Examining Determinants of IUD Use in India: An Exploratory Analysis of the National Family Health Surveys (NFHS-4) using Machine Learning

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While India is making progress towards achieving fertility goals, contraceptive use patterns remain lopsided and sterilization-focused, with limited use of contraception to delay or space pregnancies. IUDs are an effective contraceptive method, available free or at low cost in primary care, with low discontinuation rates, but uptake among married women is low (1.5% per recent NFHS). We used machine learning approaches to explore the determinants and barriers to IUD use in India. Data from 499,627 married women were analyzed where the outcome of interest was IUD/PPIUD use; all variables in the dataset were included in the machine learning models using logistic regression (lasso and ridge) and neural network approaches along with qualitative coding. Findings revealed that couple's joint decision-making on family size and contraception as the strongest predictor of IUD use, demonstrating the importance of couple engagement in family planning interventions rather than the singular focus on women. Other key determinants included family planning counselling and contraceptive access, and access to maternal and child services, emphasizing the importance of an integrated approach to women's health services. Findings also confirm the role of socioeconomic determinants, especially wealth and education in continuing to determine the access and use of family planning services.

Background: While India is making progress towards achieving fertility goals, contraceptive use patterns in India remain lopsided with the predominance of sterilization and limited use of modern methods to delay and space pregnancies. A range of modern contraceptive methods (e.g. pills, condoms, IUDs) are available at free or low cost through the Indian public health system. Despite this, the uptake of these methods, particularly of IUDs, an effective contraceptive method, remains low (1.5% among married women in NFHS-4), with some evidence of a decline in use over the past decade (IIPS, 2018). The low rate of use notwithstanding, the rates of continued use are better amongst IUD users than for users of other methods of contraception. NFHS-4 data indicate that the discontinuation rate for IUD/PPIUD was 26%, which was much lower than the corresponding discontinuation rates for other forms of contraception such as injectable (51%), withdrawal (50%), condoms (47%), rhythm (44%), pills (42%), and "other methods" (77%) (IIPS, 2018).

At present, there is limited understanding of the correlates of IUD use in India. Available literature shows that sociodemographic factors such as geography, education, religion and the number and sex of children may affect IUD use (IIPS, 2018). There is growing evidence that knowledge of the method may be another factor influencing use, as noted among sexually active 15–49-year-olds participating in the NFHS-4, 36% of women and 54% of men were unaware of IUDs as a contraceptive option. This lack of knowledge may also be complicated by *attitudes towards, and the perception of side effects* of IUDs (Bhat & Halli, 1998; Sharma et al., 2014), as well factors in marital relationships including experience of *violence and reproductive coercion* from husbands (Chen et al., 2020; Tomar et al., 2020). Factors related to health systems such as quality of care (Prasad et.al 2018) and client satisfaction (Agha et.al 2011) may have impacts on IUD use.

This study aimed to use a novel method of integrating machine learning big data approaches with qualitative coding to understand potential determinants and barriers of IUD use in India. These determinants and barriers can provide insight into improving family planning programming aimed at increasing the delivery and uptake of IUD use in India.

Data and Research Methods: We used data from the National Family Health Survey - 4 (NFHS-4), a nationally representative survey conducted from 2015 to 2016, across all states of India. A total of 699,686 women of age 15-49 years were interviewed in this survey, of which 499,627 were currently married and were retained for analysis. The outcome of interest for the purpose of this study is IUD/PPIUD use, measured as whether currently married women were using IUD at the time of the survey (n=9,499). The study used machine learning (ML) models that allow for the adoption of an inductive approach including a large number of variables as independent variables, while avoiding overfitting and noise, addressing multi-collinearity, and generating coherent and relevant results. The analytical method has been validated in prior studies that examined child marriage and gender-based violence in India (Raj et al., 2020). We used three specific types of ML models - a) an L1 regularized logistic regression model, or Least Absolute Shrinkage and Selection Operator (lasso), b) an L2 regularized logistic regression model, or ridge, and c) a neural network (NN) model. The first two regression models were used in an iterative categorization method, which combined the two methods with a qualitative coding approach. The NN model was carried out as an explorative exercise to validate our findings and assess whether accounting for non-linear relationships among the predictor features might generate any different results. All variables in the NFHS-4 dataset were included as the independent variables after pre-processing as dummy variables.

Analytical approach:

Following the method of iterative categorization used by Raj et. al (2020), we ran lasso and ridge models to identify key emergent themes that were coded by two researchers. Variables such as wealth, religion, and place of residence (rural/urban) were coded as socio-economic characteristics, and those on receipt of counselling on side effects of contraceptives and receipt of counselling on different types of

contraceptive methods were coded as family planning (FP) counselling. After coding the themes from the first model, the theme with the highest variance was dropped, and the model was repeated, until saturation was reached and no new themes were identified.

Findings: In the NFHS-4 data, 1.5% of currently married women of age 15-49 years were using IUD/PPIUD. Participants were women (mean age 32 years) and around 18% belonged to the highest wealth quintile. Over two-thirds (72%) lived in rural areas. Participants who reported currently using IUD were on average 31 years of age, with 33% belonging to the highest wealth quintile and 61% residing in rural areas. The percentage of women in the overall sample and the sub-sample of women who used IUD/PPIUD also differed by birth parity.

In the first round of thematic generation, the study identified five themes associated with IUD/PPIUD use, including FP decision-making, Access to contraceptives, FP counselling, Fertility and Unmet need. Dropping FP decision-making, the theme with the highest variance, followed by qualitative coding led to identification of three new themes: Contraceptive knowledge, Socio-economic status, and Access to maternal and child health (MCH) services. These findings show couple joint decision-making related to family size and contraception use as the strongest predictor of IUD use, demonstrating the importance of couple engagement in family planning interventions instead of focusing only on women. Additionally, we found that provision of good quality family planning counselling along with access to maternal and child health care access were strong correlates of IUD use. These factors demonstrate that interventions targeting IUD use must use an integrated approach to family planning and strengthen systems side constraints. Our study also points to the continuing role of socioeconomic determinants (wealth, education and knowledge of contraception) as barriers and that need to be accounted for in the design and delivery of IUD use in India

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Table: Determinants and Barriers to IUD Use in India as Identified by Machine Learning Models on the National Family Health Surveys (NFHS-4).

Family planning decision making	**Access to contraceptives**	**FP counselling**	**Fertility**	**Unmet need**	**Contraceptive knowledge**	**Socio- economic status**	**Access to maternal and child health services**
Both husband and wife want same # of children	Has accessed contraceptive from govt. clinic/ pharmacies	Has been told about side effects of contraceptives	Fertility preference : no more	Using contraceptives for limiting	Knows about the IUD method	Is literate	Antenatal care check ups received: ultrasound, weight, BP, abdomen, blood test, urine test
Joint decision (husband and wife) making for contraceptive use	Has accessed contraceptives from private clinic	Has been told about other FP methods	Does not want any more children	Using contraceptives for spacing	Knows about traditional method of contraception	Highest wealth quintile	Received ANC at private health facility
	Has never used female sterilization	Has been told about how to deal with side effects	Women category: fecund			Highest education level: secondary	Received polio vaccine for child
						Religion: Sikh, Jain, Other (non Hindu/non Muslim)	