Geospatial differences among natural regions in the utilization of maternal health care services in India

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ABSTRACT

Background: The chances of a woman dying or becoming disabled during childbirth are closely connected to her socioeconomic status, cultural norms and values, and her home's geographical remoteness. Most of the studies were undertaken to address the issue of accessibility of the hospital's location and its impact on utilization of maternal healthcare utilization. Some studies also attempted to understand the pattern of utilization of healthcare utilization according to administrative and political regions.

Objectives: This study aims to identify the Geographical differences in the utilization of maternal health services in India according to geographical regions, caste, religion, wealth status, and place of residence.

Data and methods: Data for analysis was taken from the National Family Health Survey-4 (2015–16). Data management and analysis were performed using statistical software Stata 13.0. To identify the regional differences in the use of maternal healthcare services, study used the 75 th round of NSS's classification of India into 88 natural regions. Regional variations in the usage of maternal health care were plotted using ArcGIS 10.5, and the bivariate method.

Results: Results shows that the utilization of partial ANC ranges from 33.8% to 91.9%. Utilization is lowest in the Northern Kerala region (33.8%) and, in ascending order, higher in Lakshadweep (34.4%), Goa (36.2%), Puducherry (43.1%), Southern Kerala (43.4%), Inland Tamil Nadu (44.5%), and Andaman and Nicobar Island (46.2%), the mountainous region of Jammu and Kashmir (46.7%), Coastal northern Tamil Nadu (49.9%) and Eastern Maharashtra (51.6%). Institutional delivery was the highest in Northern Kerala (100%) and lowest in the Nagaland (35.7%). Near-universal institutional delivery was also found in Southern Kerala (99.9%), Puducherry (99.9%), Coastal Northern Tamil Nadu (99.6%) and Lakshadweep (99.2%).

Conclusions: Differences in the utilization of MCHS by women can be seen among India's natural regions. Utilization is lagging in the Himalayan Mountain ranges, areas with dense forest cover, the Ganga and Brahmaputra plains, and the Desert region of Rajasthan.

1. Introduction

In 2000, the United Nations Millennium Summit adopted what is now known as the Millennium Declaration. The Declaration identified targeted outcomes in eight human development indicators, officially designated as the Millennium Development Goals (MDGs). These targets were to be achieved by 2015. MDG 5 (the Fifth Millennium Development Goal) was related to maternal health and had two components—MDG-5A and MDG-5B. MDG-5A stipulated a reduction of the maternal mortality rate by 75% (based on 1990 figures) by 2015. This was expected to be achieved by increasing the proportion of births attended by skilled

health personnel. MDG-5B was targeted at universal access to reproductive health. However, as a country, India failed to achieve the targets set in MDG-5. Only a few states—Kerala, Maharashtra, Tamil Nadu and Andhra Pradesh, to name some—achieved them.¹ Subsequently, the Sustainable Developmental Goals which are expected to be met by 2030.²

Due to the efforts of United Nations and supporting organizations, worldwide, maternal deaths have decreased by 44% during the 25-year period between 1990 and 2015—from 338 per 1,00,000 live births to an estimated 216. It is estimated that there were 3,03,000 maternal deaths in the world in 2015. The risk of maternal death also fell considerably

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from 1 in 73 to 1 in 180.³ Maternal deaths account for a significant proportion of all deaths among women of reproductive age, especially in rural areas of India. There are also wide regional disparities: maternal mortality is estimated to be almost twice as high in the four northern states of India, Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh (823 per 1,00,000 births) than in the rest of India, which is 457 per 1,00,000 birth.⁴

Geographical influences on women's sexual and reproductive health are significant. "Geographical distribution is usually an important dimension because regions, as well as individuals, can be multiply deprived and because there are usually significant variations in the ill health and in the avoidable or remediable ill health of regions".⁵ UNPF has reported that geographical remoteness is associated with higher probability of dying and disability during pregnancy and childbirth, which has strong association with socioeconomic status, and cultural norms and values of the pregnant women and the communities they live in.⁶

India has a unique physiography. Due to diversity—geological and geomorphological—classification according to its physical features has challenged the efforts of several scholars. It is now accepted that India can be divided into five physiographic divisions: the Himalayan Mountains, the Great Plain of North India, the Peninsular Plateau, the Coastal Plains and the Islands.⁷ There is wide variety in relief features in the vast country in terms of drainage, climate, natural vegetation, wild life, soil, and environment. In recent studies, social scientists have shown a strong association of caste and health status with the utilization of maternal health services across India states and union territories. Emerging evidence suggests stark differences in the health status and utilization of health services between social and geographical areas. The present paper examines the utilization of maternal healthcare services in the different natural regions of India and the differences among them.

2. Data and Methods

Data for analysis was taken from the National Family Health Survey-4 (2015–16). NFHS-4 was a nationally representative survey of a sample of 6,01,509 households from the 640 districts of the country. The survey included interviews of 6,99,686 eligible women aged 15–49 years. National Family Health Survey is conducted along the lines of other Demographic Health Surveys. They are multi-round and are conducted with a sample of households that represent more than 99% of India's population. NFHS collects detailed information related to demographics, health, nutrition of children and women, and related data. All the four rounds of NFHS involved several organizations, such as the Ministry of Health and Family Welfare, International Institute for Population Sciences (IIPS), the United States Agency for International Development (USAID), Department for International Development (DFID), United Nations Children's Fund (UNICEF) and United Nations Population Fund (UNFPA). Out of all women the sample distribution of live birth in the last five years preceding the survey among women age 15–49 by background characteristics is 1,87,632.

2.1. Operational definitions in the study

Geographical/Natural Region: In the 75th round of the National Sample Survey (NSS) India was divided into 88 natural regions. "Regions were formed in consultation with different Central Ministries, Planning Commission, Registrar General and State Statistical Bureaus, by contiguous grouping districts having similar geographical features, rural population densities and crop-pattern".⁸ NSS's classification system is used in the study.

Maternal Healthcare: According to WHO, "Maternal Health" refers to the health of women during pregnancy, childbirth and the postpartum period.⁹ Maternal Healthcare spans the period beginning with a woman's pregnancy and last still 6 weeks (or 42 days) after delivery.

Full ANC: "Full antenatal care includes at least four antenatal visits,

at least one tetanus toxoid (TT) injection, and iron folic acid supplement [taken as] tablets or syrup for 100 or more days".¹⁰

Partial ANC: A woman is considered as having received partial ANC if she has had two ante natal care services of the four recommended, at least one tetanus toxoid (TT) injection and 100 days of iron folic acid supplement.

Institutional Delivery: "Institutional deliveries are deliveries that take place in a health facility".¹¹

Post Natal Care (PNC): Women who got a medical check-up within the first 48 h (within two days) after delivery are considered to have had a postnatal health check.

2.2. Geographical grouping

To identify the regional differences in the use of maternal healthcare services, this study used the 75th round of NSS's classification of India into 88 natural regions. NFHS-4 collected data from 640 districts of the country, which was aggregated natural region-wise using the NSS's system of dividing the country into 88 natural regions based on geographical homogeneity or natural characteristics.

2.3. Data analysis

Data management and analysis performed using statistical software Stata 13.0. Geographical distribution of the antenatal healthcare services utilization coverage and the differences were determined using geographical mapping techniques. Regional variations in utilization of antenatal care were with the help of ArcGIS 10.5. A composite index was developed to rank the natural regions according to their performance in overall maternal healthcare services: use of full ANC, institutional delivery and PNC.

2.4. Variables

Responses to each of the variables Full ANC, Partial ANC, Institutional Delivery and Post Natal Care were obtained in the binary form ('Yes/No', i.e. for the analysis. Full ANC (Yes/No), Partial ANC (Yes/No), Institutional Delivery (Yes/No), Post Natal Care (Yes/No).

2.5. Weighted percentage of women receiving antenatal care, institutional delivery and Post Natal Care

To analyse the patterns and differences in the utilization of services by currently married women across the 88 geographical regions, this study uses weighted proportions of the indicators while calculating regional distribution of Partial ANC, full ANC, use of Institutional Delivery and Post-natal checks.

2.6. Composite index

Composite index was used for assessing objectives. The composite considered the three indicators of maternal healthcare: full ANC, institutional delivery and post-natal care. It was constructed using the following formula

$$CI = \frac{\text{Observed value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}}$$

2.7. Geographical mapping

Geographical mapping methods provide an intuitive means for identifying discrepancies across regions and the country. The differences in utilization of maternal healthcare services in different geographical regions can be easily identified with the help of geographical maps. Geographical mapping is used in this study for showing the patterns of usage of Partial ANC, full ANC, institutional

Table 1

Sample distribution, MHCS utilization and Ranking natural regions of India according to their score on the Composite Index women age 15–49 years in the five years preceding the survey (by Natural Regions, in 2015–16).

State	Natural Region	Birth	Total	Partial ANC	Full ANC	Instit. Deli.	PNC	CI	Rank
Jammu & Kashmir	Jhelum Valley	2,694	6,599	78.3	20.1	94.8	83.5	65.8009	29
	Ladakh	545	1,176	72.2	26.2	90.9	84.1	66.7609	27
	Outer Hills	2,275	5,191	63.4	24.0	72.4	59.3	51.5942	62
Himachal Pradesh	Mountainous	703	2,066	46.7	50.0	91.1	84.2	74.8209	10
	Trans-Himalayan & Southern	1,295	4,118	58.4	36.1	75.8	73.7	61.5242	43
	Central	973	3,269	60.2	37.4	80.4	78.4	65.0842	31
Punjab	Northern	1,822	6,102	64.8	33.8	92.0	88.9	71.2442	15
	Southern	2,250	7,628	69.8	28.0	92.1	89.7	69.6442	20
Chandigarh	Chandigarh	149	505	64.5	34.1	93.5	91.4	72.6909	12
Uttarakhand	Uttarakhand	4,253	11,870	83.3	11.5	72.0	58.3	46.9775	73
Haryana	Eastern	3,716	10,514	73.4	20.0	79.7	67.7	55.4609	55
	Western	1,948	5,739	78.8	18.7	91.4	77.0	62.0409	40
Delhi	Delhi	1,240	3,938	57.6	38.9	87.0	65.8	63.5975	36
Rajasthan	Western	3,041	7,415	79.3	8.1	75.6	58.6	47.1509	72
	North-Eastern	3,808	9,871	84.0	10.1	88.7	65.3	54.3975	57
	Northern	1,774	5,323	86.3	10.3	89.4	68.8	55.8342	54
Uttar Pradesh	Southern	1,316	3,233	84.5	8.9	84.2	66.0	52.7342	59
	South-Eastern	1,904	5,388	85.5	11.5	92.3	68.3	57.0675	52
	Northern Upper Ganga Plains	5,402	12,560	83.8	9.1	69.5	74.6	50.7509	66
Bihar	Central	2,851	7,294	84.4	5.1	73.1	54.4	43.8942	78
	Southern Upper Ganga Plains	7,760	17,567	84.1	4.9	65.8	61.3	43.7042	79
	Southern	1,924	5,358	90.7	3.0	82.4	57.5	47.3275	71
Sikkim	Eastern	10,480	23,710	85.0	5.8	70.5	52.6	42.6542	80
	Northern	9,108	18,508	87.3	2.9	61.6	40.2	34.6009	85
	Central	7,545	16,865	91.9	4.2	75.6	57.3	45.3542	74
Arunachal Pradesh	Sikkim	884	3,343	60.4	39.3	95.2	74.9	69.5009	21
Nagaland	Arunachal Pradesh	3,781	10,226	66.9	3.6	55.4	30.2	29.4175	87
Manipur	Nagaland	3,020	6,646	69.7	2.4	35.7	23.3	20.1275	88
Mizoram	Plains	2,672	5,788	54.1	43.5	84.5	75.6	67.5609	25
Tripura	Hills	1,652	3,084	75.4	12.7	46.5	44.5	34.2375	86
Meghalaya	Mizoram	3,213	7,006	54.9	38.2	80.1	64.1	60.5109	48
Assam	Tripura	1,144	3,646	87.9	7.8	82.8	63.1	50.9175	65
West Bengal	Meghalaya	2,890	5,559	63.9	23.4	54.5	54.9	43.9709	77
	Central Brahmaputra Plains	1,620	3,877	79.5	17.3	75.3	52.3	47.9909	70
	Plains Eastern	2,003	5,466	64.9	32.1	87.3	74.2	64.2475	33
Jharkhand	Cachar Plain	1,606	3,569	82.7	10.2	59.6	56.8	41.9042	82
	Plains Western	3,184	7,731	70.2	13.6	69.2	51.6	44.4909	76
	Himalayan	594	2,017	76.2	21.7	87.8	74.2	60.9109	46
Odish	Eastern Plains	1,551	4,485	80.0	17.8	71.7	55.7	48.0909	68
	Southern Plains	641	1,977	80.4	18.9	73.9	61.4	51.0475	63
	Central Plains	627	2,138	69.8	28.4	87.0	70.3	61.6175	41
Chhattisgarh	Western Plains	990	3,129	72.9	25.8	78.6	67.8	57.0809	51
	Hazaribagh Plateau	5,176	12,834	88.0	8.3	64.0	53.2	41.5142	83
	Ranchi Plateau	3,627	8,615	84.9	7.8	64.3	42.0	37.7209	84
Madhya Pradesh	Northern	2,815	7,884	70.7	27.2	88.1	80.5	64.9609	32
	Coastal	2,502	7,197	76.7	19.6	92.8	78.7	63.4142	37
	Southern	3,544	8,857	73.2	23.5	79.4	77.0	59.6242	50
Gujarat	Northern Chhattisgarh	860	2,167	77.8	14.5	67.1	54.9	45.1975	75
	Mahanadi Basin	4,104	11,012	75.2	23.0	74.0	72.1	56.0575	53
	Southern Chhattisgarh	1,719	3,996	78.1	19.9	71.1	63.0	51.0109	64
Maharashtra	Northern	2,852	7,812	88.2	8.5	88.2	60.6	52.1175	61
	Vindhya	2,966	7,779	83.1	5.8	74.4	47.9	42.3909	81
	Central	1,779	4,628	82.7	10.5	82.4	52.1	48.0209	69
Andhra Pradesh	Malwa	4,372	11,742	80.4	13.0	88.0	63.1	54.3742	58
	South Western	2,918	7,890	79.7	13.0	76.5	59.1	49.2042	67
	South	2,294	6,978	79.1	18.5	81.8	57.2	52.2042	60
Daman & Diu	Kachchh	233	606	67.8	29.6	85.1	70.6	61.4309	44
	Dry Areas	516	1,378	76.7	17.1	91.8	58.1	55.3575	56
	Plains Northern	1,293	3,936	58.2	38.1	93.7	68.9	66.5875	28
Dadra & Nagar Haveli	Saurashtra	1,452	4,615	69.3	28.1	91.7	60.2	59.7075	49
	South Eastern	2,236	6,490	63.0	30.1	86.2	69.4	61.5775	42
	Daman & Diu	328	922	56.2	29.7	91.5	61.5	60.5842	47
Maharashtra	Dadra & Nagar Haveli	239	594	62.9	32.9	89.2	66.7	62.6309	39
	Inland Northern	888	2,637	70.3	25.8	82.5	76.2	61.2042	45
	Inland Eastern	1,441	4,622	64.3	33.5	91.4	79.2	67.7375	24
Telangana	Eastern	695	2,386	51.6	45.9	92.8	78.4	72.0775	13
	Inland Central	1,964	5,508	71.8	25.2	90.1	78.1	64.1375	34
	Coastal	901	2,917	60.0	36.0	95.1	83.0	71.0642	16
Andhra Pradesh	Inland Western	1,116	3,724	62.5	34.7	94.7	80.8	69.7442	19
	Inland North Weste	1,114	3,411	54.3	43.0	90.9	78.9	70.6075	18
	Inland North East	636	2,192	59.1	40.9	96.4	91.1	75.8209	7
Andhra Pradesh	Coastal Northern	786	3,032	57.6	41.4	93.3	82.1	71.9942	14

(continued on next page)

Table 1 (continued)

State	Natural Region	Birth	Total	Partial ANC	Full ANC	Instit. Deli.	PNC	CI	Rank
Karnataka	Coastal Southern	659	2,510	53.1	46.1	96.5	83.3	74.9609	8
	Inland Southern	785	2,495	54.4	44.5	88.2	76.0	69.2675	22
	Inland Northern	3,074	9,402	60.5	35.9	92.6	61.7	63.1175	38
	Coastal and Ghats	521	1,728	62.5	33.6	97.0	74.1	67.9509	23
	Inland Eastern	649	2,349	66.9	27.4	97.8	66.8	63.6875	35
	Inland Southern	1,547	5,524	65.0	30.8	96.9	69.8	65.5175	30
Goa	Goa	344	1,095	36.2	63.1	98.3	92.5	84.3175	3
Lakshadweep	Lakshadweep	260	738	34.4	65.6	99.2	92.6	85.4909	1
Kerala	Northern	1,085	3,835	33.8	66.0	100.0	90.4	85.1709	2
	Southern	1,023	4,259	43.4	56.4	99.9	87.3	80.9009	4
Tamil Nadu	Coastal Northern	1,351	4,811	49.9	47.5	99.6	74.1	73.4275	11
	Inland	1,638	5,779	44.5	52.4	98.9	79.7	76.6942	6
	Southern	1,564	5,357	59.9	34.3	98.9	70.4	67.5575	26
	Coastal	1,528	5,113	52.6	42.9	99.2	71.9	70.9942	17
Puducherry	Puducherry	872	2,850	43.1	55.6	99.9	84.9	79.8042	5
Andaman and Nicobar Island	Andaman and Nicobar Island	518	1,927	46.2	53.5	96.3	75.8	74.8909	9
Total		1,87,632	4,99,627	73.7	21.0	81.2	65.2	–	–

Fig. 1. Coverage of partial ANC in the natural regions of India.

Fig. 2. Coverage of full ANC in the natural regions of India.

delivery, and Post-natal care at a national or macro-level, as well as the differences in utilization. The geographical maps were prepared with the help of ArcGIS software.

3. Results

Table 1 shows the distribution of live birth over the natural regions in the last five years preceding the survey. The 1,87,632 women in the sample represented all 88 natural regions of India. Women from eastern Uttar Pradesh formed the largest group from a natural region (10,480), while those from Chandigarh were the smallest (149). The second largest group in the sample was from Northern Bihar (9,108) followed by the Southern Upper Ganga Plains of Uttar Pradesh (7,760), Central Bihar (7,545), Northern Upper Ganga Plains of Uttar Pradesh (5,402), Hazaribagh Plateau of Jharkhand (5,176), Malwa region of Madhya Pradesh (4,372), Uttarakhand (4,253), Mahanadi Basin of Chhattisgarh (4,104) and North-Eastern Rajasthan (3,808).

Other small-sized groups besides Chandigarh were from Kachchh region of Gujarat (233), Dadra & Nagar Haveli (239), Lakshadweep (260), Daman & Diu (328), Goa (344), Dry Areas of Gujarat (516), Andaman and Nicobar Island (518), Coastal and Ghats of Karnataka

(521), and the Ladakh region of Jammu & Kashmir (545).

3.1. Differences in coverage of ANC among natural regions

Table 1 presents data on coverage of partial and full ANC among women age 15–49. The utilization of partial ANC ranges from 33.8% to 91.9%. Utilization is lowest in the Northern Kerala region (33.8%) and, in ascending order, higher in Lakshadweep (34.4%), Goa (36.2%), Puducherry (43.1%), Southern Kerala (43.4%), Inland Tamil Nadu (44.5%), and Andaman and Nicobar Island (46.2%), the mountainous region of Jammu and Kashmir (46.7%), Coastal northern Tamil Nadu (49.9%) and Eastern Maharashtra (51.6%). However, these ten natural regions were seen to perform better in full ANC in the country.

Central Bihar showed highest utilization of partial ANC (91.9%) and followed by Southern Uttar Pradesh (90.7%), Northern Madhya Pradesh (88.2%), Hazaribagh Plateau of Jharkhand (88.0%), Tripura (87.9%), Northern Bihar (87.3%), Northern Rajasthan (86.3%), South-Eastern Rajasthan (85.5%), Eastern Uttar Pradesh (85.0%) and Ranchi Plateau of Jharkhand (84.9%). It is also seen from the table that in the regions with high percentage of use of partial ANC services, the proportion of women not using full ANC was also high (Fig. 1).

Fig. 3. Institutional deliveries in the natural regions of India (2015–16).

3.2. Utilization of full ANC

The utilization of full ANC among women varied widely from 2.4% in Nagaland to 66.0% in Northern Kerala. Other states where utilization of full ANC was low included Northern Bihar (2.9%), Southern Uttar Pradesh (3.0%), Arunachal Pradesh (3.6%), and Central Bihar (4.2%). Nearly five women in a hundred in Southern Upper Ganga plains (4.9%) and the Central (5.1%) region of Uttar Pradesh utilized full ANC care services. Other regions included the Vindhya region of Madhya Pradesh (5.8%), Eastern part of Uttar Pradesh (5.8%), Tripura (7.8%), and the Ranchi Plateau of Jharkhand (7.8%). In Western Rajasthan utilization of full ANC was 8.1%, and higher in Hazaribagh Plateau of Jharkhand (8.3%), and Northern Madhya Pradesh (8.5%), Southern Rajasthan (8.9%) and Northern Upper Ganga Plains of Uttar Pradesh (9.1%). In North-Eastern Rajasthan, utilization of full ANC was 10.1%, 10.2% in the Cachar Plain of Assam, 10.3% in Northern Rajasthan, 10.5% in Central Madhya Pradesh, 11.5% each in South-Eastern and Uttarakhand, 12.7% in Manipur Hills, 13% each in the Malwa region and South Western Madhya Pradesh, 13.6% in the Plains of Western Assam

(13.6%) and 14.5% in Northern Chhattisgarh.

As can be seen from the table, the highest utilization of full ANC was in Lakshadweep (65.6%) and followed by Goa (63.1%), Southern Kerala (56.4%), Puducherry (55.6%), Andaman and Nicobar Island (53.5%), the Inland area of Tamil Nadu (52.4%), the Mountainous region of Jammu and Kashmir (50%), Coastal Northern region of Tamil Nadu (47.5%), Coastal Southern region of Andhra Pradesh (46.1%) and Eastern Maharashtra (45.9%).

In Inland Southern Andhra Pradesh utilization of full ANC services was 44.5% and followed by, in descending order, Manipur Plains (43.5%), Inland North Western Telangana (43%), Coastal Tamil Nadu (42.9%), Coastal Northern Andhra Pradesh (41.4%) and Inland North Eastern Telangana (40.9%) (Fig. 2).

Data in the table show that all regions in south India are performing better in the utilization of full ANC than the regions in north India. The only region in north India that was ranked in the ten best performing regions was the Mountainous region of Jammu and Kashmir.

Women in sixteen of the country's eighty-eight natural regions were not using full ANC. Nineteen regions had less than two women who used

Fig. 4. PNC cover in India's Natural Regions of India (2015–16).

full ANC; and in eighteen regions, the number of women using full ANC was less than three. In seventeen natural regions, more than 40% of the women had full ANC and in seven regions, more than half received full ANC services.

3.3. Regional differences in place of delivery

As seen in Table 1, the percentages of women aged 15–49 years having live births in institutions in 2015–16 varied from 35.7% to 100%. The effect of geographical isolation is seen in the choice of place of delivery. Institutional delivery was the highest in Northern Kerala (100%) and lowest in the Nagaland (35.7%). Near-universal institutional delivery was also found in Southern Kerala (99.9%), Puducherry (99.9%), Coastal Northern Tamil Nadu (99.6%) and Lakshadweep (99.2%). Other regions with very high percentage of institutional delivery were Southern Tamil Nadu (98.9%), Inland Tamil Nadu (98.9%), Goa (98.3%), Inland Eastern Coastal (97.8%) and Ghats (97%), and the Inland Southern region Karnataka (96.9%), Coastal Southern Andhra Pradesh (96.5%), Inland North East Telangana (96.4%) and Andaman

and Nicobar Island (96.3%).

Besides Nagaland, other regions with low percentages of institutional deliveries include Manipur Hills (46.5%), Meghalaya (54.5%) and Arunachal Pradesh (55.4%). It was relatively higher in the Cachar Plain of Assam (59.6%), Northern Bihar (61.6%), Hazaribagh Plateau (64%) and Ranchi Plateau (64.3%) of Jharkhand. In Southern Upper Ganga Plains of Uttar Pradesh, the proportion of institutional deliveries was 65.8%, 67.1% in Northern Chhattisgarh, 69.2% in Plains Western of Assam 69.2% and 69.5% in the Northern Upper Ganga Plains of Uttar Pradesh. Relatively higher utilization of institutional deliveries were seen in Eastern Uttar Pradesh (70.5%), Southern Chhattisgarh (71.1%), Eastern Plains of West Bengal (71.7%), Uttarakhand (72%), Outer Hills of Jammu & Kashmir (72.4%), Central Uttar Pradesh (73.1%), Southern Plains of West Bengal (73.9%), Mahanadi Basin of Chhattisgarh (74%), Vindhya region of Madhya Pradesh (74.4%) and Central Brahmaputra Plains of Assam (75.3%) (Fig. 3).

Fig. 5. Composite Index of utilization of maternal healthcare services by natural regions (2015–16).

3.4. Differences in utilization of PNC among natural regions

Table 1 presents data on coverage of post-natal care among women aged 15–49 years who had live births in the five years preceding the survey in 2015–16. Nagaland showed the lowest utilization of PNC (23.3%), while Lakshadweep had the highest (92.6%). Utilization of PNC services was 92.5% in Goa, 91.4% in Chandigarh, 91.1% in Inland North Eastern Telangana, 90.4% in Northern Kerala, 89.7% and 88.9% respectively in Southern and Northern (88.9%) Punjab, and 87.3% in Southern Kerala. Other states with high utilization of PNC services were Puducherry (84.9%), Mountainous region (84.2%), Ladakh region (84.1%), Jhelum Valley region of Jammu & Kashmir (83.5%), Coastal Southern Andhra Pradesh (83.3%), Coastal Maharashtra (83%), Coastal Northern Andhra Pradesh (82.1%), Inland Western Maharashtra (80.8%), and Northern Odisha (80.5%).

Besides Nagaland, regions showing low utilization of PNC services were Arunachal Pradesh (30.2%), Northern Bihar (40.2%), Ranchi Plateau of Jharkhand (42%) and Manipur Hills (44.5%) were getting PNC. Relative to these states, a higher proportion of utilization of PNC

was seen in the Vindhya region of Madhya Pradesh (47.9%), Western Plains of Assam (51.6%), Central Madhya Pradesh (52.1%), Central Brahmaputra Plains of Assam (52.3%), Eastern Uttar Pradesh (52.6%), Hazaribagh Plateau of Jharkhand (53.2%), Central Uttar Pradesh (54.4%), Northern Chhattisgarh (54.9%), and Meghalaya (54.9%) (Fig. 4).

3.5. Ranking natural regions for utilization of maternal healthcare services in 2015–16 using a composite index

Ranking of the regions for utilization of maternal health care is presented in Table 1. A composite index of utilization in 2015–16 was developed with which the regions were ranked. Three variables were considered for computing the index: full ANC, institutional delivery and post-natal care services. Table 1 shows the ranking of the regions based on the overall performance of each region in all the three indicators. Lakshadweep (CI 85.49,087) was ranked first followed by, in that order, Northern Kerala, Goa, Southern Kerala, Puducherry, Inland Tamil Nadu, Inland North East Telangana, Coastal Southern Andhra Pradesh,

Andaman and Nicobar Island, and Mountainous region of Jammu & Kashmir (CI 74.82,087).

Nagaland ranked the lowest in utilization of maternal healthcare services (CI 20.12,753). Above Nagaland, in ascending order, were Arunachal Pradesh, Manipur Hills, Northern Bihar, Ranchi and Hazaribagh Plateaus of Jharkhand, Cachar Plain of Assam, Vindhya region of Madhya Pradesh, Eastern region, Southern Upper Ganga Plains and Central part of Uttar Pradesh, Meghalaya, Plains Western of Assam, Northern Chhattisgarh, and Central Bihar (CI 45.35,420) (Fig. 5). The low CI values indicate poor utilization of maternal healthcare services in the respective regions.

4. Discussion

Data showing the differences in utilization of maternal healthcare were presented in this paper. This paper aimed at providing the differentials of maternal health care utilization which includes full antenatal care, institutional deliveries and postnatal care services by natural regions. Results clearly show that there is wide gap in the utilization of maternal health care services by the natural regions. Full ANC is considered as one of the important interventions to increase the chances of successful deliveries and positive health outcomes for both mother and infant. However, the results show that the full ANC services are uniformly utilized across the natural regions results were found in previous studies in India.

The results show wide differences in the utilization of maternal health services among the natural regions of India. The natural regions in Southern India led the rest of the country in the utilization of all components of maternal healthcare. Regions in north and north-east India ranked low in the utilization of maternal health services. One possible reason for the wide differences in the utilization of maternal healthcare services is that these services are not widely available in the regions that perform poorly. Some previous studies had reported the similar results.¹²

A lower proportion of Women from natural regions located in the Himalayan mountain ranges, including Nagaland, Arunachal Pradesh, Manipur Hills, Meghalaya, and the Vindhya mountainous ranges are seen to utilize maternal healthcare services as compared to other regions. These regions also characterized by dense forest cover—52% of land area in Nagaland, 61% in Arunachal Pradesh, 78% in Manipur Hills, and 42% in Meghalaya.¹³ Utilization of Maternal Healthcare services was also low Northern Chhattisgarh which also has dense forest cover. Northern Chhattisgarh includes two districts, Koriya and Surguja. Koriya has 62.03% forest cover and Surguja 45.02%.¹⁴

Utilization of MHCS was also low in the plains of Ganga and Brahmaputra of the country. They include Northern and Central Bihar, the Eastern region, Southern Upper Ganga Plains and Central part of Uttar Pradesh, Cachar and the Western Plains of Assam. The plateau regions of central India—the Ranchi Plateau and Hazaribagh Plateau of Jharkhand—also showed poor utilization of maternal healthcare services. The influence of geographical factors was invisible in the natural regions of south Indian regions where utilization of maternal healthcare services were high in Lakshadweep, Northern Kerala, Goa, Southern Kerala, Puducherry, Inland Tamil Nadu, Inland North East Telangana, Coastal Southern Andhra Pradesh, and Andaman and Nicobar Island.

5. Conclusion

Differences in the utilization of MCHS by women can be seen among

India's natural regions. Utilization is lagging in the Himalayan Mountain ranges, areas with dense forest cover, the Ganga and Brahmaputra plains, and the Desert region of Rajasthan. This study establishes that geographical remoteness significantly impacts delivery of MHCS. Such regions had low utilization of institutional delivery services. The influence of geographical factors was invisible in the natural regions of south Indian regions.

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Data availability statement

The data used for the study is obtained from the web portal of The DHS Program (<https://www.dhsprogram.com/data/available-datasets.cfm>). No separate ethics statement and consent for publication was required for this study as the NFHS-IV collect the secondary data from the health facilities of India.

Declaration of competing interest

None to declare.

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References

- Chandramouli DC. *Child and Maternal Mortality; 1990-2015*. 2011.
- General Assembly. *Transforming Our World: The 2030 Agenda for Sustainable Development*. 16301. General Assembly 70 session; 2015.
- WHO, UNICEF, UNFPA WBG and UNPD. *Trends in Maternal Mortality : 1990 to 2015* [Internet]. World Health Organization; 2015. Available from: http://whqlibdoc.who.int/publications/2010/9789241500265_eng.pdf.
- Mari Bhat PN, Navaneetham K, Rajan SI. *Maternal Mortality in India; Estimates from an Econometric Model*. Dharward; 1992.
- Culyer AJ. Equity - some theory and its policy implications. *J Med Ethics* [cited 2017 Aug 22];27(4):275–83. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1733434/pdf/v027p00275.pdf>; 2001 [Internet].
- United Nations Population Fund. Rich mother, poor mother; the social determinants of maternal health and disability [cited 2017 Jun 14]. Available from: http://www.unfpa.org/sites/default/files/resource-pdf/EN-SRH_fact_sheet-Poormother.pdf; 2012 [Internet].
- Khullar DR. *India - A Comprehensive Geography*. 2005.
- Sastry NS. concepts and definitions used in NSS [internet]. Golden jubilee publication http://mospi.nic.in/sites/default/files/publication_reports/concepts_golden.pdf; 2001 [cited 2018 Apr 6]. Available from: http://mospi.nic.in/sites/default/files/publication_reports/concepts_golden.pdf.
- World Health Organization. Maternal health [internet]. World Health Organization. World Health Organization http://www.who.int/topics/maternal_health/en/; 2016 [cited 2017 Jun 21]. Available from: http://www.who.int/topics/maternal_health/en/.
- IIPS. *National Family Health Survey India; India Fact Sheet*. 2016.
- International Institute for Population Sciences (IIPS). *National Family Health Survey (NFHS-4) 2015-16*. Mumbai: IIPS; 2017.
- Awasthi A, Pandey CM, Chauhan RK, Singh U. Disparity in maternal, newborn and child health services in high focus states in India: a district-level cross-sectional analysis [cited 2017 Sep 13];6(8):e009885. Available from: <http://bmjopen.bmj.com/content/bmjopen/6/8/e009885.full.pdf>; 2016. *BMJ Open* [Internet].
- Forest Survey of India. India state of forest report 2019 [internet]. Forest Survey of India Ministry of Environment, Forest & Climate Change Government of India http://www.fsi.org.in/cover_2011/uttarakhand.pdf%5C; 2019. Vol. I.
- Forest Survey of India. India state of forest report 2019 [internet]. Forest Survey of India Ministry of Environment, Forest & Climate Change Government of India http://www.fsi.org.in/cover_2011/uttarakhand.pdf%5C; 2019. Vol. II.