Spatial and Multilevel Analysis of Hysterectomy in India and Its states

1. Introduction

Hysterectomy is defined as the removal of the uterine corpus with (total hysterectomy) or without the cervix (subtotal or supracervical hysterectomy). The route of hysterectomy can be via laparotomy, vaginally, by applying minimally invasive techniques (laparoscopy, robotic surgery) or a combination of the latter two [1, 2]. Medical indications for hysterectomy include fibroids, dysfunctional uterine bleeding, uterine prolapse and chronic pelvic pain [3]. Physicians' views on the appropriate use of the procedure diverge widely—contributing to variation in rates and suspected misuse in some settings [4, 5].

Variations in hysterectomy rates have been associated with women's demographic characteristics such as race, education and socio-economic status and insurance status, as well as their physician's gender, training and geographical location, suggesting that the procedure is related to the broader social and health system environment as well as to biological risk [6, 7]. The early life factors of age at menarche and parity is also associated with hysterectomy [8, 9].

Particularly in settings with a high lifetime risk of hysterectomy such as the United States, where one in three women undergoes the procedure, hysterectomy has been scrutinized and contested as a symbol of a more comprehensive culture of unnecessary medical intervention in women's bodies [10]. The majority performed for benign indications such as uterine fibroids, dysfunctional uterine bleeding, uterine prolapse, and endometriosis [11]. It is the most frequent gynecological procedure performed after cesarean section worldwide. The incidence of hysterectomy, like cesarean section, varies between and within countries. An estimated 5.1 women per 1000 women above age 15 underwent a hysterectomy in 2004 in the United States, compared to 3.1 per 1000 women in Australia [12, 13]. Within Germany, the incidence varies across states, ranging from 2.1 to 3.6 per 1000 women [14]. Community-based research in India has reported hysterectomy prevalence estimates of between 1.7 and 9.8% of adult women [15, 16]. The prevalence of hysterectomy is considerably lower in lower income countries compare to high-income countries such as the United States (26.2%), Australia (22.0%) and Ireland (22.2%) [17], but closer to prevalence in Taiwan and Singapore (8.8% and 7.5%, respectively [18, 19].

In 2012, media reports in India raised suspicion of increasing misuse of hysterectomy as a routine treatment for gynecological ailments, particularly in young, premenopausal women [20]. Analyses of facility and insurance data have recommended hysterectomy is correlated with profit incentives under the national health insurance scheme and unregulated private health care [21]. Research from one of the Indian states (Gujarat) identified that hysterectomy is the leading reason for hospitalization among both insured and uninsured women. However, the cross-sectional nature of the data prevented comparison with other settings or conclusive findings related to predictors associated with the procedure [22]. A study in rural area of other states of India (Andhra Pradesh) has established that 59% cases of hysterectomy also had removal of both ovaries with an average age at hysterectomy of 29 years [23]. In response to such findings, two states in India have already restricted publicly funded insurance coverage for hysterectomy in private facilities [24].

Health policy interventions require improved access to sexual and reproductive health services and health education, along with surveillance and medical audits to promote high-quality choices for women through the life cycle. Improved access to sexual and reproductive health services within primary health care services is a first step, along with understanding the links between sterilization and hysterectomy [25]. Hysterectomy with ovarian conservation was found to be associated with cardiovascular risk factors, particularly obesity [26]. Hysterectomy performed for malignancy had a detrimental effect on sexual function [27]. The lower educational level associated with a higher hysterectomy prevalence among women aged 20–64 years. Several mediators related to educational level and hysterectomy including women's disease risk, women's treatment preference, and women's access to uterus-preserving treatment may explain this association [28]. The hysterectomy group showed slightly higher mean scores regarding anxiety and depression. Quality of life was excellent in all domains in both groups whereas sexual problems are slightly more in hysterectomy group [29]. The study suggested that hysterectomy performed without appropriate diagnostic evaluation or alternative treatments tried [22]. Similar findings of medical audits in the United States, the lack of clear clinical guidelines for hysterectomy may leave it prone to misuse [30]. Despite widespread media coverage and policy changes regarding insurance, there is limited population-level data and information available on hysterectomy to inform policy. In India, hysterectomy has gained attention in health policy debates in the past few years. The trigger for increased focus is provided by a series of media reports that have highlighted an unusual surge in the number of women undergoing a hysterectomy in the many parts of the country, which a significant number of cases involving young and pre-menopausal women [31-34].

2. Objectives

1. To analysis the socio-economic and demographic determinants of hysterectomy.
2. To analysis the spatial distribution and covariates of the prevalence of hysterectomy.

3. Data source and methodology: -

3.1 Data source: - National Family Health Survey (NFHS-IV) has been used to assess the objectives. NFHS IV was conducted in 2015-16. NFHS is conducted by International Institute for Population Sciences, under the auspices of Ministry of Health and Family Welfare (MoHFW), Government of India (GOI). NFHS is similar to DHS survey. NFHS-4 provides information on population, health, and nutrition for India and each state /union territory and District. In all, 28,586 Primary Sampling Units (PSUs) were selected across the country in NFHS-4, of which fieldwork completed in 28,522 clusters. A total of 601,509 households were successfully Interviewed, with a response rate of 98%. From the interviewed households, 723,875 eligible women age 15-49 were identified for interview. Interviews with 699,686 women were completed with 97% response rate.

The spatial analysis district level maps of India as per census 2011, District and state wise geo-referenced shapefile of India have used to estimate the prevalence of hysterectomy at district and state level.

3.2 Variable Description: -

3.2.1 Dependent variables

NFHS IV, for the first time, has provided information on hysterectomy across the country. We have used Hysterectomy as an outcome variable in the present study. The survey asked following questions related to hysterectomy to women age (15-49).

1. Some women undergo an operation to remove the uterus. Have you undergone such operation?
2. How many years ago this operation (Hysterectomy) was performed?
3. Where this operation was performed?
4. Why this operation performed? Any other reason?
The outcome variable has made dichotomous having categories “having a hysterectomy” and “not having a hysterectomy”

3.2.2 Independent variable

To examine the association of hysterectomy and menopause with various socio-economic, demographic factors, the covariates used in the analysis were age, education completed, occupation, marital status, place of residence, religion, caste, wealth index, age at marriage, age at first cohabitation, age at first birth, parity, occurrence of sterilization, age at sterilization, insurance status and empowerment status

3.3 Methodology

3.3.1 Logistic regression

The study used logistic regression to find the probability of occurrence of hysterectomy and menopause among independent variable or background characteristics.
The logistic regression equation is –

$$\textbf{Logit (p)} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \, b_kX_k$$

The logit transformation defined as the logged odds:

$$\text{Odds} = (p / 1\text{-}p)$$

$$\textit{Logit (p)} = \text{Ln } (p/1\text{-}p)$$

Where,
p: the probability of the presence of the characteristic of interest (Dependent variable).
1-p: the probability of non-occurrence of the characteristic of interest.
X1, X2, X3……….Xk are predictor variables
b0: intercept when there is no effect of any predictor variable on the dependent variable.
b1, b2, b3………….bk are co-efficient of predictor variables.

3.3.2 Spatial Analysis:-

Spatial analysis refers to “a general ability to manipulate spatial data into different forms and extract additional meaning as a result.” Specifically, the spatial analysis comprises a body of techniques “requiring access to both the locations and the attributes of objects” [64]. Spatial statistics quantify geographic variation in geographic variables, and it can identify violations of assumptions of independence required by many epidemiological statistics; and measure how populations, their characteristics, covariates and risk factors vary in geographic space.

3.3.2 Spatial Autocorrelation:-

Spatial autocorrelation analysis was applied to summarise the extent to which persons with a similar health status tend to occur next to each other, i.e., form spatial clusters[8]. Spatial autocorrelation statistics depend on the definition of neighborhood relationships through which the spatial configuration of the sampled subpopulation was defined before analysis. High or low values for a random variable tend to cluster in space (positive spatial autocorrelation), or location tends to be surrounded by neighbors with very dissimilar values (negative spatial autocorrelation). We used a binary weight matrix to assign weights to the neighbors. This binary weight matrix assigns a weight of unity for neighbors and zeroes for non-neighbors. The spatial patterns were investigated by global measures that allowed for spatial clustering tests. The present study used exploratory spatial data analysis (ESDA) techniques to measure the spatial autocorrelation among districts that are spatially contiguous. The measure used in this study is a local indicator of spatial association (LISA) measure of local Moran's *I*, which indicates the "presence or absence of significant spatial clusters or outliers for each location" in a dataset.

3.3.3 Moran's Index

Moran's statistics: Local spatial autocorrelation, measured by Moran's *I*, captures the extent of overall clustering or quantify the degree of spatial autocorrelation that exists in a dataset across all the districts. A Moran's *I* value near +1.0 indicates clustering; 0 indicates randomness; and a value near -1.0 indicates dispersion. The value of Moran's *I* statistics ranges from -1 to 1, where positive values indicate observations with similar values being close to each other and negative values suggest observations with high values are near those with low values, or vice-versa.
Moran's *I* can be depicted in a scatter plot categorized into four groups as-
High-high: High values surrounded by high values
Low-high: Low values surrounded by high values
Low-low: Low values surrounded by low values
High-low: High values surrounded by low values
High-high, low-low is positive autocorrelation and high-low, low-high is negative autocorrelation.

Moran's *I* defined as

$$\boldsymbol{I = N\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\,(X_i - \bar{X})\,(Y_i - \bar{Y})}{(\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij})\,(\sum_{i=1}^{n} X_i - \bar{X})^2}}$$

Where *N* is the number of spatial units indexed by *I* and *j; X* is the variable of interest; $\bar{X}$ is the mean of X; and Wij is an element of a matrix of spatial weights.
The expected value of Moran's *I* under the null hypothesis of no spatial autocorrelation is
E (I) = -1/ (N-1)
Its variance equals to -

$$\text{Var (I)} = \frac{NS_4 - S_3S_4}{(N-1)\,(N-2)\,(N-3)\,\left(\sum_i\sum_j W_{ij}\right)} - (E(I))^2$$

Where,

$$S_1 = \frac{1}{2}\sum_i\sum_j(W_{ij} + W_{ji})^2$$
$$S_2 = \sum_i(\sum_j W_{ij} + \sum_j W_{ji})^2$$

$$S_3 = \frac{\frac{1}{N}\sum_i (x_i - \bar{x})^2}{\frac{1}{N}\sum_i (x_i - \bar{x})}$$

$$S_4 = (N^2 - 3N + 3)S_1 - NS_2 + 3\left(\sum_i \sum_j W_{ij}\right)^2$$

$$S_5 = (N^2 - N)S_1 - 2NS_2 + 6\left(\sum_i \sum_j W_{ij}\right)^2$$

3.3.4 Local Indicators of Spatial Association (LISA) statistics: The index used to observe spatial autocorrelation at the local level is Anselin's LISA (Local Indicator of Spatial Autocorrelation), which can be seen as the local equivalent of Moran's-*I*. LISA essentially measures the statistical correlation between the value in subarea *I* and the values in nearby subareas. Univariate LISA statistics are used for the purpose, which measures the extent of spatial non-stationary and clustering to its neighborhood values.

$$I_i = Z_i \sum_j W_{ij} Z_j$$

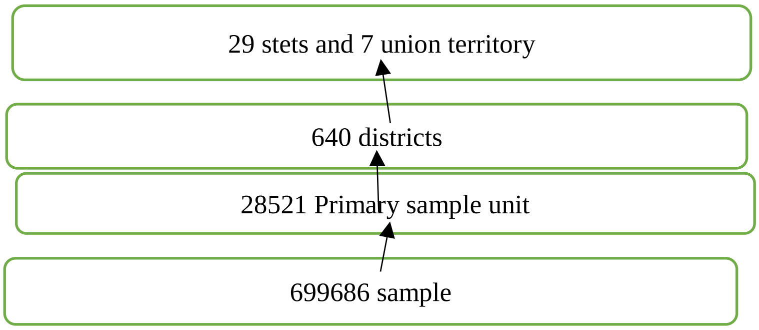
Where observation Z_i, Z_j are in deviations from the mean from i^{th} location to j^{th} location and the summation over j such that only neighboring values j $\sum$Ji are included. Also, W_{ij} is a spatial weight measuring the nearness of subareas i and j. For ease of interpretation, the weights w_{ij} may be in row standardized form, though this is not necessary and by convention, $W_{ij}=0$. LISA values close to zero indicate little or no statistical association among neighboring values.

A positive LISA statistic identifies a spatial concentration of similar values. When the LISA statistic is negative, we have a spatial cluster of dissimilar values, such as an area with a high outcomes values surrounded by areas with low outcomes values. For each location, LISA values allow for the computation of its similarity with its neighbors and test its significance. Five scenarios may emerge: (a) location with high values with similar neighbours: high-high spatial clusters (red dot marks), also known as "Hot-Spots"; (b) location with low values with similar neighbours: low-low spatial clusters (blue dot marks), also known as "Cold spots", they represent positive spatial autocorrelation or locations surrounded by neighbours with similar values; (c) Locations with high values with low-value neighbours: high-low (light pink dot marks); (d) locations with low values with high-value neighbours: low-high (light blue dot marks), these locations are "Spatial outliers" which represent negative spatial autocorrelation or locations surrounded by neighbours with dissimilar values; and (e) locations with no significant, there is no autocorrelation. India, states and district shapefile were extracted from India shapefile after downloading through DivaGIS; the final feature class had 640 polygons representing each survey district in NFHS-4. Then, selected estimates of hysterectomy and menopause from the districts level data were joined to the polygon dataset. After that Moran's-*I* and LISA was carried out through GeoDa.

3.3.5 Multi-level model

Multilevel modeling was used to see the Intra Cluster Correlation Coefficient of hysterectomy and menopause at four level states, district, PSU and Individual after adjusting women's background characteristics.

The NFHS-4 collected data from 28 states including 7 union territories. Which includes 640 districts 28521 PSUs from all PSUs 699686 individuals were selected for the study.
We have considered three geographic levels in our analysis because each had specific importance that could potentially influence prevalence of hysterectomy and menopause at the individual level (level 1). States and union territory (level 4) are the political unit at which federal policies operate. The Constitution of India distributes the sovereign executive and legislative powers exercisable with respect to the territory of any State between the Union and that State. Districts (level 2) are the lowest administrative unit in India at which central and state plans are executed. Since the mid-1960s, the elected district councils have been responsible for planning the provision of rural service infrastructure and other services. PSUs (level 3) Primary sampling unit is typically geographically localized the reason being the members of the local community share a common attachment to some kind of physical resource land, livestock and so on. The PSUs are typically villages in rural areas and wards in urban areas.



Multi-level modelling approach has been used for portioning of variation in prevalence of hysterectomy and menopause at different geographical level. By using multilevel models, we can apportion the variance in the response variable according to the different levels of the data. Our data is following four-level hierarchical structure with individuals at level-1, PSUs at level-2, districts at level-3 and state and union territory at level-4.

In order to decompose variation in any chronic disease and specific chronic disease, we specified a series of four-level random intercept logistic models for the probability of a individual *"I"* in PSU "j", district "k", state "l" had hysterectomy or in menopause (Yijkl=1) as:

$$\textbf{Logit}\ (\pi_{ijkl}) = \beta_0 + BX'_{ijkl} + (f_{0l} + v_{0kl} + u_{0jkl})$$

Multi-level modeling approach is an efficient method to combine data from different geographical level validly and deal with small area rate instability. The estimates and the variations apportioned to each level are precision-weighted for both small cluster sizes and imbalance in the nesting structure (Goldstein, 2005). This model estimates the log odds of $\pi ijkl$ adjusted for a vector $(X'ijkl)$ of above-mentioned independent variables measured at the individual level. The parameter $\beta 0$ represents the log odds of having hysterectomy and in menopause for an individual belonging to the reference category of all the categorical variables. The random effect inside the brackets are interpreted as residual differential for the state *l* (f*0l),* district *k* (V*0kl*) and PSU *j* (*U0jkl*). All three residuals are assumed to independent and normally distributed with mean 0 and variance σ^2 f_0, σ^2 v_0, and σ^2 u_0 respectively. These variance quantify between state (σ^2 f_0), between district (σ^2 v_0) and between PSU (σ^2 u_0) variations respectively in the log odds of women undergoing hysterectomy and in menopause conditional on all the individual characteristics. For binary outcome the variance at lowest level cannot be obtained directly from the model and the remaining variance is assumed to simply be a function of the binomial distribution. Based on the variance estimate of random effects, the proportion of variation in the log odds of having hysterectomy or in menopause attributable to each level also known as variance partitioning coefficient(VPC) can be calculated. For example the proportion of total variation in having hysterectomy (in log odds scale) attributable to PSU can be obtained by dividing the between PSU variation by the total variation. Total variation is calculated using latent variable method approach and treated the between individual variation as having a variance of a standard logistic distribution approximated as π2/3=3.29 (Goldstein et al., 2002). Hence, VPC for any level z can be calculated using following formula:

$$\mathbf{VPC_z = \sigma^2_z \;/\; (\sigma_{f0}^2 + \sigma_{v0}^2 + \sigma_{u0}^2 + 3.29)}$$

The analysis using four level model for hysterectomy and menopause was done for individuals in urban population, rural population and total population to test for consistency of the finding for the individuals.

As a sensitivity analysis, we estimated simplified two level model structures, for which we assumed individuals to be nested within one and only one higher geographic level. As a result four different models: individuals with PSU, individuals within districts and individuals within states were obtained allowing us to evaluate the changes in variance estimate and proportion of variation attributable to the higher levels when only one geographic level was considered at a time.

We used MLwiN 2.36 software to obtain all estimates using 2nd-order predictive quasi-likelihood (PQL) to approximate linearization based on a Taylor series expansion to transform discrete response model to a continuous response model (Harvey, 2003). 2nd-order PQL is known to be more stable than the 1st-order PQL or marginal quasi-likelihood (MQL), which may lead to estimates that are biased downward. STATA 14.2 has been used to obtain results of cross tabulation and Binary logistic regression.

4. Results

4.1 Determinants of Hysterectomy

Findings from the study portrays that the overall mean age at hysterectomy in India is 34 years. It varied significantly across different characteristics. The mean age at hysterectomy in an urban area is 34.6 years, which is higher than mean age at hysterectomy in rural areas 33.5 years. In the figure-1.1, we have shown that the prevalence of hysterectomy was higher (9.3%) in age 40-49 compared to younger ages (e.g., 3.6% among 30-39 years). Hysterectomy prevalence was high in a rural area (3.4%) than urban India (2.4%). Prevalence of hysterectomy was negatively associated with the level of education. A higher proportion of Hindu women (3.4%) underwent hysterectomy as compared to Muslim and other women. Similarly, the prevalence of hysterectomy was more among women from general (3.1%) and OBC (3.6%) than scheduled caste/scheduled tribe (2.7%). Among women, who were employed in the sales job, engaged in agriculture and service sector, the proportion of hysterectomy was 5.9%, 5.4%, and 4.7% respectively. Whereas, only approximately 3% women had hysterectomy among the women who either did not work or were engaged in other types of economic activities. Less proportion of women from the poorest background (2.5%) underwent hysterectomy as compared to women belonging to other economic strata.

Figure-1.2 reveal that the prevalence of hysterectomy was higher among women with low age at marriage. Five percent women had a hysterectomy if they had their first birth before the age 21 year. Low age at first birth showed a higher prevalence of hysterectomy. Parity positively associated with the prevalence of hysterectomy, as women who has three or more children prevalence of hysterectomy among those are 6 percent. Prevalence among sterilized women is 5.2 percent that higher than not sterilized women (3.4%). Some of the literature shows that insurance had a positive relation with the prevalence of hysterectomy similar result we have found. Insure women has approximately two times higher prevalence of hysterectomy compared to not insured women. Prevalence of hysterectomy is higher among south Indian states and women empowerment also high in south Indian. Therefore we have checked prevalence of hysterectomy through empowerment status. We have found that women empowerment positively associated with the prevalence of hysterectomy. The prevalence of hysterectomy among low empowered women is 1.8 percent wherein medium empowered women's has 4 percent prevalence and highly empowered women's has 4.2 percent.

In the causes of hysterectomy, the most frequent cause is excessive menstrual bleeding. Approximately half of the total hysterectomy done because of the excessive menstrual bleeding. The second most prevalent cause is fibroids/cysts (17.63%) followed by uterine disorder (12.74%), uterine prolapse (7.58%), cancer (5.36%), severe post-partum hemorrhage (3.43%) and other (7.44). Most of the hysterectomy operations were done in private hospitals (66.8%), and 32.3% were conducted in public sector, and 0.9% were in NGO and other hospitals.

Table 1 portrays that the chances of hysterectomy are more frequent after age 40. The chances of hysterectomy are 28% higher in rural population compared to the urban population. Level of education negatively associated with the chance of hysterectomy. Muslims are less likely to have chances of hysterectomy compare to their counterparts. Similarly, SC/ST has less chance to have hysterectomy compare to their counterparts. Wealth positively associated with chances of hysterectomy. Age at marriage negatively associated with chances of hysterectomy. Age at first cohabitation below 15 years has more likely to have hysterectomy compare to their counterparts. The chances of hysterectomy are more among those women who have more children. The chance of hysterectomy is 28 percent less among the women who ever had the pregnancy terminated. Insured women are 14 percent more likely to have hysterectomy compare to no insured women.

In the table (1.) After adjusting all other background characteristics, the chances of hysterectomy is 20%, more likely in central region compared to the northern region. Similarly, chances of hysterectomy 68% in the eastern region, 50% more in the western region and 85% in southern region more likely compare to north region of India. However, in case of the northeastern region, the chances of hysterectomy are 44% less compared to the north region of India.

In table (2) shows the results of multilevel modeling that portray the partition variation in prevalence of hysterectomy at four level states, district, PSU, and individuals, after fully adjusting all individual-level characteristics: 11% of the variation in prevalence of hysterectomy was attributable to PSU, 6.1% to the district and 6.3% percent to states. PSU had the greatest contextual effect on the prevalence of hysterectomy over and above individual effect after that states and district. Result from multilevel model also give the adjusted odds ratio of hysterectomy, which follows similar pattern as multivariate logistic regression. Through the multi-level model we have found that, chances of hysterectomy among age group (30-39) were 5.57 times and among age group (40-49) were 14.23 times more likely compare to age group (15-29). Compare to urban are chances of hysterectomy in rural area were 21% more likely among women (15-49). Multilevel also verified that level of education were inversely related with chances of hysterectomy. As compare to women with no education chances of hysterectomy among women who had, primary education (2%), secondary education (32%) and higher education 63% less likely to have hysterectomy. Muslim had 24% and Others had 9% less chances to have hysterectomy compare to Hindus. OBC and Other cast have 20% more chances to have hysterectomy compare to SC/ST. Compare to poorest people chances of hysterectomy among poorer, middle, richer and richest were 46%, 83%, 2.22 times and 2.68 times respectively higher, which also verified the logistic regression result where wealth index were positively correlated with chances of hysterectomy. Parity were positively correlated with chances of hysterectomy. As compare to women with no children chances of hysterectomy among women, with one children 3.37 times, with two children 4.85 times and three or more than three children has 4.96 times more chances of hysterectomy.

4.2 Distribution of hysterectomy

Table number-3 shows that in the NFHS-4, a total number of women interviewed is 699,686 out of these sample 22074 (3.2 %) women in the country had a hysterectomy. Distribution across the region medicate that 34.5% of hysterectomies women were from south India, 23.2% were the eastern part of India, 18% from central, 14.1% from the west, 9.2 percent from the north and 1.2% were from the northeast (lowest among all). Which is 1.2 percent. The highest prevalence state are Andhra Pradesh with 8.91% followed by Telangana (7.7%), Bihar (5.4%), Gujarat (4.2%), Dadra & Nagar Haveli (3.6%) and the prevalence of hysterectomy was the lowest in Lakshadweep (0.9 %) followed by Assam (0.9%), Mizoram (1%), Delhi (1.1%), Meghalaya (1.1%) and Tripura (1.23%).

Among districts, Warangal district of Telangana (15.9) had the highest prevalence of hysterectomy operations followed by Guntur district (15.7), Andhra Pradesh, Nizamabad (14.4%), Telangana, Krishna (13.5%) and West Godavari (12.8%) districts, Andhra Pradesh, East Champaran (12%) from Bihar and Karimnagar (11.4%) from Telangana. The prevalence of hysterectomy was higher in Rural India (3.38%) compare to urban (2.72%). In the northern states of India, the prevalence in a rural area was 2.3 hysterectomy per 100 exposed women and in urban area 1.85. In case of central region prevalence in a rural area is 2.49 percent and in urban area 2.17 percent. In east India, rural prevalence is 3.45 percent and urban area 2.77 percent. In western states, the gap between rural and urban was the widest (6.7% vs. 2.5% respectively). Among South Indian states, rural prevalence was approximately two times higher than urban prevalence (3.69%). However, in case north-eastern states rural prevalence (0.99 percent) is lower than urban prevalence (1.38%).

Figure-2.1 depicts the district wise prevalence of hysterectomy in India of women aged 15-49. The red color stands for the high prevalence of hysterectomy, green color stand for the low prevalence of hysterectomy and yellow color shows the medium prevalence of hysterectomy. The prevalence of hysterectomy, highest was observed in Andhra Pradesh, Telangana and some of the district of Bihar, Gujarat, and Karnataka. The lowest prevalence of hysterectomy were observed in North-eastern states of India. In India, 108 districts have less than one percent of hysterectomy prevalence, 333 districts have 1 to 3 percent of hysterectomy prevalence, 126 districts have 3 to 5 percent of hysterectomy prevalence, 47 districts have 5 to 7 percent of hysterectomy prevalence and 26 districts were found that more than 7 percent of hysterectomy prevalence.

Figure 2.2, figure 2.3 and figure 2.4, portrays that prevalence of hysterectomy varies across the country. Spatial analysis through local Moran's Index informs about the geographical autocorrelation for hysterectomy prevalence among district. At the district level, as per Moran's index value of 58%, the districts were positively auto-correlated with the prevalence of hysterectomy. Moran's Index's LISA (local indication of special association) Map showed that 433 districts of India had no significant neighborhood association, whereas 111 districts were associated with 95% confidence interval, 57 districts were associated with 99% confidence interval and 34 districts had the highest neighborhood association with 99.9% confidence interval. The spatial association of prevalence of hysterectomy among 76 districts was high to high which are hot spot districts, 115 districts had low to low, 9 districts had low to high, and 2 district had high to the low spatial association.

Figure 2.5 and 2.6 described the differences in the distribution of prevalence of hysterectomy in urban and rural area respectively. In the urban area, 2.7 women had gone for hysterectomy per 100 women, and in a rural area, 3.4 had gone for hysterectomy. Figure 2.5 has more red color area compare to figure 2.6 which shows that hysterectomy prevalence more in rural population compare to the urban population.

Figure 2.7 and 2.8 shows the special association for the prevalence of hysterectomy in urban areas, the Moran's Index indicates 39% spatial autocorrelation for the prevalence of hysterectomy between districts. Results from LISA of the urban area shows that 469 districts of India have no significant neighborhood association with prevalence of hysterectomy. However, 102 districts have neighborhood association with 95% CI, 43 districts at 99% CI and 19 districts were an association with 99.9% CI. In urban India, 63 districts had high to the high association, 73 had low to the low association, 15 had low to the high association, and 13 had high to the low association.

Figure 2.9 and 2.10 portrays spatial autocorrelation through the Moran's I, the prevalence of hysterectomy in rural area are more correlated compared to an urban area. The value of Morasn's I for the rural area was 0.55, which shows that the rural areas had higher neighborhood association compare to an urban area. The result from the LISA of the rural area shows that there was no significant association among 434 districts. However, 102 district has neighborhood association with 95% confidence interval, 60 district at 99% confidence interval and 60-districts had highest neighborhood association with 99.9% confidence interval. Among the 72 district of rural India, females were highly (high-high) correlated with the prevalence of hysterectomy. Among 103 district low to low, 11 district had low to high, and 2 district had high to low neighborhood association for the prevalence of hysterectomy.

4. Summary and conclusion:

The study has highlighted the significant variation in the distribution of hysterectomy across the country. Many neighbourhood districts were correlated with prevalence of hysterectomy.

The mean age at hysterectomy in India is 34 years and chances of hysterectomy was higher in older ages. The unnecessary hysterectomy in early ages may deteriorate the quality of life of the women. Women who had more facilities like money and insurance, they are more prone to had hysterectomy. The most prevalent reported the cause of hysterectomy was excessive menstrual bleeding.

Limitation of the study:-

- All information is available only for reproductive age group (15-49) which is not sufficient to develop cause and effect relationship.
- All are self-reported outcomes, which may introduce some bias.

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Figure (1.1) Parentage of women who had hysterectomy among different groups in India NFHS-IV (2015-16).

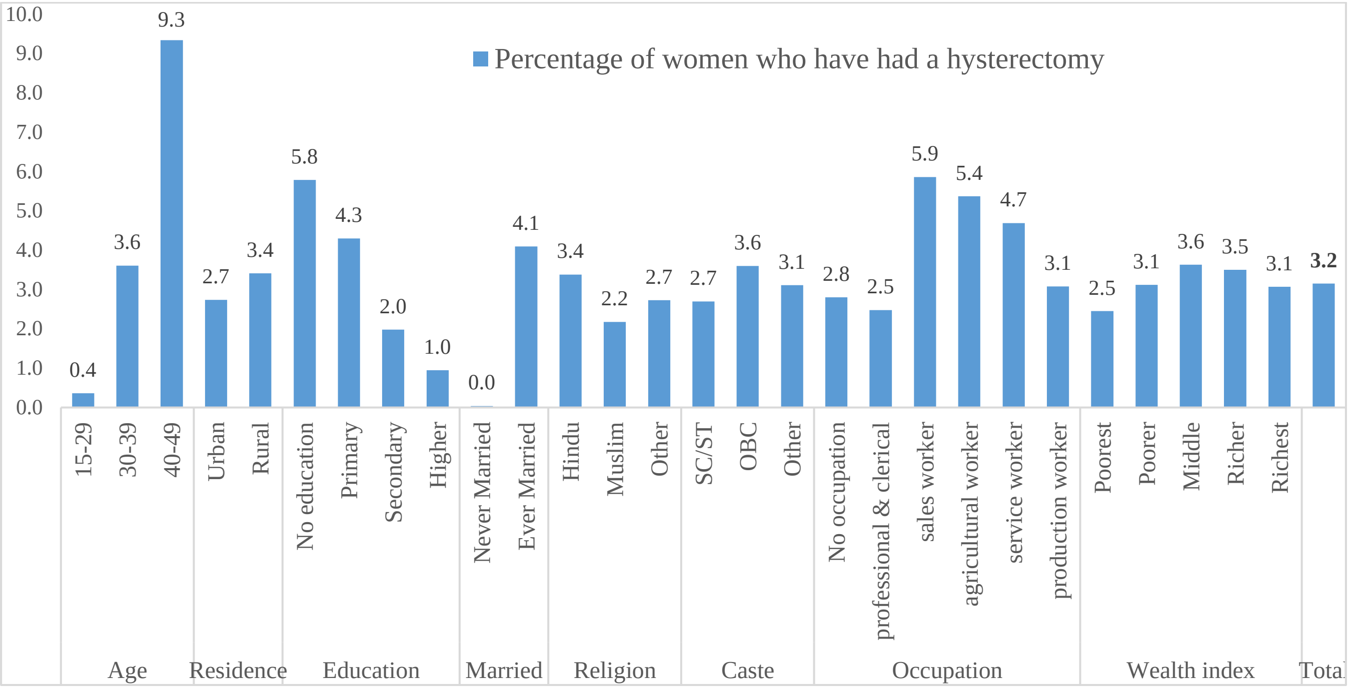


Figure (1.2) Prevalence of hysterectomy by characteristics of women in India, NFHS-IV (2015-16).

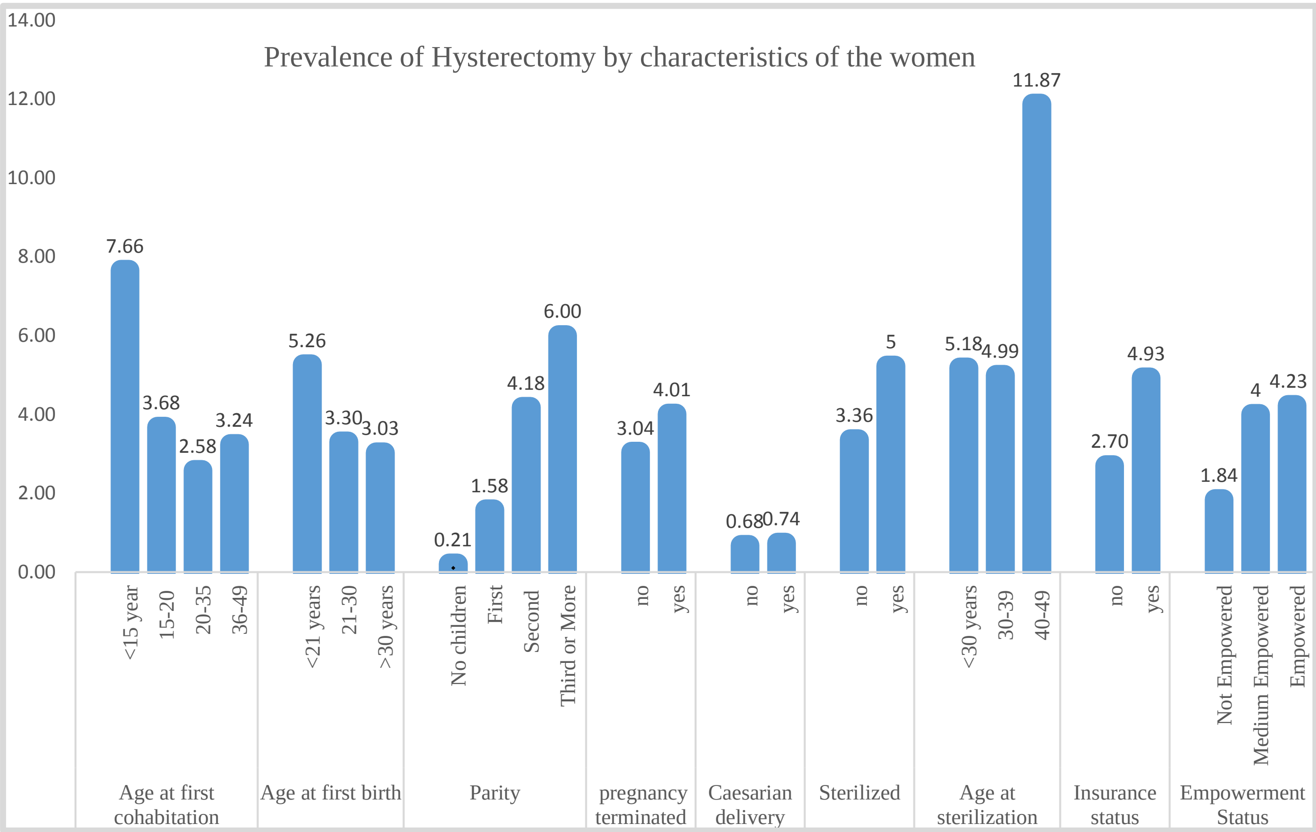


Table (1.) Adjusted odds ratio for women who had Hysterectomy by their background characteristics in India NFHS-IV (2015-16).

Background characteristics	Reference group	Model-I	Model-II	Model-III	Model-IV
		Adjusted Odds Ratio of hysterectomy			
Age	15-29	AOR (CI)	AOR (CI)	AOR (CI)	AOR (CI)
30-39		9.01***(8.43 9.64)	4.79***(4.46 5.14)	4.99***(4.64 5.36)	4.93***(4.58 5.29)
40-49		21.57***(20.19 23.04)	11.92***(11.1 12.8)	12.53***(11.66 13.46)	12.22***(11.37 13.12)
Residence	Urban				
Rural		1.23***(1.18 1.28)	1.22***(1.17 1.27)	1.23***(1.18 1.28)	1.28***(1.22 1.33)
Education Completed	No education				
Primary		0.86***(0.83 0.9)	0.88***(0.84 0.93)	0.87***(0.83 0.92)	0.87***(0.83 0.92)
Secondary		0.58***(0.55 0.6)	0.7***(0.67 0.73)	0.68***(0.65 0.71)	0.65***(0.62 0.68)
Higher		0.29***(0.27 0.32)	0.48***(0.44 0.53)	0.44***(0.4 0.49)	0.42***(0.38 0.46)
Religion	Hindu				
Muslim		0.71***(0.67 0.75)	0.75***(0.71 0.79)	0.68***(0.65 0.72)	0.69***(0.66 0.73)
Other		0.66***(0.62 0.7)	0.76***(0.72 0.81)	0.72***(0.67 0.77)	0.96 (0.9 1.03)
Caste/Tribe	SC/ST				
OBC		1.39***(1.34 1.45)	1.4***(1.34 1.46)	1.42***(1.36 1.48)	1.31***(1.26 1.37)
Other		1.25***(1.2 1.31)	1.27***(1.21 1.33)	1.29***(1.23 1.36)	1.3***(1.24 1.37)
Wealth index	Poorest				
Poorer		1.34***(1.27 1.41)	1.28***(1.21 1.35)	1.32***(1.24 1.39)	1.43***(1.35 1.51)
Middle		1.73***(1.64 1.82)	1.61***(1.52 1.7)	1.7***(1.61 1.8)	1.84***(1.73 1.95)
Richer		2.04***(1.93 2.16)	1.9***(1.79 2.02)	2.04***(1.93 2.17)	2.22***(2.09 2.37)
Richest		2.28***(2.14 2.42)	2.12***(1.98 2.27)	2.3***(2.15 2.46)	2.63***(2.45 2.83)
Age at marriage	<20yrs				
20-30			0.65***(0.59 0.71)	0.64***(0.58 0.7)	0.65***(0.59 0.71)
>30 year			0.46***(0.36 0.59)	0.45***(0.35 0.57)	0.5***(0.39 0.63)
Age at first cohabitation	Below 15 year				
15-20			0.62***(0.59 0.64)	0.62***(0.6 0.65)	0.64***(0.61 0.67)
20-35			0.63***(0.57 0.69)	0.62***(0.57 0.69)	0.65***(0.59 0.71)
36-49			0.68 (0.4 1.16)	0.68 (0.4 1.15)	0.71 (0.42 1.21)
Parity	No children				
First			1.7***(1.47 1.97)	1.75***(1.51 2.02)	1.75***(1.51 2.03)
Second			2.48***(2.17 2.85)	2.84***(2.47 3.25)	2.95***(2.57 3.38)
Third or More			2.3***(2.01 2.64)	2.66***(2.32 3.05)	2.98***(2.6 3.41)
Sterilization	No				
Yes				1.01 (0.96 1.05)	1.03 (0.99 1.08)
Pregnancy terminated	No				
Yes				0.67***(0.65 0.7)	0.62***(0.6 0.64)
Insurance status	No				
Yes				1.26***(1.21 1.31)	1.14***(1.09 1.19)
Indian regions	North				
Cantal					1.2***(1.13 1.26)
East					1.68***(1.58 1.77)
Northeast					0.66***(0.61 0.72)
West					1.5***(1.4 1.6)
South					1.85***(1.74 1.96)
constant		0.0022396	0.0028466	0.0026041	0.0018009
Number of Women		6,99,405	4,89,732	4,89,651	4,89,651
Log likelihood value		-71569.608	-62264.67	-61949.809	-61432.562
Significance level	"P<0.1= * ", "P<0.05=**", "P<0.01=***"				
Dependent Variable	Hysterectomy " No (0), Yes (1)"				

Table-2. Multilevel analysis of women (15-9) who had hysterectomy or in menopause by background characteristics to four level Individual, PSU, District and States, India 2015-16.

Background characteristics	**AOR of Hysterectomy**
Age	
15-29	
30-39	5.57***(5.18 5.99)
40-49	14.23***(13.24 15.29)
Residence	
Urban	
Rural	1.21***(1.16 1.28)
Education Completed	
No education	
Primary	0.98 (0.93 1.03)
Secondary	0.68***(0.65 0.71)
Higher	0.37***(0.33 0.4)
Religion	
Hindu	
Muslim	0.76***(0.71 0.81)
Other	0.91**(0.84 0.99)
Caste/Tribe	
SC/ST	
OBC	1.2***(1.15 1.26)
Other	1.2***(1.14 1.26)
Wealth index	
Poorest	
Poorer	1.46***(1.38 1.54)
Middle	1.83***(1.72 1.94)
Richer	2.22***(2.08 2.37)
Richest	2.68***(2.49 2.89)
Parity	
No Children	
one children	3.37***(2.99 3.81)
two children	4.85***(4.34 5.43)
Third or More	4.96***(4.43 5.55)
constant	0.0004131
Number of Women	6,99,405
Number of PSU	28,521
Number of District	640
Number of states	36
Variance PSU level	0.45
VPC PSU level	10.54
Variance District level	0.26
VP District level	6.09
State level variance	0.27
VPC level ICC	6.32
Significance level	If "P<0.1= * ", "P<0.05=**", "P<0.01=***"
Dependent Variable	Hysterectomy (0 'No") (1 "Yes")

Table (3) Percent distribution of women (15-49) who had hysterectomy and place of hysterectomy among Indian States and Union tertiary, NFHS-IV, 2015-16.

State/union territory	Percentage of women who had hysterectomy	Percentage of Rural women who had/in	Percentage of Urban women who had/in	Place of hysterectomy			Total Number of women
				Public sector	Private sector	NGO and Other	
India	**3.16**	**3.38**	**2.72**	**32.29**	**66.77**	**0.94**	**699686**
North	**2.12**	**2.3**	**1.85**	**38.64**	**60.49**	**0.86**	**95012**
Chandigarh	1.53	0	1.59	54.28	45.72	0	573
Delhi	1.11	1.94	1.72	41.28	57.72	1.01	10536
Haryana	1.86	2.18	2.53	45.85	52.01	2.14	15583
Himachal Pradesh	2.22	2.47	2.78	62.48	37.22	0.29	3842
Jammu & Kashmir	2.56	1.9	1.11	35.84	62.64	1.52	6809
Punjab	2.63	2.72	2.51	35.2	63.19	1.61	15212
Rajasthan	2.25	2.3	2.12	33.8	65.82	0.38	36529
Uttarakhand	2.05	2.1	1.96	38.82	60.46	0.72	5928
Central	**2.4**	**2.49**	**2.17**	**30.94**	**68.44**	**0.62**	**165322**
Chhattisgarh	1.88	1.87	1.92	34.95	64.54	0.51	16502
Madhya Pradesh	3	3.12	2.75	44.24	55.21	0.55	43729
Uttar Pradesh	2.24	2.35	1.92	22.97	76.35	0.67	105092
East	**3.29**	**3.45**	**2.77**	**31.13**	**67.43**	**1.44**	**154503**
Bihar	5.36	5.39	5.15	17.77	80.84	1.38	56254
Jharkhand	2.33	2.23	2.6	27.05	71.56	1.4	17596
Odisha	2.13	2.09	2.33	71.43	28.41	0.16	24929
West Bengal	2.03	2.09	1.92	49.24	48.57	2.19	55723
Northeast	**1.07**	**0.99**	**1.38**	**61.66**	**36.79**	**1.55**	**24583**
Arunachal Pradesh	1.86	1.88	1.74	70.42	28.09	1.49	599
Assam	0.94	0.9	1.17	65.67	33.3	1.03	17303
Manipur	1.58	1.26	2.04	52.25	45.99	1.77	1222
Meghalaya	1.14	1.09	1.26	71.4	28.6	0	1587
Mizoram	1.04	0.74	1.23	62.86	35.95	1.19	584
Nagaland	1.56	1.2	2.11	48.96	50.28	0.76	798
Sikkim	1.31	1.16	1.62	55.02	44.98	0	319
Tripura	1.29	1.25	1.41	41.45	52.49	6.06	2172
West	**3.1**	**6.69**	**2.59**	**30.84**	**67.74**	**1.42**	**100433**
Dadra & Nagar Haveli	3.62	3.74	3.47	60.98	39.02	0	171
Daman & Diu	2.96	2.94	2.97	25.57	74.43	0	91
Goa	2.63	2.87	2.49	44.31	55.69	0	861
Gujarat	4.19	4.37	3.96	30.58	66.87	2.55	32670
Maharashtra	2.57	3.15	1.98	30.76	68.69	0.55	66639
South	**4.77**	**7.32**	**3.69**	**31.65**	**67.77**	**0.58**	**159553**
Andaman & Nicobar Islands	1.82	1.29	2.51	24.09	75.91	0	231
Andhra Pradesh	8.91	9.67	7.27	16.67	82.8	0.53	30410
Karnataka	3	3.69	2.11	52.79	46.91	0.31	34867
Kerala	1.82	1.68	1.99	41.62	58.14	0.24	19267
Lakshadweep	0.91	0.96	0.89	20.69	79.31	0	43
Puducherry	1.69	1.11	1.94	68.18	31.82	0	793
Tamil Nadu	3.43	3.47	3.38	52.42	46.6	0.97	51570
Telangana	7.69	10.25	5.01	18.76	80.76	0.49	22371

Figure 2.1 District level spatial patterns of prevalence of hysterectomy among women aged 15–49 years in India, 2015-16

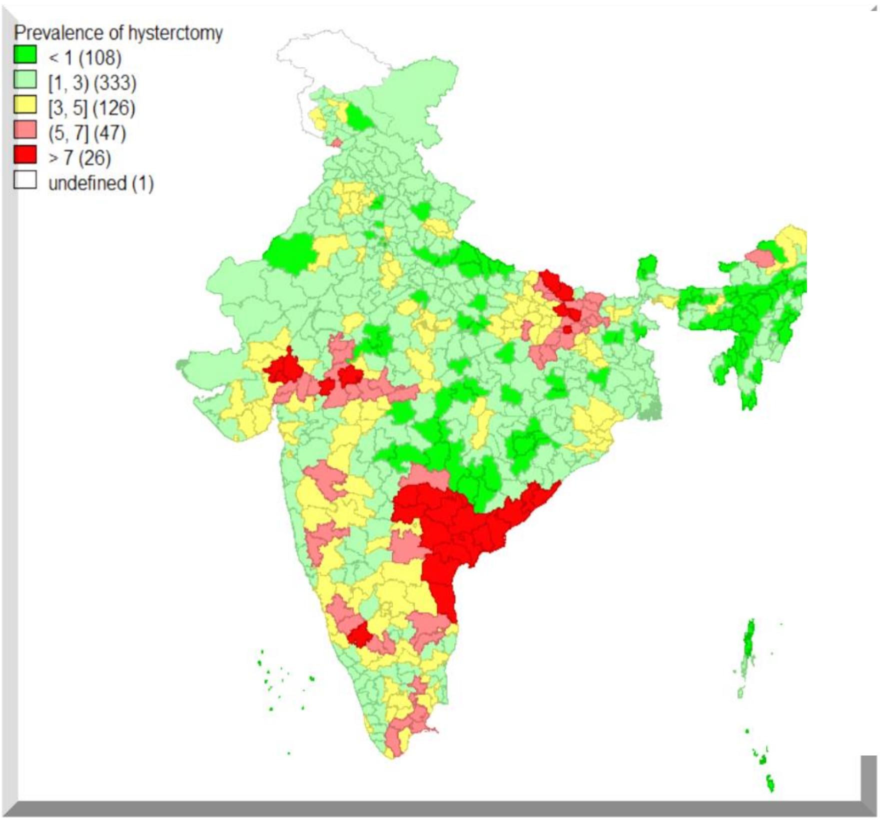


Figure 2.2 Clustering among district for prevalence of hysterectomy in India 2015-16.

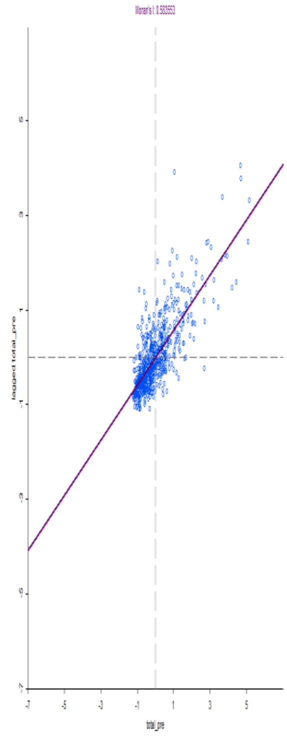
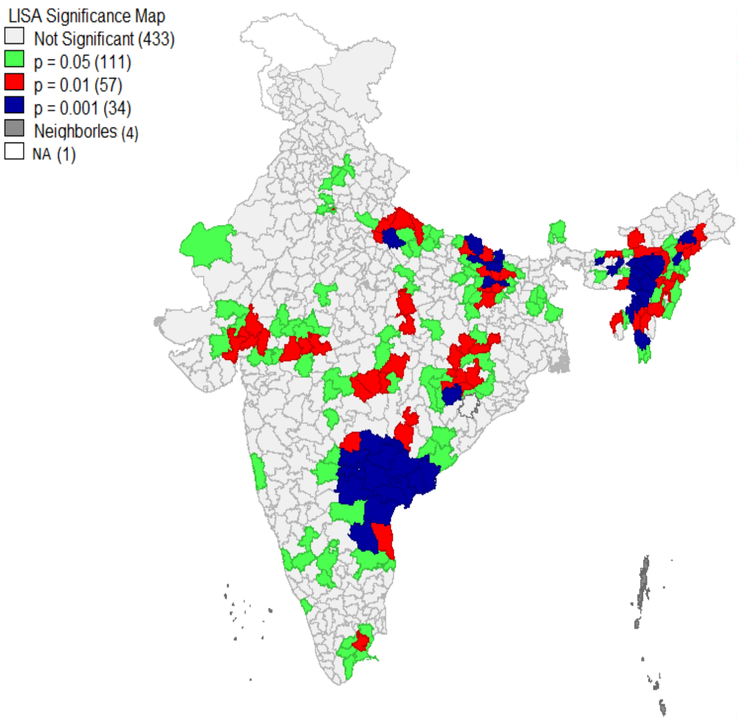


Figure No. – 2.3 & 2.4 spatial autocorrelation for prevalence of hysterectomy in urban area, among 640 districts of India through LISA map, NFHS (2015-16).



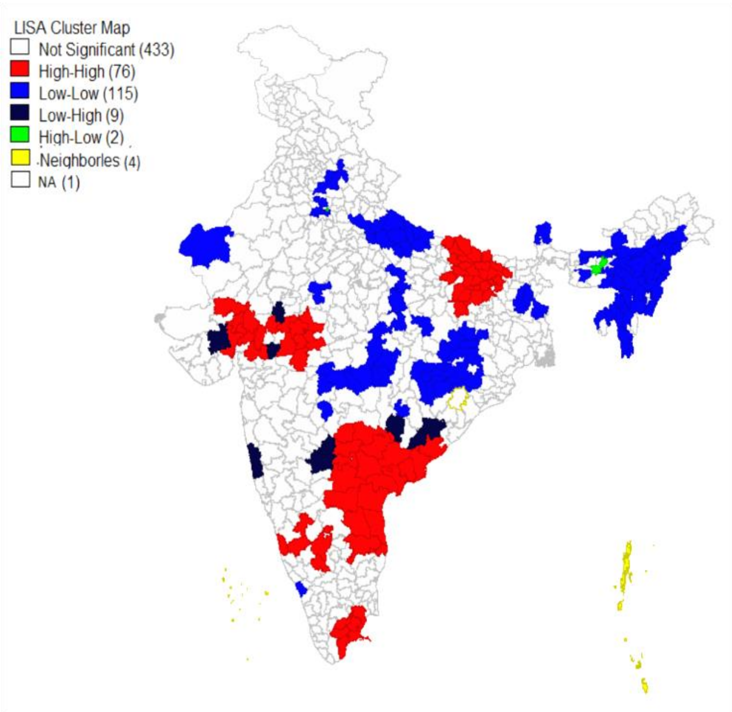


Figure No. – 2.5 Distribution of hysterectomy prevalence in an urban area among 640 districts of India, NFHS (2015-16)

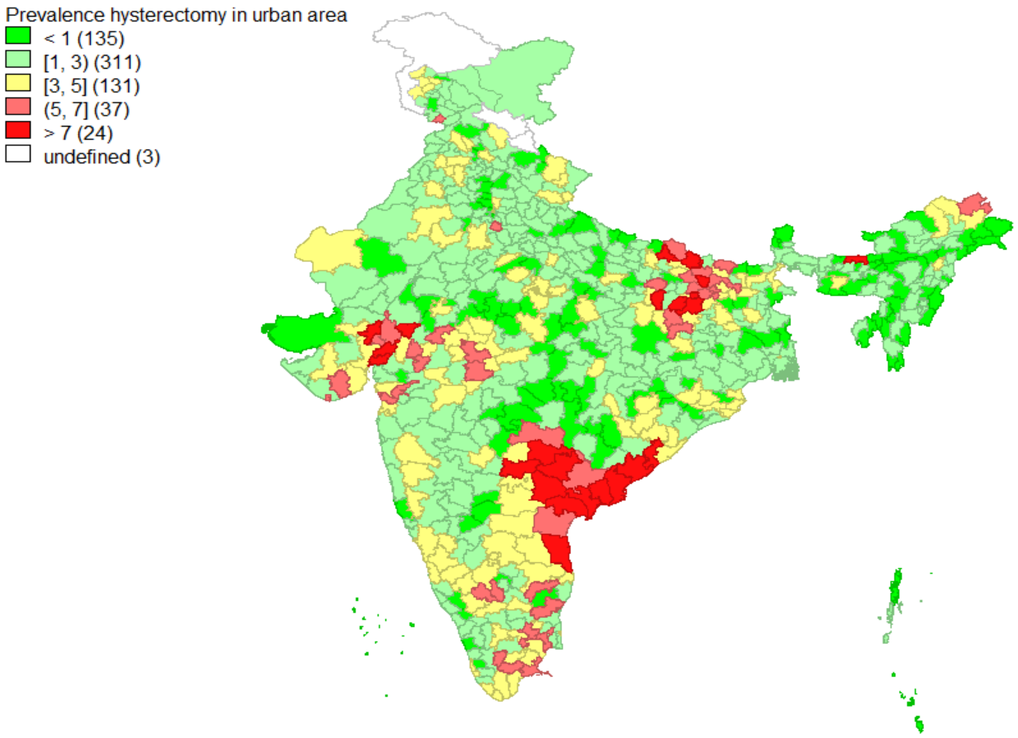


Figure No. – 2.6 Distribution of hysterectomy prevalence in a rural area among 640 districts of India, NFHS (2015-16).

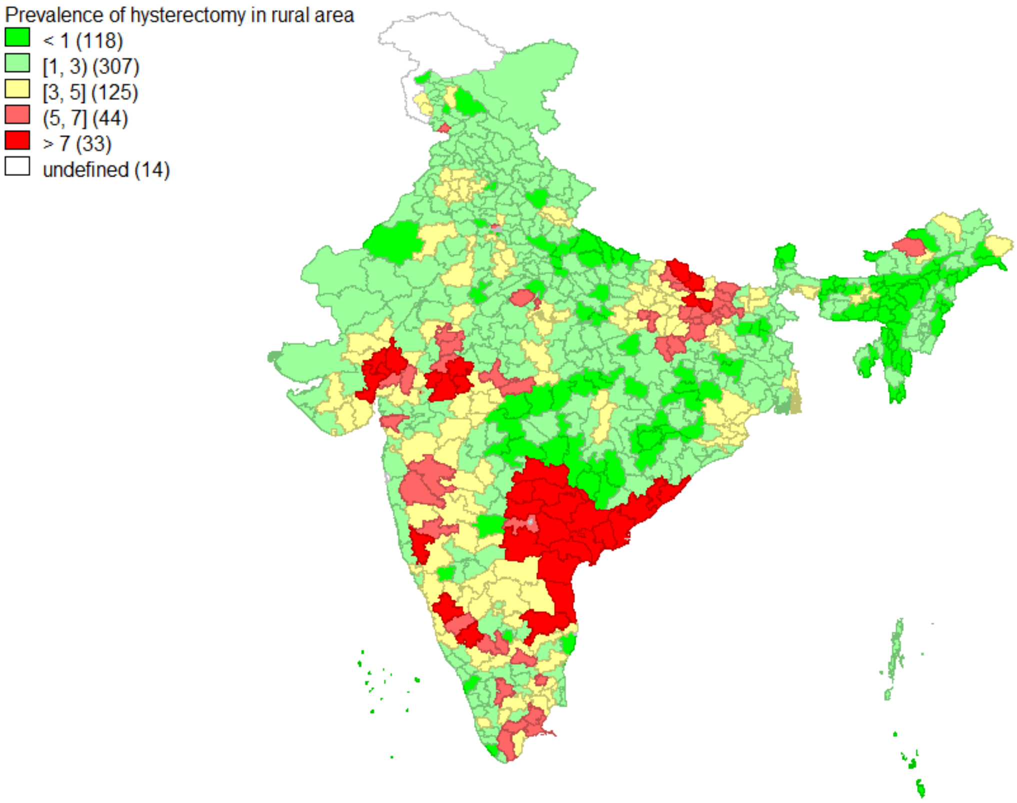


Figure No. – 2.7 & 2.8 spatial autocorrelations for the prevalence of hysterectomy in an urban area, among 640 districts of India through LISA map, NFHS (2015-16).

Figure – 2.7

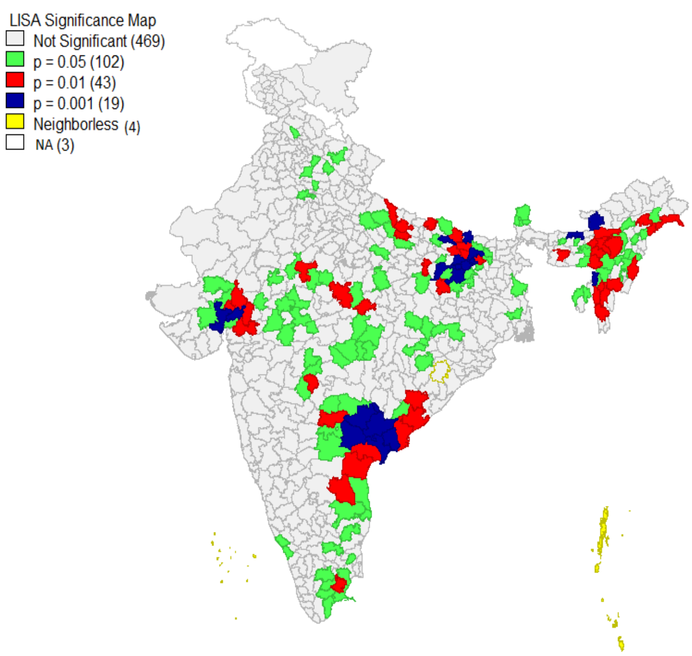


Figure – 2.8

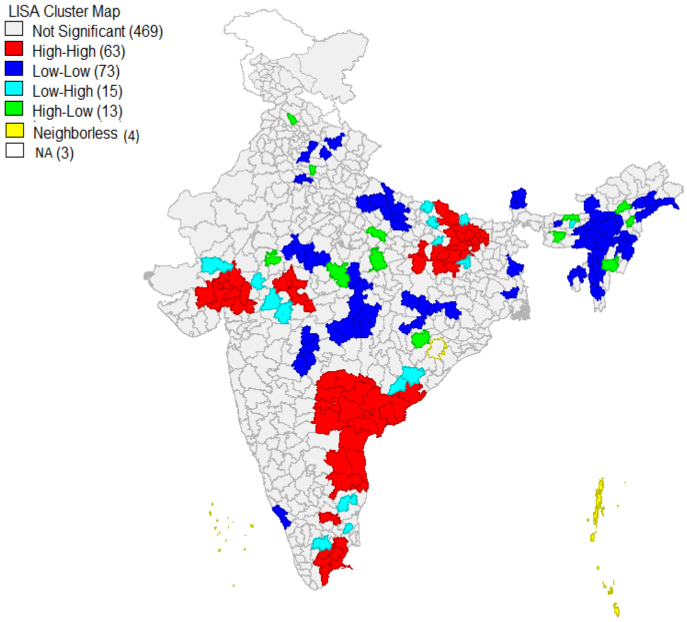


Figure No. – 2.9 & 2.10 spatial autocorrelations for the prevalence of hysterectomy in a rural area, among 640 districts of India through LISA map, NFHS (2015-16).

Figure – 2.9

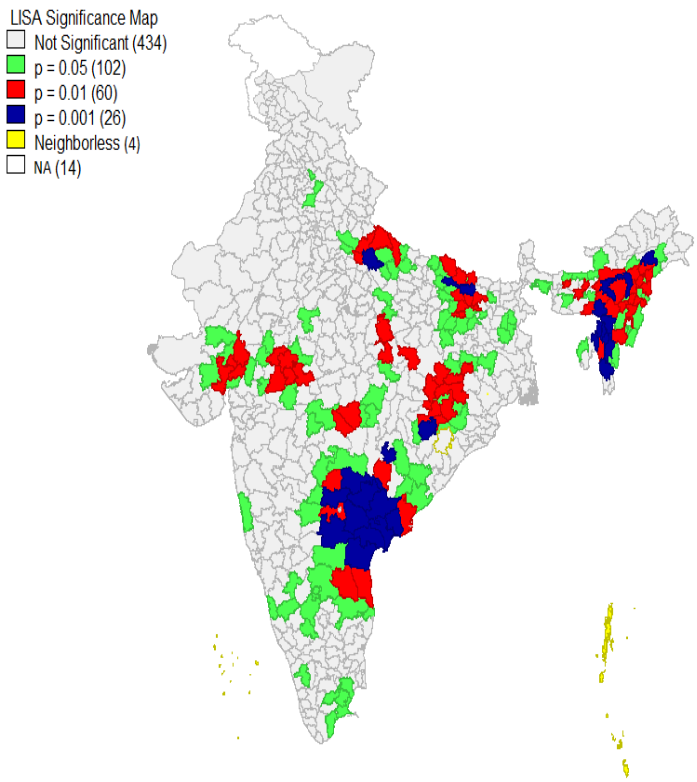


Figure -2.10