exposure to family planning programs has significant and positive influence only on Muslim women. Exposure to television improves a woman's outlook and can modify their perception towards women autonomy and son preference (see Jensen & Oster, 2009). In case of educational status of women and her partner, the results point out the misnomer that highly educated individuals are less keen on modern contraceptive methods. It is only for Christian women that we see a positive association between partner's education levels and modern contraception usage. Patel et al. (2013) analyzed the sex ratio among families headed by physicians (who are generally more educated and wealthier than an average Indian) and found it to be more skewed than the national average. Therefore, education alone cannot ensure that an individual will prefer small families as societal and family expectations can overrule such preferences.

Age and Gender Composition of Children

The marginal effect of discrete predictors – age, gender composition of children, interaction with public health worker and continuous predictors – proportion of women belonging to an ethnic or religious subgroup who are using modern contraceptive methods, reveal interesting patterns for all subgroups. In case of age there are distinct peaks. Hindu women (across all caste groups) prefer modern contraceptive methods in early 30s while Christian and Muslim women decide to stop having children through modern methods much later in life. Deciphering of different patterns across various ethnic/religious groups is one of the advantages of running the model

separately over subgroups. There is slight shift of two or three years in the peak conditional marginal effects of age in 2015-2016 for Hindu caste subgroups, but the shift in the peak is more dramatic for Christian and Muslim women. Overall, the conditional marginal effect of age is more subdued for Christian and Muslim women relative to Hindu caste subgroups and this pattern remains unchanged over ten years. Women belonging to Other religion behave quite similarly to Hindu women. The evidence of son preference is present in all women irrespective of their caste and religious affiliation; this can be gauged through the negative sign on "percent daughter" variable. From 2005-2006 to 2015-2016 we see slight dampening of the negative effect across all the subgroups. Having more daughters than boys encourages a woman to keep trying for male child. But the negative marginal effect of having more daughters is miniscule and remains flat as one has more daughters is evident from figures B.1 to B.4. This reveals a "meta preference" for sons irrespective of the number of daughters a woman still desires more sons. This "meta preference have been documented in GoI (2017).

Research Question 1 (Contraception Preferences of Social Network)

The mixed effects logistic regression model estimated the community effects on modern contraceptive usage and the results show that there is a positive same-caste and same-religion effect and this positive effect comes across in both time periods 2005-2006 and 2015-2016. The marginal effect of same-community's preference for modern contraceptive methods is shown in figures C.1 to C.4.

These figures plot the marginal effects against the percentage of women belonging to own community who are using modern contraceptive. As more members in her peer group adopt modern contraceptive methods, the chances of an individual women adopting the same behavior goes up. Interestingly this relationship is inverse u-shaped with inflexion points, but nowhere does the marginal effects turn negative. There are benefits to mass adoption of positive health behaviors, but it has its limits and multifaceted approaches are required. The relationship peaks around 50 percent for all ethnic and religious subgroups except Christian women, for this subgroup the marginal effect peaks at 60 percent. One can conclude that Christian women are relatively more individualistic than average Indian women. In 2005-2006 the cross-community contraceptive usage variables are not significant and due to larger size of study sample in 2015-2016, we see evidence of negative cross-caste and negative cross-religion effect for certain subgroups (see Tables 3 and 4), but the size of the coefficient tells us that the marginal effects are miniscule and remain flat as more women in cross-communities adopt modern contraception methods. This shows that Indian women tap into their ethnicity-based and religion-based peer network to make her choice and influence of the community they identify with is the strongest.

Research Question 2 (Interaction with Public Health Worker)

The surprising result is the negative association between interaction with health worker and woman's decision to choose modern contraceptive. This negative association is weakly significant in 2005-2006 for Scheduled Caste women only and strongly significant in 2015-2016 for Hindu caste subgroups. For these specific caste groups in 2015-2016, the marginal effects become less negative as they interact more frequently with public health workers.

The situation does not improve much because the marginal effects never breach the zero line as intensity of interaction (measured by number of visits) increases. Health workers play a

vital role in taking the message of family planning to women and the results suggest that they are neither successful nor efficient in doing so. There can be couple of reasons why this is the case. One reason may be that caste and religious discrimination is being practiced by the health worker or by the respondent or by both. Dasgupta, Mani and Singh (2016) did not find evidence of religious discrimination being practiced by anganwadi workers in Chandigarh and Delhi, but the results may not be extended to rest of India. NFHS-3 and NFHS-4 did not collect information on caste affiliation, educational status, age and gender of health workers; therefore, it was not possible to control for such covariates in the empirical model. The second reason may be that health workers are not effective communicators of message on family planning which may be attributed to their lack of training and workload management. It is not known a) what kind of initial and on the job training is imparted to public health workers and b) whether there exists a feedback mechanism through which they can relay the difficulties and challenges faced by them while performing their duties.

Table 3: Estimates and Z-Scores from Multilevel Logistic Regression of Woman's Modern Contraceptive Usage on Individual, Social Network and State Characteristics

	Hindu SC		**Hindu ST**		**Hindu OBC**		**Hindu Forward Caste**	
Variables	**2005-06**	**2015-16**	**2005-06**	**2015-16**	**2005-06**	**2015-16**	**2005-06**	**2015-16**
Age	0.209***	0.272***	0.414***	0.334***	0.318***	0.311***	0.176***	0.224***
	(6.55)	(18.29)	(7.28)	(17.86)	(12.30)	(29.68)	(7.18)	(14.40)
Age^2	-0.002***	-0.003***	-0.005***	-0.004***	-0.004***	-0.004***	-0.002***	-0.003***
	(-4.69)	(-14.85)	(-6.11)	(-14.85)	(-10.09)	(-24.33)	(-5.61)	(-11.67)
Percent of Girl Children	-0.498***	-0.551***	-0.774***	-0.586***	-0.595***	-0.532***	-0.423***	-0.433***
	(-5.39)	(-14.03)	(-4.62)	(-11.82)	(-8.56)	(-20.22)	(-7.04)	(-11.69)
Education (Reference Group=No Education)								
Primary Education	-0.169	-0.092*	-0.138	-0.083	0.013	-0.031	0.092	-0.074
	(-1.81)	(-2.26)	(-0.75)	(-1.59)	(0.17)	(-1.05)	(1.17)	(-1.46)
Secondary Education	-0.301**	-0.311***	-0.165	-0.306***	-0.249***	-0.277***	-0.395***	-0.463***
	(-3.22)	(-8.06)	(-0.84)	(-5.87)	(-3.34)	(-10.35)	(-5.55)	(-10.55)
Higher Education	-1.178***	-0.614***	-1.308**	-0.772***	-0.435**	-0.622***	-0.690***	-0.769***
	(-5.40)	(-8.20)	(-2.69)	(-6.18)	(-3.21)	(-14.28)	(-7.17)	(-13.53)
Employed	0.299***	0.061	0.324*	0.163**	0.202***	0.110***	0.083	0.0416
	(4.42)	(1.41)	(2.41)	(2.68)	(3.80)	(3.83)	(1.65)	(1.04)
Exposure to Family Planning Ads	0.006	0.002	-0.108	-0.000	0.056	-0.025	-0.025	-0.163**
	(0.09)	(0.07)	(-0.83)	(-0.00)	(0.97)	(-1.16)	(-0.42)	(-4.82)
Self or Joint Decision Regarding Contraception	4.049***	4.137***	4.449***	4.339***	4.450***	4.359***	3.859***	4.134***
	(54.23)	(130.19)	(33.91)	(104.84)	(75.46)	(199.24)	(73.27)	(133.22)
Husband's Education (Reference Group=No Education)								
Primary Education	0.072	-0.04	-0.239	-0.021	0.119	0.035	-0.092	-0.085
	(0.76)	(-0.91)	(-1.59)	(-0.40)	(1.49)	(1.12)	(-0.92)	(-1.66)
Secondary Education	-0.006	-0.006	-0.388*	-0.073	-0.060	0.022	-0.284**	-0.098*
	(-0.08)	(-0.14)	(-2.45)	(-1.42)	(-0.86)	(0.76)	(-3.27)	(-2.32)
Higher Education	0.125	-0.052	-0.593	-0.053	-0.249*	-0.084**	-0.372***	-0.111**

	Hindu SC		**Hindu ST**		**Hindu OBC**		**Hindu Forward Caste**	
Variables	**2005-06**	**2015-16**	**2005-06**	**2015-16**	**2005-06**	**2015-16**	**2005-06**	**2015-16**
	(0.83)	(-1.11)	(-1.79)	(-0.86)	(-2.29)	(-2.67)	(-3.59)	(-2.59)
Household's wealth (Reference Group=Poorest)								
Poorer	0.139	0.011	0.428**	0.083	0.227*	0.047	0.353**	0.031
	(1.36)	(0.27)	(2.88)	(1.88)	(2.57)	(1.58)	(2.60)	(0.48)
Middle	-0.093	-0.038	0.290	0.013	0.081	0.095**	0.298*	0.081
	(-0.85)	(-0.84)	(1.54)	(0.22)	(0.91)	(2.95)	(2.29)	(1.25)
Richer	0.0498	-0.107*	0.192	-0.117	0.216*	0.0343	0.380**	0.0296
	(0.40)	(-2.04)	(0.81)	(-1.45)	(2.19)	(0.97)	(2.88)	(0.45)
Richest	-0.144	-0.125	0.099	-0.211	0.005	-0.070	0.242	-0.056
	(-0.96)	(-1.93)	(0.31)	(-1.88)	(0.04)	(-1.70)	(1.72)	(-0.79)
Proportion of Women within ethnic-religious groups using Modern Contraceptive Methods in an individual woman's Social Network								
Hindu SC	**5.974*** **	**6.007*** **	0.0295	0.005	0.175*	-0.062*	0.038	-0.059
	(33.18)	**(86.33)**	(0.19)	(0.10)	(2.50)	(-2.48)	(0.63)	(-1.66)
Hindu ST	0.143	0.0565	**6.172*** **	**5.990*** **	0.038	0.076*	0.023	0.040
	(1.28)	(1.24)	**(19.95)**	**(65.03)**	(0.48)	(2.48)	(0.30)	(0.85)
Hindu OBC	0.068	-0.110*	-0.067	-0.170***	**5.732*** **	**5.301*** **	0.078	-0.126**
	(0.66)	(-2.56)	(-0.37)	(-3.38)	**(37.52)**	**(105.11)**	(1.19)	(-3.11)
Hindu Forward Caste	0.120	0.007	-0.145	-0.002	-0.109	-0.037	**5.420*** **	**5.642*** **
	(1.18)	(0.18)	(-0.84)	(-0.04)	(-1.47)	(-1.41)	**(39.23)**	**(80.05)**
Muslim	0.232*	-0.077	0.0474	-0.0734	-0.091	-0.167***	-0.104	-0.158**
	(2.15)	(-1.57)	(0.21)	(-0.87)	(-1.13)	(-4.86)	(-1.31)	(-3.25)
Christian	-0.138	-0.184*	-0.147	-0.291***	-0.085	-0.109*	-0.143	-0.232**
	(-1.04)	(-2.28)	(-0.57)	(-3.52)	(-0.80)	(-2.03)	(-1.37)	(-2.70)
Other	-0.234	-0.199*	-0.554*	-0.073	-0.207*	-0.0366	-0.229**	-0.171**
	(-1.71)	(-2.45)	(-2.26)	(-0.72)	(-2.00)	(-0.63)	(-3.12)	(-2.90)
Interaction with Health Worker	-0.077*	-0.053***	-0.015	-0.062***	-0.041	-0.048***	0.015	-0.022**
	(-2.46)	(-7.40)	(-0.29)	(-7.12)	(-1.48)	(-9.14)	(0.51)	(-2.64)
Interaction with Health Worker^2	0.0021	0.0019***	-0.003	0.002***	0.001	0.002***	-0.001	0.0008**
	(1.73)	(6.88)	(-0.95)	(6.08)	(0.84)	(8.11)	(-1.00)	(2.66)
Rural Location	0.0896	0.0844*	-0.556**	-0.095	0.027	0.039	0.027	-0.003
	(1.14)	(2.37)	(-2.92)	(-1.45)	(0.44)	(1.61)	(0.48)	(-0.08)
Intercept	-9.298***	-9.847***	-12.01***	-10.76***	-11.25***	-10.56***	-8.109***	-8.602***
	(-16.78)	(-35.37)	(-12.33)	(-30.64)	(-24.42)	(-50.11)	(-18.18)	(-28.68)
Social Network Variance	-1.021***	-0.816***	-0.946***	-0.629***	-0.735***	-0.678***	-1.072***	-0.698***
	(-5.74)	(-5.93)	(-3.80)	(-4.11)	(-4.58)	(-5.08)	(-6.60)	(-4.95)
State Variance	-15.89	-18.34	-17.86	-10.70	-17.85	-20.44	-23.23	-24.05
	(-0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)
Analytical Sample	12496	75405	4914	46238	22547	156696	21095	71606
BIC	7369.6	38632.4	2609.9	23529.0	12259.0	82816.9	14539.4	39406.6

Note: Z-Scores in parentheses; "* p<0.05 ** p<0.01 *** p<0.001"; All model runs include state fixed effects

Table 4: Estimates and Z-Scores from Multilevel Logistic Regression of Woman's Modern Contraceptive Usage on Individual, Social Network and State Characteristics

	Muslim		**Christian**		**Other**	
Variables	**2005-06**	**2015-16**	**2005-06**	**2015-16**	**2005-06**	**2015-16**
Age	0.169***	0.176***	0.160**	0.173***	0.227***	0.251***
	(4.84)	(11.28)	(2.83)	(5.68)	(3.74)	(8.66)
Age^2	-0.002***	-0.002***	-0.002*	-0.002***	-0.003**	-0.003***
	(-3.90)	(-10.36)	(-2.28)	(-4.61)	(-3.26)	(-7.31)
Percent of Girl Children	-0.278**	-0.257***	-0.411**	-0.182*	-0.706***	-0.365***
	(-2.66)	(-6.04)	(-2.88)	(-2.34)	(-4.26)	(-5.18)
Education (Reference Group=No Education)						
Primary Education	0.188	0.0310	-0.103	-0.255**	-0.226	-0.312***
	(1.82)	(0.69)	(-0.58)	(-2.81)	(-1.24)	(-3.74)
Secondary Education	-0.243*	-0.212***	-0.254	-0.327***	-0.610***	-0.588***
	(-2.49)	(-5.32)	(-1.52)	(-3.84)	(-3.50)	(-7.85)
Higher Education	-0.595**	-0.410***	-0.680**	-0.893***	-0.225	-0.874***
	(-2.83)	(-5.32)	(-2.78)	(-6.46)	(-0.82)	(-7.49)
Employed	0.0861	0.0307	0.145	0.108	0.238	0.184*
	(1.09)	(0.78)	(1.40)	(1.17)	(1.83)	(2.36)
Exposure to Family Planning Ads	0.165*	0.117***	-0.025	0.007	0.142	0.118
	(2.15)	(3.76)	(-0.22)	(0.12)	(1.04)	(1.90)
Self or Joint Decision Regarding Contraception	4.153***	3.917***	4.535***	5.518***	4.303***	4.097***
	(53.56)	(119.50)	(37.36)	(67.99)	(32.66)	(72.67)
Husband's Education (Reference Group=No Education)						
Primary Education	-0.005	-0.052	0.462*	0.089	0.044	0.159
	(-0.05)	(-1.13)	(2.32)	(0.92)	(0.22)	(1.81)
Secondary Education	-0.067	-0.012	0.187	0.005	-0.07	0.164*
	(-0.75)	(-0.29)	(1.02)	(0.06)	(-0.40)	(2.13)
Higher Education	-0.316*	0.0441	-0.200	0.115	-0.683**	0.155
	(-2.01)	(0.89)	(-0.87)	(1.31)	(-2.79)	(1.86)
Household's wealth (Reference Group=Poorest)						
Poorer	0.008	-0.015	-0.029	0.014	0.288	0.133
	(0.06)	(-0.30)	(-0.10)	(0.14)	(0.91)	(1.17)
Middle	0.135	-0.172**	0.190	0.09	0.137	0.232*
	(0.94)	(-3.23)	(0.66)	(0.86)	(0.45)	(1.98)
Richer	0.185	-0.223***	0.255	0.057	0.205	0.047
	(1.23)	(-3.88)	(0.86)	(0.49)	(0.65)	(0.37)
	Muslim		Christian		Other	
Richest	0.198	-0.156*	0.198	-0.01	0.113	-0.102
	(1.15)	(-2.41)	(0.63)	(-0.07)	(0.34)	(-0.75)
Proportion of Women within ethnic-religious groups using Modern Contraceptive Methods in an individual woman's Social Network						
Hindu SC	-0.110	-0.011	-0.031	0.025	-0.170	0.091
	(-1.05)	(-0.23)	(-0.15)	(0.22)	(-0.87)	(1.00)
Hindu ST	0.153	0.135*	-0.191	-0.943***	0.057	-0.125

	Muslim		**Christian**		**Other**	
Variables	**2005-06**	**2015-16**	**2005-06**	**2015-16**	**2005-06**	**2015-16**
	(1.04)	(2.34)	(-0.74)	(-5.37)	(0.26)	(-1.03)
Hindu OBC	-0.0657	-0.156*	0.0547	-0.495**	0.008	-0.04
	(-0.55)	(-2.54)	(0.24)	(-3.27)	(0.05)	(-0.52)
Hindu Forward Caste	0.094	-0.006	0.178	-0.483**	-0.440	0.013
	(0.61)	(-0.13)	(0.80)	(-2.99)	(-1.76)	(0.13)
Muslim	**5.718*** **	**5.657*** **	-0.251	0.006	0.234	-0.002
	(24.99)	**(65.65)**	(-1.32)	(0.04)	(0.97)	(-0.02)
Christian	0.0966	-0.110	**6.324*** **	**6.775*** **	0.274	0.004
	(0.60)	(-1.03)	**(19.25)**	**(33.43)**	(1.33)	(0.03)
Other	-0.085	0.081	0.137	0.395	**6.430*** **	**5.977*** **
	(-0.52)	(0.76)	(0.54)	(1.88)	**(19.54)**	**(38.50)**
Interaction with Health Worker	0.023	0.004	-0.052	-0.043*	0.051	-0.028
	(0.53)	(0.48)	(-0.69)	(-2.43)	(0.81)	(-1.86)
Interaction with Health Worker^2	-0.000	-0.000	0.002	0.001*	-0.003	0.001
	(-0.06)	(-0.46)	(0.70)	(2.16)	(-1.10)	(1.59)
Rural Location	0.257**	0.003	0.084	-0.054	0.165	-0.038
	(2.85)	(0.09)	(0.74)	(-0.79)	(1.14)	(-0.58)
Intercept	-8.349***	-7.384***	-8.660***	-8.631***	-9.469***	-9.836***
	(-14.01)	(-26.14)	(-8.50)	(-15.07)	(-8.91)	(-18.27)
Social Network Variance	-1.141***	-0.927***	-0.622**	-0.349*	-0.849**	-0.812***
	(-5.71)	(-6.40)	(-2.66)	(-2.04)	(-3.25)	(-4.32)
State Variance	-22.86	-16.39	-23.46	-1.466***	-22.39	-18.37
	(-0.00)	(-0.00)	(-0.00)	(-3.38)	(-0.00)	(-0.00)
Analytical Sample	10966	59880	6589	32791	4393	22559
BIC	6510.0	34585.6	3289.6	11387.3	2590.2	11606.0

Note: Z-Scores in parentheses; "* p<0.05 ** p<0.01 *** p<0.001"; All model runs include state fixed effects

Fig A.1: Effect of Age for Hindu Caste Groups 2005-2006

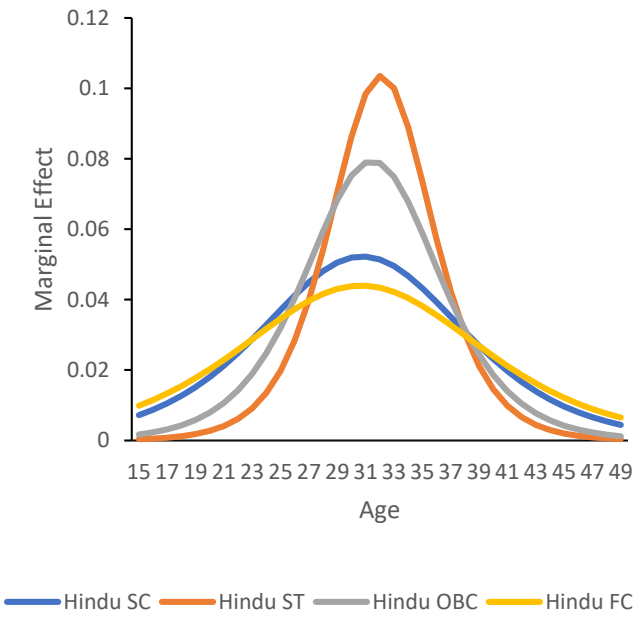


Fig A.2: Effect of Age for non-Hindu Groups 2005-2006

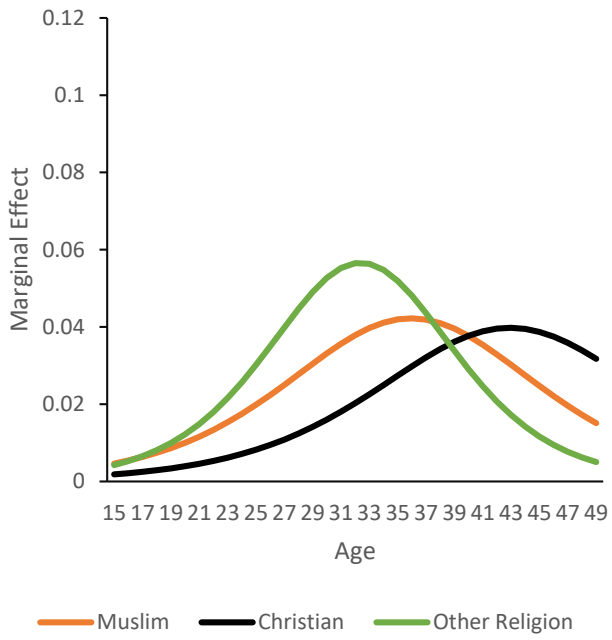


Fig A.3: Effect of Age for Hindu Caste Groups 2015-2016

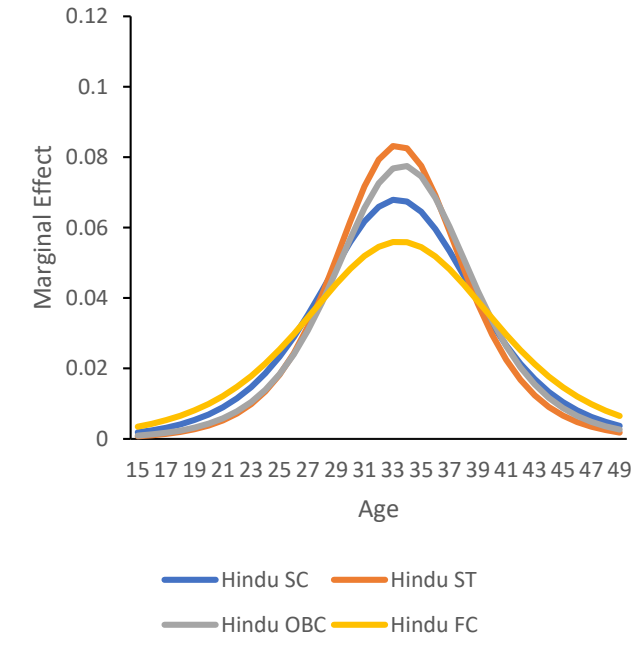


Fig A.4: Effect of Age for non-Hindu Groups 2015-2016

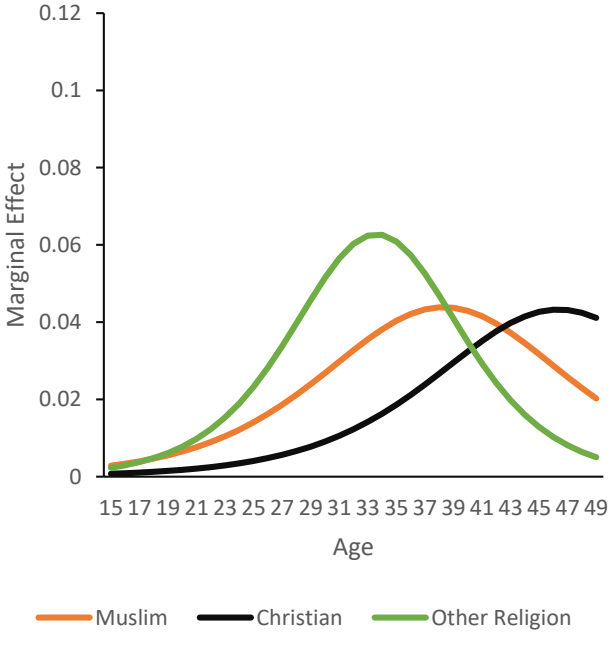


Fig B.1: Effect of Gender Compostion of Children for Hindu Caste Groups 2005-2006

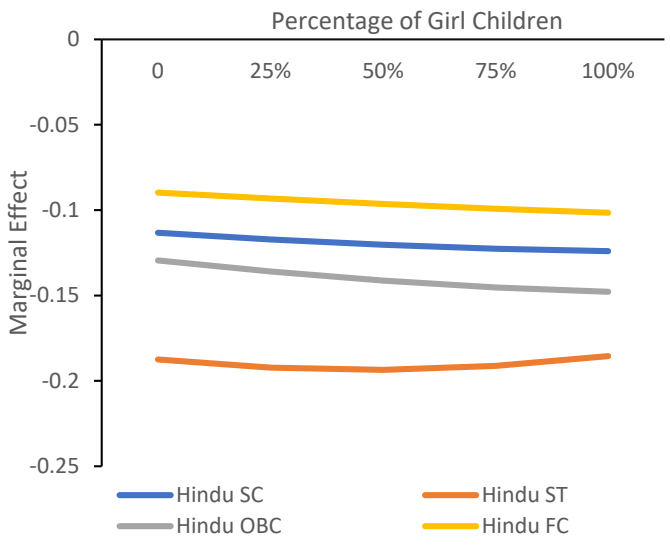


Fig B.2: Effect of Gender Compostion of Children for non-Hindu Groups 2005-2006

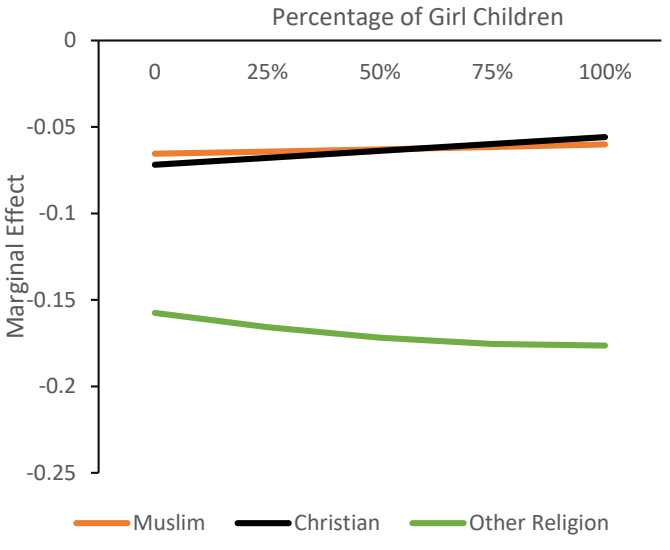


Fig B.3: Effect of Gender Compostion of Children for Hindu Caste Groups 2015-2016

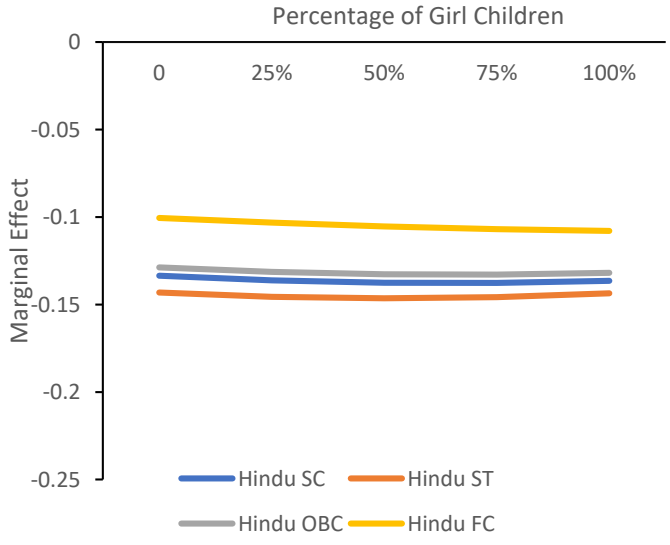


Fig B.4: Effect of Gender Composition of Children for non-Hindu Groups 2015-2016

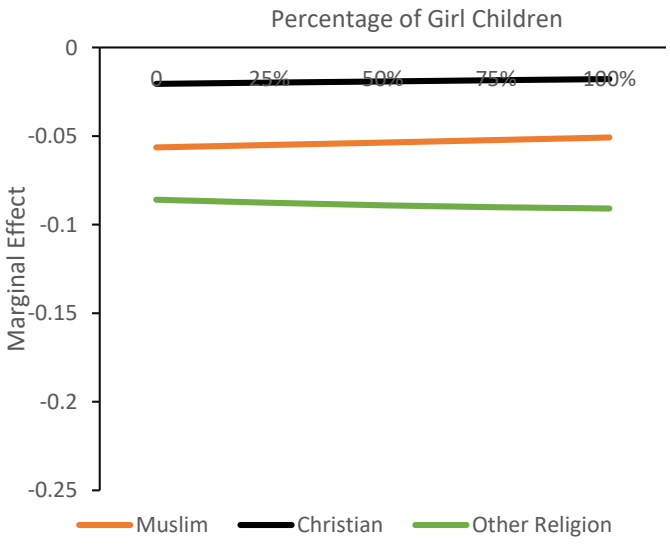


Fig C.1: Own Community Effect for Hindu Caste Groups 2005-2006

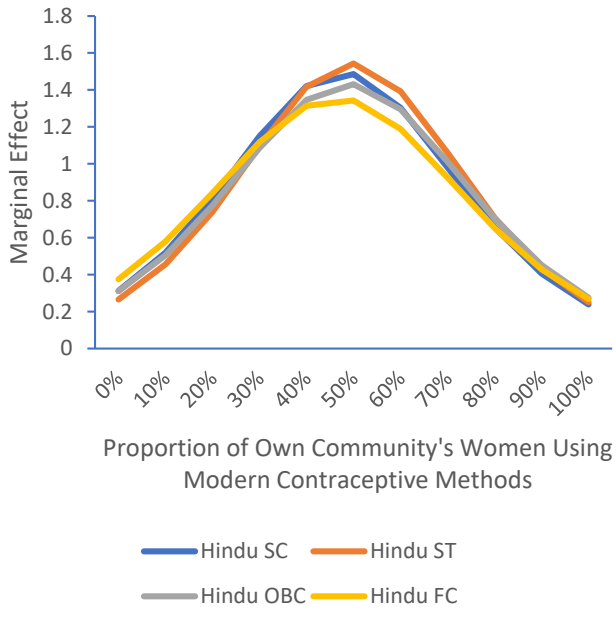


Fig C.2: Own Community Effect of non-Hindu Groups 2005-2006

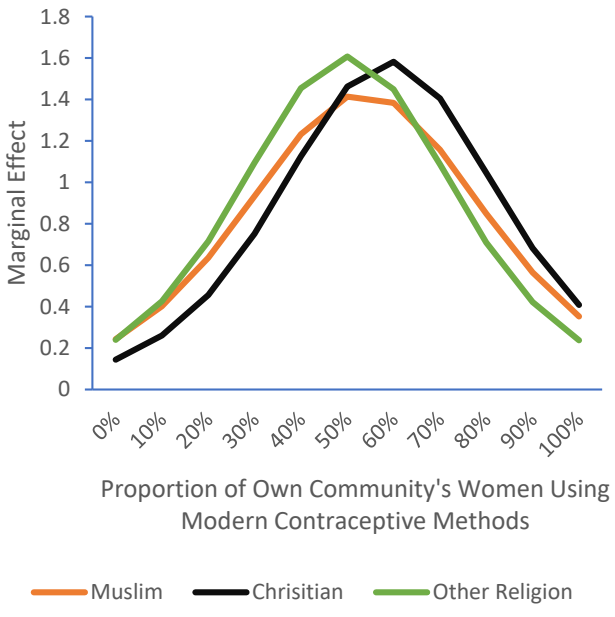


Fig C.3: Own Community Effect of Hindu Caste Groups 2015-2016

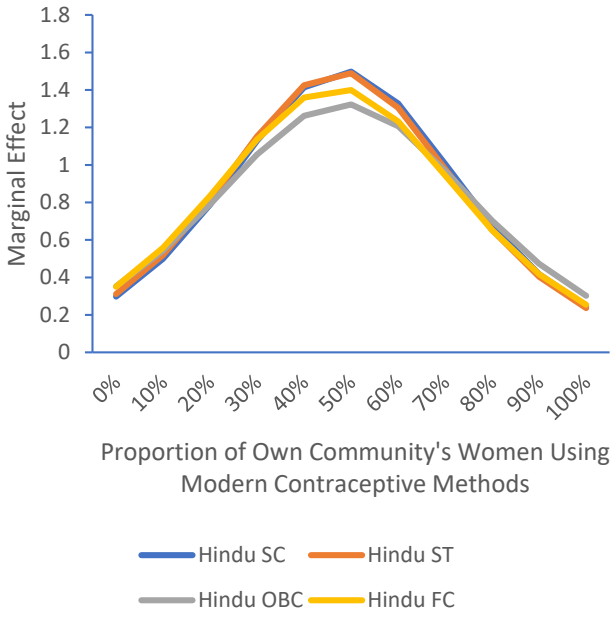


Fig C.4: Own Community Effect of non-Hindu Groups 2015-2016

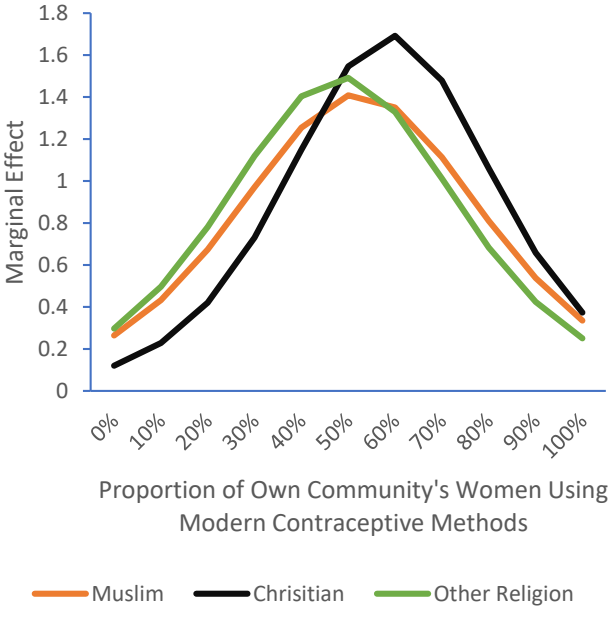
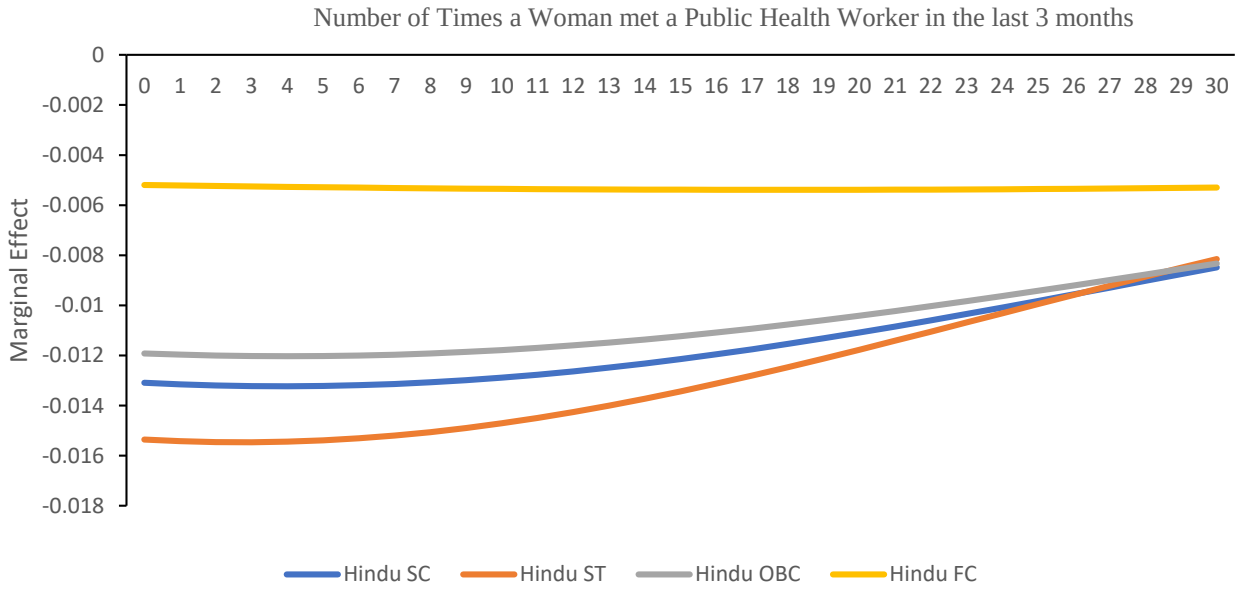


Figure D: Interaction with Public Health Worker by Hindu Caste Groups 2015-16



Conclusions and Policy Recommendations

This paper investigates the influence of two factors – 1) caste-based and religion-based network, 2) interaction with public health worker on contraceptive choices made by married Indian women in two time periods separated by 10 years. The empirical analysis revealed caste and religion-based networks are strong determinants of contraceptive choice made by women, while interaction with health workers have the opposite impact. These two factors have not received significant attention in the literature. Papers that have explored the influence of social network on health outcomes of women suffered from two limitations, firstly they did not define social network around caste or religion lines and thereby ignored the caste-based and religion-based residential segregation in India and secondly, the analysis was restricted to selected samples of women which makes it hard to generalize results and decipher trends. The strongest predictor of contraceptive choice is independent/joint decision making by the woman and her partner, therefore contraceptive choices are very much a private decision for Indian women/couples with social networks playing a positive mediating factor. These results can serve as useful guidelines to design programs aimed at increasing uptake of modern and safe contraceptive practices. Firstly, it is crucial to involve spouses of women to get the messaging across and secondly, public health workers should conduct mass outreach sessions for local women in their jurisdiction. If husbands/partners are aware of modern and safe contraceptive choices, it can help in increasing the chances of making an informed choice while mass outreach sessions can increase general awareness levels on the health benefits of controlling fertility.

Acknowledgements

This is a completely independent work not supported by any company, organization or authority. Author claims full responsibility of the work done and written material. Author is grateful to anonmyous reviewers for their construction comments and suggestions.

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