

Spatial Clustering of Nutritional Status of Women in Uttar Pradesh, India

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Abstract

The objective of this paper is to analyse spatial clustering of nutritional status of non-pregnant women of reproductive age in Uttar Pradesh, India based on the data available through the National Family Health Survey, 2015-16. The nutritional status of non-pregnant women of reproductive age woman is measured in terms of Body Mass Index (BMI) and the variation in the nutritional status of non-pregnant women of reproductive age across the districts of the state is used for spatial cluster analysis. The analysis reveals that the districts of Uttar Pradesh can be grouped into four clusters based on the distribution of the nutritional status of non-pregnant women of reproductive age in the district which has implications for policy and planning for improving the nutritional status of the women of the state.

Introduction

The nutritional status of women is affected by a host of social, economic and cultural factors including poverty, inadequate availability of and access to health care services, low level of education, especially of females, limited employment opportunities for women; socio-cultural factors including social and cultural norms and practices, gender discrimination, domestic violence, sexual abuse, poor environmental hygiene; and demographic factors including reproductive life span, marriage and child bearing at a young age, demand for children and practice of family planning, unsafe abortions. Spatial diversity of these factors is well-known which implies that variation in the nutritional status of women has a spatial dimension. It is, therefore, imperative that the spatial dimension of the nutritional status of women is also taken into consideration at the policy level and in planning programming for improving the nutritional status of women. It has been observed that social, economic, and demographic characteristics of women largely remain invariant under identical spatial circumstances. Identification of geo-political clusters having similar nutritional status of women may help in adopting different approaches to improve the nutritional status of women. Such targeted approach may be more effective in meeting the challenge of nutrition in women compared to the population wide approaches.

Poor nutritional status of reproductive age women is one of the most important concerns in India. Poor nutritional status is an indication of insufficient intake of energy and essential nutrients to maintain good health. India ranks 101 out of 116 qualifying countries with a score of 27.5 in terms of hunger index 2021 (Grebmer et al, 2021). It is argued that the prevailing culture and traditional practices in India, especially during pregnancy and lactation is a major factor in the prevailing poor nutritional status of reproductive age women. According to the National Family Health Survey, 2015-16 (NFHS-4) 53 per cent of the reproductive age women; 50 per cent pregnant women; and 58 per cent lactating mothers are anemic (International Institute for Population Sciences and ICF, 2017). Responding to the prevailing situation, the Government of India launched the national-wide POSHAN Abhiyaan or National Nutrition Mission with specific focus on under nutrition among children, pregnant women, and lactating mothers (Government of India, 2021). Government of India has also launched a nutrition awareness programme, known as Anaemia Mukt Bharat, in association with United Nations Children's Fund (UNICEF) to bring about the behaviour change in people towards healthy living. The programme aims at reducing the prevalence of anaemia by three percentage points per year among children, adolescents, and reproductive age women by the year 2022.

The nutrition situation in Uttar Pradesh, the most populous state of the country is particularly serious. This state is the home of the largest number of under-nourished people in the country. The prevalence of under nutrition in the state is also amongst the highest in the world (UNICEF, 2016). At the same time, there appears only a marginal improvement in the situation during the past decade as is evident from the third and the fourth rounds of the National Family Health Survey. The prevalence of under nutrition is particularly high in the rural areas of the state where income and food security is low (Government of India, 2017). The Government of Uttar Pradesh has launched the Uttar Pradesh State Nutrition Mission in 2014 to address the challenge of under nutrition in children and women with financial and technical support from UNICEF. From the geopolitical perspective, the state is divided into 71 districts as they existed at the 2011 population census. The available evidence indicates that there is a very substantial disparity across districts of the state in all dimensions of population and development. The data available from NFHS-4 suggest that the nutritional status of reproductive age women varies widely across the districts of the state.

The present study analyses the distribution of the nutritional status of reproductive age women in the districts of the state. The study also attempts to group or cluster districts to examine regional pattern, if any, in the within district distribution of nutritional status of reproductive age women. This clustering may help in identifying factors that have significant influence on the growth and development of the communities and contribute to designing and implementing appropriate regional and state-specific strategies for improving the nutritional status of reproductive age women.

The paper is organized as follows. The next section of the paper presents a snapshot of the status of women in Uttar Pradesh. The data used and the methodology adopted in the paper are discussed in section three of the paper. The paper is based on the data on the nutritional status of reproductive age women available through the fourth round of the National Family Health Survey carried out in 2015-16. Findings of the analysis are discussed in section four while the last section summarises the findings of the analysis and discusses their policy and the programme implications in the context of improving the nutritional status of reproductive age women in particular and reproductive health status of the people in general.

Status of Women in Uttar Pradesh

The status of women in Uttar Pradesh remains low by national standards. The female life expectancy at birth is 65.8 years which is less than the national average of 69 years (Government of India, 2020). In the rural areas of the state, the female life expectancy is less than 65 years. The maternal mortality ration in the state is 197 maternal deaths for every 100 thousand live births which is the second highest in the country (Government of India, 2020). The accounts for more than 16 per cent of the population of the country. The population density in the state is 828 person per Km². Between 2001 and 2011, the population of the state increased by more than 20 per cent. The population sex ratio in the state was 908 females for every 1000 males at the 2011 population census while the child sex ratio was 899 girls for every 1000 boys. Both population sex ratio and child sex ratio in the state are lower than the national average. At the 2011 population census, less than 60 per cent of females aged seven years and above were able to read and write with understanding and this proportion was well below the national average. Only 23 per cent of reproductive age women in the state have completed twelve or more years of schooling (Government of India, 2017).

The state is one of those few states of the country which are yet to achieve the replacement fertility. The total fertility rate in this state is estimated to be 2.9 births per women of reproductive age. In the rural areas of the state, the total fertility rate is more than 3 birth per woman of reproductive age (Government of India, 2020). The fertility of currently married reproductive age women is estimated to 6.8 births per currently married woman of reproductive age. In the urban areas of the state, total marital fertility rate is more than 7 births per married woman of reproductive age (Government of India, 2020). Around one-fifth of the women aged 20-24 years reported to have got married before reaching the legal minimum age of marriage of 18 years (Government of India, 2017). The median age at first marriage is estimated to be 18.5 years among women aged 20-49 years (Government of India, 2017). The contraceptive prevalence rate in the state is only 46 per cent which is well below the national average (Government of India, 2017). Less than half of the currently married women of the state received first antenatal check-up during the first trimester of their last pregnancy while

only around 26 per cent had at least four antenatal care visits. Almost one third of the deliveries in the state occurred at home according to NFHS-4. Over one-third of women aged 15-49 years in the state have experienced physical or sexual violence according to NFHS-4 (Government of India, 2017).

More than one fourth of the women of the state were found to be under nourished having a BMI of less than 18.5 Kg/m² according to NFHS-4, although this proportion has decreased from more than 36 per cent in 2005-06 according to the third round of the National Family Health Survey (Government of India, 2017). On the other hand, more than 16 per cent of women were found to be obese having a BMI of more than 25 Kg/m² according to NFHS-4 and this proportion has increased from around 9 per cent in 2005-06 according to the third round of the National Family Health Survey. Within Uttar Pradesh, the proportion of women with low BMI varies widely across districts from almost 36 per cent in district Sitapur to less than 15 per cent in Gautam Buddha Nagar, Lucknow, and Kanpur Nagar districts of the state. On the other hand, more than 30 per cent women in district Ghaziabad are found to be obese, the highest in the state, whereas, in district Hamirpur, this proportion is found to be less than 7 per cent which is the lowest in the state.

Data and Methodology

The paper is based on the data available through the fourth round of the National Family Health Survey (NFHS-4). The National Family Health survey (NFHS) programme is the nationwide household sample survey programme which collects information on selected demographic and health parameters, including anthropometric measurements of children below five years of age and women in the reproductive age group (15-49 years). The programme was launched in 1992-93 and four rounds of the survey have been carried out while the fifth round is in progress. Details of the National Family Health Survey Programme are available elsewhere (Government of India, 2021). The present paper is based on the data available from the fourth round of the survey which was carried out during the period 2015-16 and is confined to currently married women in the reproductive age group who reported that they were not pregnant at the time of the survey. In Uttar Pradesh, 7166 currently married women in the reproductive age group reported that they were not pregnant at the time of the survey and these women are included in the present analysis. Out of these women, the BMI could be computed for 7129 women only. The average BMI of these 7129 women is estimated to be 22.229 ± 4.300 .

The analytical strategy of the present analysis involved two steps. The first step was to characterise the nutritional status of currently married, non-pregnant women of reproductive age in each district of the state. We have characterised the distribution of the nutritional status of currently married non-pregnant women of reproductive age in terms of the distribution of BMI using four parameters of the distribution: 1) arithmetic mean; 2) standard deviation; 3) skewness or the deviation from normality; and 4)

kurtosis or the peakedness of the distribution of currently married, non-pregnant, reproductive age women. For each district of the state, the four parameters, characterizing the distribution of the nutritional status in currently married, non-pregnant, reproductive age women, were calculated from the data available from NFHS-4. Inter-district variation in these four parameters, in combination, depicted how the distribution of the nutritional status of currently married, non-pregnant women of reproductive age varied across the districts of the state.

The second step in the analysis was related to the clustering of the districts using the four parameters of the distribution of BMI in currently married, non-pregnant women of reproductive age as classification variables. The k-means clustering method using the Euclidian distance between districts was used for clustering purpose (MacQueen, 1967). The clustering exercise grouped the districts of the state into mutually exclusive yet exhaustive clusters or groups of districts in such a way that the distribution of BMI of currently married, non-pregnant, reproductive age women of districts within the same cluster is very similar while that in districts of different clusters is different. The clustering exercise classifies a district in one and only one of the clusters identified. The distribution of BMI of the currently married, non-pregnant, women of reproductive age in different clusters identified through the clustering exercise, as characterised through the four parameters of the distribution, then, reflected how the nutritional status of currently married, non-pregnant, reproductive age women varied across different clusters or groups of districts identified through the clustering exercise. The analysis was carried out using the Statistical Package for Social Sciences (SPSS) software.

Results

Table 1 presents the distribution of currently married, non-pregnant, women of reproductive age by their nutritional status as reflected through BMI for the state and for its 71 districts as they existed at the time of NFHS-4. At the state level, the distribution of currently married, non-pregnant reproductive age women may be characterised as a leptokurtic positively skewed distribution with mean BMI of 22.229 and standard deviation 4.300. The distribution is positively skewed which means that the proportion of women having BMI less than the mean BMI is higher than the proportion of women having BMI more than the mean BMI. On the other hand, the distribution is leptokurtic which implies that there is only a small proportion of women with BMI substantially lower or higher than the mean BMI.

Table 1 also reveals that the distribution of the nutritional status currently married non-pregnant women of reproductive age, as reflected through BMI, varies widely across the districts of the state. The lowest value of BMI ranges from 10.01 to 16.85 across the districts of the state whereas the maximum value ranges from 29.49 to 43.21. On the other hand, the mean BMI ranges from 19.81 to 24.52 across the districts. There are 17 districts in the state where there was at least one currently

married, non-pregnant woman of reproductive age with a BMI of just around 10 whereas there is no district in the state where all women had BMI at least 18.5 at the time of NFHS-4. There is only one district - district Hardoi – where the mean BMI is estimated to be less than 20 but there is no district in the state where the mean BMI is estimated to be at least 25. On the other hand, the skewness in the distribution of BMI in women ranges from 0.07 to 1.97 which means that there is no district where the proportion of women having BMI less than the mean BMI is smaller than the proportion of women having BMI larger than the mean BMI. The skewness in the distribution of BMI is very small in Kheri and Rai Bareilly districts of the state but it is very high in Gonda and Pratapgarh districts. On the other hand, kurtosis in the distribution of BMI in women ranges from -0.89 to 7.32 across the districts. A negative value of kurtosis implies a platykurtic distribution which means that the tails of the distribution are small whereas the higher the value of kurtosis the longer the tails of the distribution which implies outliers and extreme values present in the distribution. There are 13 districts in the state where the kurtosis in the distribution of BMI in currently married non-pregnant women of reproductive age has been found to be negative which means that the distribution of BMI in women is platykurtic in these districts. In the remaining districts of the state, the distribution of BMI is leptokurtic as the value of kurtosis is found to be positive. In Pratapgarh, Gonda, and Hamirpur districts of the state, kurtosis in the distribution of BMI is estimated to be more than 7 which implies that the distribution of BMI in these districts has very long tails indicating presence of outliers and extreme values. This also means that there is very heavy concentration of BMI around the mean BMI. The inter-district coefficient of variation in the four parameters of the distribution of BMI in women is found to be the highest in case of kurtosis (1.321) but the lowest in case of standard deviation (0.116). It is clear from the table that the distribution of BMI in currently married non-pregnant women of reproductive age is different in different districts.

Table 2 presents results of the clustering exercise based on the four parameters of the distribution of BMI in currently married non-pregnant women of reproductive age in each district. The table indicates that the 71 districts of the state can be grouped into 4 clusters and as the distribution of BMI in currently married non-pregnant women of reproductive age in the four clusters is essentially different. Cluster 1 is the largest cluster comprising of 54 districts of the state. The mean BMI in the districts of this cluster ranges between 19.81 and 23.37 with an unweighted average of 21.95 and standard deviation 0.795. The cluster 2, on the other hand, comprises of 10 districts and the mean BMI, in these districts, ranges from 21.41 to 23.38 with an unweighted average of 21.20 and standard deviation 0.659. Clusters 3 and 4 are very small clusters comprising of 3 and 4 districts respectively. The BMI ranges between 23.68 and 24.52 in cluster 3 whereas it ranges between 20.41 and 22.75 in cluster 4. The three districts of cluster 3 constitute a geographical continuity as may be seen from figure 2. The clustering exercise thus reveals that the distribution of BMI in currently married non-pregnant reproductive age women in 17 districts of the state is different from the distribution of BMI that prevails in majority of districts of the state.

Table 1: Distribution of the body mass index (BMI) of currently married non-pregnant reproductive age women in Uttar Pradesh

State/District	Lowest	Mean	SD	Highest	Skewness	Kurtosis	N
Uttar Pradesh	10.01	22.23	4.30	43.21	0.84	1.20	7129
Saharanpur	13.61	22.76	4.48	36.74	0.71	0.01	178
Muzaffarnagar	15.35	23.38	5.09	43.03	1.41	3.37	84
Bijnor	12.71	22.04	4.17	33.63	0.70	0.30	97
Moradabad	14.97	23.01	4.52	37.40	0.73	0.37	197
Rampur	14.13	22.65	4.74	39.64	1.05	1.47	103
Jyotiba Phule Nagar	15.43	22.51	4.55	36.33	0.97	0.61	108
Meerut	14.81	24.52	4.66	39.03	0.35	0.15	245
Baghpat	14.85	23.68	4.60	33.06	0.18	-0.79	95
Ghaziabad	10.01	23.74	4.64	35.54	0.16	-0.40	191
Gautam Buddha Nagar	13.11	23.31	4.10	40.67	0.66	0.95	191
Bulandshahr	15.46	22.58	5.15	41.72	1.24	1.63	99
Aligarh	13.29	22.86	4.75	40.29	1.05	1.20	179
Mahamaya Nagar	10.01	22.83	5.05	34.87	0.49	-0.11	90
Mathura	16.16	23.37	3.79	33.44	0.64	-0.05	99
Agra	10.01	22.27	4.17	37.65	0.88	1.26	210
Firozabad	13.99	22.27	4.35	39.79	1.07	1.57	185
Mainpuri	16.58	22.58	4.16	35.40	0.94	0.49	96
Budaun	12.33	21.75	4.35	38.73	0.93	1.69	100
Bareilly	10.01	22.76	4.41	35.48	0.20	-0.12	192
Pilibhit	14.92	21.70	4.31	33.86	0.95	0.29	96
Shahjahanpur	13.36	21.42	4.51	37.86	0.75	0.84	92
Kheri	10.01	20.29	4.00	30.81	0.07	0.68	94
Sitapur	10.01	20.18	3.55	29.98	0.47	0.84	79
Hardoi	10.01	19.81	3.19	29.49	0.31	1.59	76
Unnao	15.57	21.32	3.62	30.65	0.80	0.00	85
Lucknow	10.01	22.85	4.91	39.00	0.54	1.60	116
Rae Bareli	10.01	21.83	3.55	31.94	0.08	0.96	89
Farrukhabad	15.67	22.48	3.93	36.64	0.90	1.14	86
Kannauj	14.57	21.83	4.00	35.46	1.24	1.86	83
Etawah	16.47	23.07	3.82	31.22	0.21	-0.89	91
Auraiya	15.74	21.68	4.06	37.68	1.56	3.30	80
Kanpur Dehat	16.34	22.15	3.92	35.28	1.32	1.67	79
Kanpur Nagar	14.74	22.66	3.89	40.60	0.97	2.37	165
Jalaun	15.70	21.79	3.54	32.59	0.75	0.91	66
Jhansi	13.88	22.62	4.21	41.51	0.89	2.18	143
Lalitpur	14.65	21.33	2.92	30.06	0.28	0.38	81
Hamirpur	14.43	20.41	3.23	36.24	1.86	7.32	68
Mahoba	10.01	20.86	4.11	31.03	0.58	0.63	59
Banda	10.01	21.38	3.95	32.09	0.49	0.86	77
Chitrakoot	16.34	21.65	3.63	37.36	1.44	3.54	90

State/District	Lowest	Mean	SD	Highest	Skewness	Kurtosis	N
Fatehpur	13.99	21.41	4.07	38.01	1.66	3.79	65
Pratapgarh	16.50	22.75	4.10	42.15	1.97	7.22	62
Kaushambi	14.83	20.74	3.47	31.95	0.97	1.26	71
Allahabad	15.69	22.39	4.47	41.17	1.27	3.07	81
Bara Banki	13.36	21.86	4.71	42.88	1.70	5.51	74
Faizabad	13.84	22.82	4.92	42.82	1.20	2.76	78
Ambedkar Nagar	10.01	21.60	4.24	33.89	0.40	0.90	92
Sultanpur	13.92	21.99	4.08	35.17	0.86	1.18	63
Bahraich	13.30	21.23	4.41	33.46	0.92	0.29	81
Shrawasti	13.32	21.31	4.10	35.91	0.87	1.76	72
Balrampur	10.01	21.83	4.31	36.47	1.27	3.15	90
Gonda	10.01	21.33	4.60	43.21	1.93	7.26	73
Siddharth Nagar	16.00	21.56	3.76	30.73	0.40	-0.87	65
Basti	15.17	21.60	3.57	30.17	0.71	-0.15	64
Sant Kabir Nagar	16.85	22.64	3.74	31.81	0.53	-0.52	75
Mahrajganj	15.59	22.29	4.49	36.36	0.98	0.52	71
Gorakhpur	15.89	22.38	3.98	34.13	0.59	0.03	76
Kushinagar	13.96	21.37	3.90	32.46	0.52	-0.31	81
Deoria	15.15	23.09	4.67	36.98	1.08	1.20	59
Azamgarh	14.66	22.28	4.13	34.27	0.70	0.34	54
Mau	15.89	21.72	3.25	31.76	0.71	0.20	71
Ballia	10.01	22.94	4.96	40.10	0.77	1.81	73
Jaunpur	15.18	22.00	4.23	33.60	0.58	-0.35	86
Ghazipur	15.19	21.52	3.62	30.47	0.57	-0.20	76
Chandauli	10.01	21.51	3.85	32.34	0.63	0.79	111
Varanasi	10.01	21.58	4.08	34.24	0.53	0.56	190
Sant Ravidas Nagar	16.13	22.12	3.61	29.63	0.31	-0.73	85
Mirzapur	14.76	21.27	4.27	36.53	1.24	1.89	86
Sonbhadra	14.97	21.09	3.48	33.84	1.23	2.08	100
Etah	15.55	21.58	4.37	40.28	1.42	3.43	82
Kanshiram Nagar	15.24	21.67	3.92	33.04	1.03	0.90	88

Source: Authors' calculations

Table 2: Results of the clustering of districts in terms of the distribution of BMI in currently married non-pregnant women of reproductive age in Uttar Pradesh

Cluster	Number of districts	Number of women	BMI			
			Mean	Standard deviation	Skewness	Kurtosis
1	54	5363	22.07	4.220	0.781	0.907
2	10	958	22.28	4.299	1.263	2.768
3	3	531	24.09	4.650	0.249	-0.188
4	4	277	21.56	4.280	1.838	6.492

Source: Authors' calculations

Table 2 also gives key parameters of the distribution of BMI in currently married non pregnant women of reproductive age in the four clusters identified through the clustering exercise. The distribution of BMI in women belonging to cluster 4 is characterised by the lowest mean BMI and the highest skewness and kurtosis among all clusters. By contrast, the distribution of BMI in women belonging to cluster 3 is characterised by the highest mean BMI and the lowest skewness and kurtosis among the four clusters. Both skewness and the kurtosis of the distribution of BMI are also quite high in cluster 2. The proportion of currently married non-pregnant women of reproductive age having BMI below 18.5 is 19.5 per cent in cluster 1; 16.6 per cent in cluster 2; 11.7 per cent in cluster 3; and 20.6 per cent in cluster 4. On the other hand, the proportion of currently married non-pregnant women of reproductive age having BMI more than or equal to 25 is 21.9 per cent in cluster 1; 20.6 per cent in cluster 2; 40.3 per cent in cluster 3; and only 14.1 per cent in cluster 4. The dendrogram depicting the linkage of districts in terms of the distribution of BMI of currently married non-pregnant women of reproductive age is depicted in figure 1 while the geographical distribution of districts belonging to different clusters is presented in figure 2. It may be seen from the figure 2 that the districts belonging to cluster 3 are geographically contiguous but there is little geographic contiguity in districts of cluster 2 or in districts of cluster 4.

Table 3: Composition of clusters of districts of Uttar Pradesh based on the distribution of the nutritional status of currently married non-pregnant reproductive age women in the district.

Cluster	Districts	
	Number	Name
Cluster 1	54	Saharanpur, Bijnor, Moradabad, Bulandshahr, Aligarh, Hathras, Mathura, Agra, Bareilly, Lucknow, Gorakhpur, Ballia, Rampur, Amroha, Firozabad, Mainpuri, Budaun, Pilibhit, Shahjahanpur, Hardoi, Unnao, Rae Bareli, Farrukhabad, Kannauj, Etawah, Kanpur Dehat, Jalaun, Banda, Ambedkar Nagar, Sultanpur, Balrampur, Siddharth Nagar, Basti, Sant Kabir Nagar, Mahrajganj, Kushinagar, Deoria, Azamgarh, Mau, Jaunpur, Ghazipur, Chandauli, Varanasi, Sant Ravidas Nagar, Mirzapur, Sonbhadra, Kasganj, Kheri, Sitapur, Lalitpur, Mahoba, Kaushambi, Bahraich, Shrawasti
Cluster 2	10	Mujaffarpur, Auriya, Kanpur Nagar, Jhansi, Chitrakoot, Fatehpur, Allahabad, Faizabad, Balrampur, Etah
Cluster 3	3	Meerut, Baghpat, Ghaziabad
Cluster 4	4	Hamirpur, Pratapgarh, Bara Banki, Gonda

Source: Authors' calculations

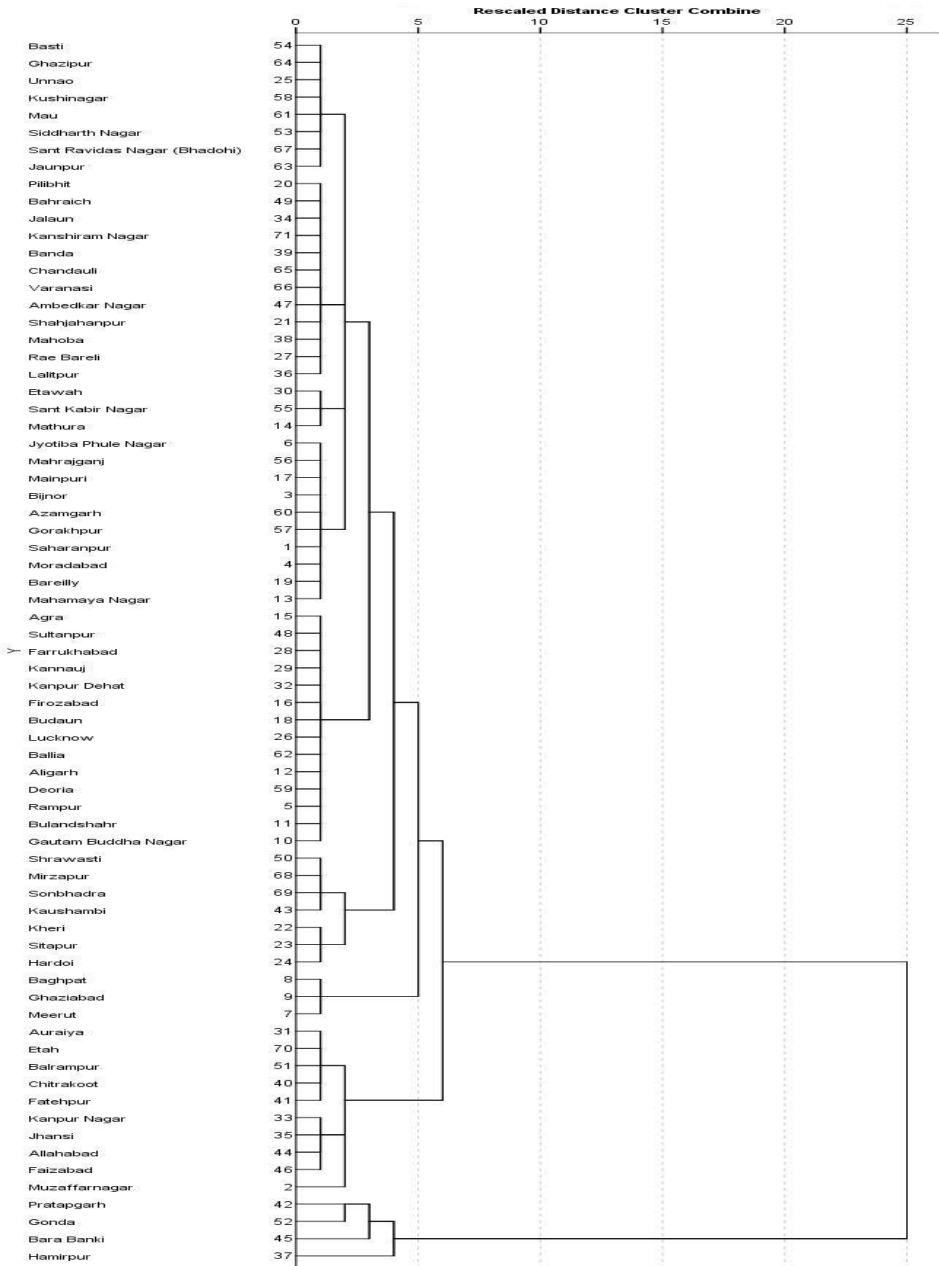


Figure 1: Dendrogram showing linkage of districts in terms of BMI in currently married non-pregnant women of reproductive age

Source: Authors

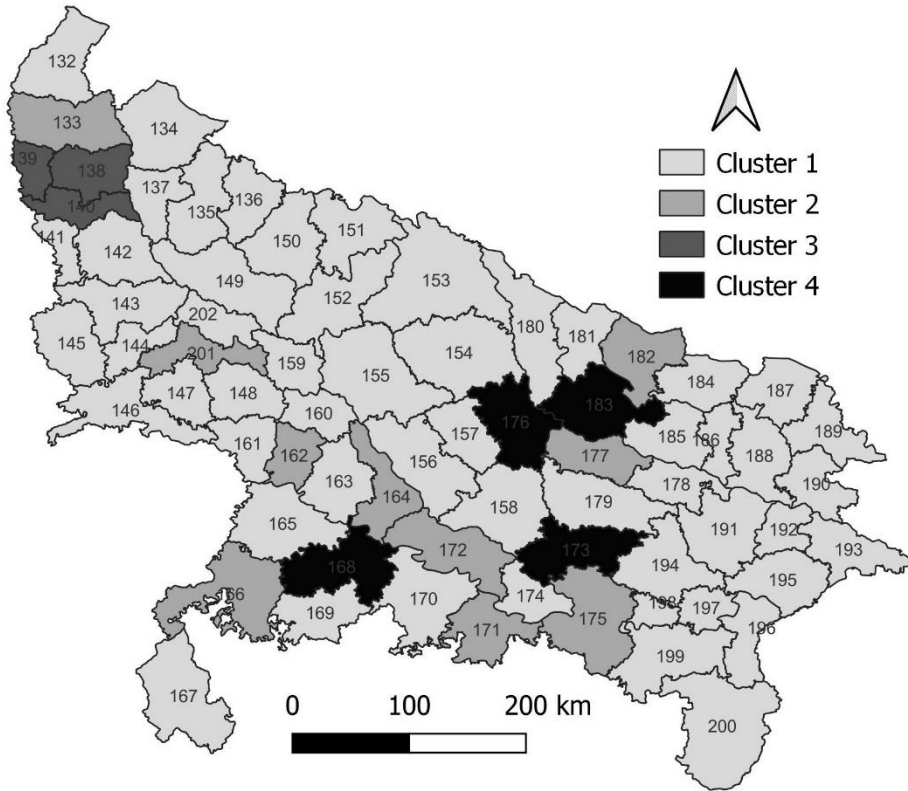


Figure 2: Cluster pattern in terms of distribution of BMI in currently married non-pregnant women of reproductive age
 Source: Authors

Discussions and Conclusions

The present analysis depicts a high degree of inter-district volatility in the nutritional status of currently married non-pregnant women of reproductive age as revealed through the distribution of BMI. A comparison of the distribution of currently married non-pregnant women of reproductive age in terms of BMI suggests that the situation is particularly poor in four districts of the state – Hamirpur, Pratapgarh, Bara Banki and Gonda. The distribution of currently married non-pregnant women of reproductive age by their BMI in these districts is found to be contrastingly different from the distribution of BMI in currently married non-pregnant women of reproductive age in other districts of the state. Similarly, the distribution of currently married non-pregnant women of reproductive age in terms of their BMI has also been found to be contrastingly different in Meerut, Baghpat and Ghaziabad districts relative to other

districts of the state. Reasons for the difference in the distribution of currently married non-pregnant reproductive age women by their nutritional status across the districts of the states are not known at present. The present analysis does not reveal any regional pattern in the distribution of the nutritional status of currently married non-pregnant reproductive age women. It appears that there are district-specific factors that influence the nutritional status of currently married non-pregnant women of reproductive age. This means that a district-based approach should be adopted for improving the nutritional status of women of reproductive age.

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