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Trends over a decade in geographical inequality for opportunity in access to maternal care services from the National Family Health Surveys in India

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4 January 2024

Trends over a decade in geographical inequality for opportunity in access to maternal care services from the National Family Health Surveys in India

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ABSTRACT

Objectives: To examine the trends in geographical inequality of opportunity in maternal health services in India considering the ENAP 2025 coverage targets.

Setting: India

Participants: Women in the National Family Health Survey (NFHS) - NFHS-4 (2014-15) and NFHS-5 (2019-21).

Primary and secondary measures: District-level coverages of 4+ antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), postnatal care (PNC) services within 48 hours of delivery, Continuum of care (CoC) services for women with most recent livebirths. Human Opportunity Index (HOI) documented the opportunities for equitable access of these services, ranging from 0 (high inequality) to 100 (universal access). HOI was compared between the survey rounds and wealth index quintiles (WI) that the women belonged to.

Results: Coverages of 4+ ANC visits, institutional delivery, PNC, and CoC in India increased by 22.8% (95% CI 22.1-23.5), 12.6% (12.2-12.9), 28.5% (28.0-29.0), and 38.6% (37.6-39.6) between NFHS-4 and NFHS-5, respectively. The HOI for 4+ ANC visits was 48.4 in NFHS-5, ranging from 11.3 to 92.4 in states and from 31.1 to 70.5 for WI I to V. The HOI for institutional delivery was 80.4 in NFHS-5, ranging from 37.4 to 99.7 in the states and from 21.0 to 100 for WI I to V. The HOI for PNC services was 73.5 in NFHS-5, ranging from 37.5 to 95.6 in the states and from 61.2 to 88.3 for WI I to V. The HOI for CoC was 37.1, ranging from 6.5 to 88.8 in the states and from 19.8 to 62.7 for WI I to V for CoC in NFHS-5.

Conclusion: Though significant improvements in the geographic inequity of maternal health services have been made, the geographic inequity for 4+ANC visits coverage lags significantly behind resulting in CoC coverage inequity to achieve the ENAP targets for these services.

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Keywords: Antenatal care services, continuum of care, human opportunity index, India, inequity, institutional delivery, NFHS, postnatal care, wealth index.

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STRENGTHS AND LIMITATIONS OF THE STUDY

- District-level inequity estimated in the coverages of maternal health services for India using large-scale demographic surveys
- Human opportunity index used to indicate the extent of inequity in the coverages by geography and by wealth index
- Quality of services not captured in the assessment

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INTRODUCTION

With the Sustainable Development Goal (SDG) 10, the governments worldwide have committed to act on inequality through multiple, interconnected goals, requiring combined policy action in order to meet an overall commitment to 'leave no-one behind'.⁽¹⁾ Access to health care for all also intersects with the inequalities related to gender, socio-economic status, education levels, employment status and geographical location, with the most marginalized being the least able to access quality healthcare.⁽²⁾ Inequality in access to essential health-care services has implications on achieving universal health coverage, including maternal health services among both the general and the most disadvantaged populations.⁽³⁾ Significant literature on the extent of inequities in maternal health services is available from developing countries including from India, predominately based on the Demographic and Health Surveys (DHS) and focusing on socio-economic inequalities in the use of maternal health services.⁽⁴⁻¹⁶⁾

In the context of Countdown to 2030, SDGs 3.1 and 3.2 which aim to reduce maternal and neonatal mortality by 2030,⁽³⁾ we examine the trends in geographical inequality of opportunity in access for the coverage of antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), and postnatal care (PNC) visits within 48 hours in India using the National Family Health Survey (NFHS), which is the equivalent of DHS in India.⁽¹⁷⁾ In addition, we also measure geographical inequality in the coverage of continuum of care (CoC), which is recommended as one of the global strategies for maternal health to improve maternal and neonatal outcomes in the developing country setting.⁽¹⁸⁻²⁰⁾ The maternal health program in India is implemented at the district level,⁽²¹⁾ and the Every Newborn Action Plan (ENAP) 2025 provides for maternal care services coverage target indicators based on the district-level coverage of these services in a state.⁽²²⁾ Therefore, we examine district-level inequality in India and its states as these have implications on planning to achieve the ENAP 2025 coverage targets.

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82 **METHODS**

83 **Study design**

84 We utilized the publicly available data from the two most recent rounds of NFHS conducted post
85 year 2010, NFHS-4 (2014-15) and NFHS-5 (2019-21).(17, 23) These nationally representative
86 population-based surveys are conducted by the International Institute of Population Sciences,
87 Mumbai, India , with the primary aim to provide estimates of maternal and child health and
88 reproductive health indicators at the district-level for India.(17, 23) No ethics approval was required
89 for this analysis as we utilised the de-identified data available in public domain.

90 The NFHS-4 provided data for livebirths between 2011 and 2015-2016 and NFHS-5 on
91 livebirths between 2016 and 2020-2021. We defined the CoC for this analysis as a woman having
92 reported four or more ANC visits and institutional delivery with SBA and PNC within 48 hours of
93 delivery for her most recent livebirth in the last 5 years. We calculated the coverage of 4 or more
94 ANC visits (4+ ANC visits), institutional delivery with SBA, PNC within 48 hours of delivery, and CoC
95 for the most recent livebirth for NFHS-4 and NFHS-5 for India, and its states and districts.

96 **Data analysis**

97 The primary objective of this analysis was to measure the trends in geographical inequality for the
98 opportunity to access maternal care services in India and its states, for which we utilised the Human
99 Opportunity Index (HOI). The HOI is a measure of the coverage rate of an opportunity discounted by
100 inequality in the distribution across the circumstance groups, and is estimated as:(24, 25)

101
$$HOI = (1 - D) \times C$$

102 Where D measures the dissimilarity between access of services for groups defined by circumstance
103 characteristics (such as wealth index, education, distance, etc) and the average access coverage for
104 the same service for the population as a whole; C is average access coverage of services the
105 population as a whole. The HOI ranges from 0 (high inequality) to 100 (universal access). In this
106 analysis, D is the index of geographical inequality at the district-level within each state compared
107 with the average coverage of a particular maternal service for a given state. The HOI for coverage of

each of the three maternal care services and CoC for India and its states was estimated using the district level coverage of these services in NFHS-4 and NFHS-5, and the change in HOI between NFHS-4 and NFHS-5 was assessed. The number of districts in each state in NFHS-4 and NFHS-5 are shown in supplemental table 1.

In addition, we explored inequality by wealth index (WI) quintile in NFHS-5. The WI quintile is provided in the NFHS dataset at the household level which is based on the number and kinds of consumer goods each household owns calculated using principal component analysis.(17, 26) We calculated HOI for India and states for each WI quintile for each maternal health service and CoC. We report the ratio of state average HOI with WI I and WI V, and the ratio of HOI WI I to WI V for each maternal health service and CoC.

The states of India were grouped based on its development status for this analysis. The Empowered Action Group of states as categorized by the government of India (Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Uttarakhand, and the north-eastern states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) were grouped as 'less developed' and the remaining states were categorised as "more developed." (27, 28) Delhi, Jammu and Kashmir including Ladakh were considered as a state for this analysis, and all the other Union Territories were excluded. We have reported 95% confidence interval for all estimates as relevant and all the analyses were carried out using STATA version 13.1 and Microsoft Excel 2016.

Patient and Public Involvement statement: Patients were not involved in planning of this analysis.

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RESULTS

A total of 188,506 and 174,796 ever-married women aged 15-49 years provided data on their most recent livebirth in NFHS-4 and NFHS-5, respectively. The coverages for 4+ ANC visits, institutional delivery with SBA, and PNC in 48 hours, and CoC for NFHS-4 and NFHS-5 for India, grouping of states, and individual states are shown in supplemental table 2.

4+ ANC visits

The coverage of 4+ ANC visits for India was 57.0% (95% CI 56.8 to 57.3) in NFHS-5. The percent change in coverage of 4+ ANC visits from NFHS-4 to NFHS-5 was estimated at 22.8% (95% CI 22.1 to 23.5), 33.3% (95% CI 32.3 to 34.3), and 3.4% (95% CI 2.6 to 4.1) for India, less developed and more developed states, respectively (supplemental table 2). This coverage ranged from 15.6% in Nagaland to 80.0% in Odisha in the less developed states, and 58.3% in Punjab to 93.2% in Goa in the more developed states in NFHS-5 (supplemental table 2). The HOI for geographic inequality in 4+ ANC visits for India was 48.4 in NFHS-5, an improvement of 35.2% (95% CI 34.5 to 35.9) between NFHS-4 to NFHS-5 (supplemental table 2), and was substantially higher for the more developed states at 68.2 than the less developed states at 40.7 in NFHS-5 (table 1 and supplemental table 3). HOI ranged from 8.3 to 88.9 in the states in NFHS-4, and 11.3 to 92.4 in the states in NFHS-5 (Figure and supplemental table 3). Three and 6 states from the less and more developed states showed a reduction in HOI between NFHS-4 to NFHS-5, respectively (supplemental table 3). The highest gains in HOI were made in the state of Uttarakhand (115.1; 95% CI 109.0 to 121.1) between NFHS-4 to NFHS-5, with the HOI for the state at 55.7 in NFHS-5.

Considering WI (table 1), HOI ranged from 33.8 for WI I to 64.4 for WI V for India, and the corresponding range was 31.1 to 57.0 and 58.6 to 70.5 for less and more developed states in NFHS-5, respectively. The HOI ratio of WI V to average was 1 or more in all states except Sikkim, Tamil Nadu and Kerala. Substantial variations were seen in HOI ratio of WI I to V, ranging from 0.16 to 1.41, with this ratio being <1 in 27 (90.0%) states in NFHS-5, and the lowest HOI ratio between WI I

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3 155 and V was seen in Mizoram at 0.16. Among the 20 states with WI I to state HOI ratio at >0.70, 15
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5 156 states had the W1 I to WI V HOI ratio at <0.70.
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159 **Table 1: Average Human opportunity index (HOI) and by wealth index quintile (WI) and ratio between WI and average HOI, WI V and**
160 **average HOI and between WI I and V for four or more antenatal care visits for India and its states, National Family Health Survey-5.**
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	Four or more ANC visits								
	Average HOI	HOI by WI					HOI Ratio		WI I: WI V
		I	II	III	IV	V	WI I: average	WI V: average	
India	48.4	33.8	44.0	53.1	59.3	64.4	0.70	1.33	0.52
Less developed states	40.7	31.1	38.9	45.4	50.1	57.0	0.76	1.40	0.55
Arunachal Pradesh	34.3	20.2	31.6	37.0	44.2	47.3	0.59	1.38	0.43
Assam	45.6	38.9	46.4	53.3	60.1	61.5	0.85	1.35	0.63
Bihar	22.9	15.6	22.9	30.2	37.4	49.2	0.68	2.15	0.32
Chhattisgarh	57.2	54.3	53.4	60.9	60.5	61.0	0.95	1.07	0.89
Jharkhand	36.0	28.6	38.5	41.9	51.8	56.0	0.79	1.56	0.51
Madhya Pradesh	52.2	44.6	49.3	56.1	59.1	62.3	0.85	1.19	0.72
Manipur	61.2	36.7	64.6	78.7	84.9	91.3	0.60	1.49	0.40
Meghalaya	45.4	36.8	45.8	50.0	61.5	55.5	0.81	1.22	0.66
Mizoram	46.6	11.0	37.8	49.9	61.5	69.9	0.24	1.50	0.16
Nagaland	11.3	5.4	10.1	20.8	26.9	20.0	0.48	1.77	0.27
Odisha	76.2	69.3	78.6	79.1	81.6	82.4	0.91	1.08	0.84
Rajasthan	51.2	45.7	45.9	49.6	52.2	59.0	0.89	1.15	0.77
Sikkim	60.1	66.9	61.1	59.1	61.3	47.6	1.11	0.79	1.41
Tripura	50.4	41.7	52.8	56.6	64.6	51.2	0.83	1.02	0.81
Uttar Pradesh	38.1	30.4	35.0	38.9	41.4	50.9	0.80	1.34	0.60
Uttarakhand	55.7	35.2	44.2	51.8	62.6	69.1	0.63	1.24	0.51
More developed states	68.2	58.6	65.1	67.1	70.1	70.5	0.86	1.03	0.83
Andhra Pradesh	68.3	45.5	64.2	64.8	66.5	69.2	0.67	1.01	0.66
Goa	92.4	100.0	81.2	89.8	92.5	93.5	1.08	1.01	1.07
Gujarat	73.1	63.2	69.1	72.4	75.9	80.5	0.86	1.10	0.79
Haryana	56.6	33.5	44.8	49.7	53.3	64.5	0.59	1.14	0.52
Himachal Pradesh	67.1	52.1	53.4	62.3	74.2	74.8	0.78	1.11	0.70
Jammu and Kashmir	76.3	60.2	75.8	76.7	80.6	79.5	0.79	1.04	0.76

	Four or more ANC visits									
	Average HOI	HOI by WI					HOI Ratio		WI I: WI V	
		I	II	III	IV	V	WI I: average	WI V: average	WI I: WI V	WI I: WI V
Karnataka	65.1	51.8	60.3	65.4	71.2	69.5	0.80	1.07	0.75	0.75
Kerala	77.3	71.3	87.6	76.0	78.6	74.8	0.92	0.97	0.95	0.95
Maharashtra	66.7	49.9	63.3	65.1	71.2	73.8	0.75	1.11	0.68	0.68
Delhi	75.3	26.6	45.1	62.2	68.6	78.8	0.35	1.05	0.34	0.34
Punjab	54.7	31.2	41.6	47.1	50.7	57.6	0.57	1.05	0.54	0.54
Tamil Nadu	89.6	88.3	89.1	89.1	90.3	87.0	0.99	0.97	1.01	1.01
Telangana	68.2	53.5	63.9	64.8	70.0	68.5	0.78	1.00	0.78	0.78
West Bengal	72.2	66.5	72.1	75.0	78.7	78.0	0.92	1.08	0.85	0.85

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

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3 165 ***Institutional delivery with SBA***
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5 166 The coverage of institutional delivery with SBA for India was 85.0% (95% CI 84.9 to 85.2) in NFHS-5.
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7 167 The percent change from NFHS-4 to NFHS-5 was estimated at 12.6% (95% CI 12.2 to 12.9), 14.6%
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9 (95% CI 14.1 to 15.1) and 6.2% (95% CI 5.8 to 6.6) for India, less developed and more developed
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11 states, respectively (supplemental table 2). This coverage ranged from 58.6% in Meghalaya to 96.3%
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13 in Sikkim in less developed states and 84.3% in Himachal Pradesh to 99.8% in Kerala in more
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15 developed states in NFHS-5 (supplemental table 2). The HOI for geographic inequality for
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17 institutional delivery with SBA for India was 80.4, 90.1 and 76.2 for India, more developed and less
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19 developed states in NFHS-5, respectively (table 2 and supplemental table 3). HOI ranged from 26.2
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21 to 99.8 in the states in NFHS-4, and 37.4 to 99.7 in the states in NFHS-5 (Figure and supplemental
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23 table 3). The highest gains in HOI between NHFS-4 and NFHS-5 were made in Arunachal Pradesh
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25 state (64.9%; 95% CI 61.3 to 68.5), with the HOI for the state at 77.5 in NHFS-5 (supplemental table
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32 178 Considering WI (table 2), HOI ranged from 65.1 for WI I to 93.7 for WI V for India, and the
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34 179 corresponding range was 63.6 to 92.0 and 76.5 to 95.1 for less and more developed states in NFHS-
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36 180 5, respectively. The WI V to average HOI ratio was 1 or more in all the states except Sikkim. The HOI
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38 181 ratio of WI I to WI V was <1 in 28 (93.3 %) states and was <0.60 in 6 (20.0 %) states in NFHS-5.
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40 182 Among the 26 states with W1 1 to state HOI ratio being >0.70, 6 states had the W1 I to WI V HOI
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42 183 ratio at <0.70.
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Table 2: Human opportunity index (HOI) by wealth index quartile (WI) and ratio between WI I and average HOI, WI V and average HOI and between WI I and V for institutional delivery with skilled birth attendant (SBA) for India and its states National Family Health Survey-5.

	Average HOI	Institutional delivery with SBA						
		HOI by WI					HOI Ratio	
		I	II	III	IV	V	WI I: average	WI V: average
India	80.4	65.1	78.8	86.0	90.2	93.7	0.81	1.17
Less developed states	76.2	63.6	76.6	83.5	87.8	92.0	0.83	1.21
Arunachal Pradesh	77.5	56.0	77.6	86.7	92.0	96.0	0.72	1.24
Assam	82.3	72.1	87.0	91.7	94.8	95.5	0.88	1.16
Bihar	72.1	63.9	76.6	81.2	82.9	88.7	0.89	1.23
Chhattisgarh	78.5	68.0	80.1	85.9	90.3	94.3	0.87	1.20
Jharkhand	70.4	60.7	77.1	83.8	91.3	94.7	0.86	1.35
Madhya Pradesh	84.1	75.4	84.8	90.0	91.7	90.3	0.90	1.07
Manipur	62.0	37.7	65.1	78.7	88.2	93.7	0.61	1.51
Meghalaya	52.5	38.8	57.6	72.6	82.5	82.2	0.74	1.57
Mizoram	72.4	26.4	59.1	80.5	92.8	95.8	0.36	1.32
Nagaland	37.4	26.2	37.9	57.1	64.7	74.9	0.70	2.00
Odisha	87.3	77.6	91.6	93.9	95.5	95.6	0.89	1.10
Rajasthan	93.9	89.2	91.8	94.1	94.8	97.1	0.95	1.03
Sikkim	95.2	88.5	94.5	94.8	97.3	94.2	0.93	0.99
Tripura	83.5	71.8	88.8	91.9	94.0	90.6	0.86	1.09
Uttar Pradesh	78.0	68.3	76.4	79.4	82.8	90.1	0.88	1.16
Uttarakhand	78.5	62.1	62.7	75.0	85.7	91.9	0.79	1.17
More developed states	90.1	76.5	85.8	90.1	92.6	95.1	0.85	1.06
Andhra Pradesh	95.4	73.9	93.0	94.2	95.9	98.7	0.77	1.03
Goa	98.5	100.0	90.6	100.0	98.5	98.7	1.02	1.00
Gujarat	87.5	75.3	85.9	88.8	92.1	91.1	0.86	1.04
Haryana	90.5	64.7	77.0	86.8	91.1	96.0	0.71	1.06

		Institutional delivery with SBA							
	Average HOI	HOI by WI				V	HOI Ratio		WI I: WI V
		I	II	III	IV		WI I: average	WI V: average	
Himachal Pradesh	82.5	54.1	68.1	80.8	86.5	90.6	0.66	1.10	60
Jammu and Kashmir	87.9	71.5	82.7	88.6	94.7	96.6	0.81	1.10	74
Karnataka	90.3	83.8	85.6	90.6	93.8	93.2	0.93	1.03	90
Kerala	99.7	100.0	100.0	99.5	99.8	99.6	1.00	1.00	100
Maharashtra	88.2	69.5	85.4	89.0	92.3	95.0	0.79	1.08	73
Delhi	90.2	21.9	68.7	82.7	83.0	91.6	0.24	1.02	24
Punjab	92.9	79.4	80.7	96.5	90.5	94.6	0.85	1.02	84
Tamil Nadu	99.2	95.6	97.9	99.2	99.5	100.0	0.96	1.01	96
Telangana	90.4	75.5	88.9	90.0	90.4	91.4	0.84	1.01	83
West Bengal	89.2	83.7	90.6	93.8	94.6	93.1	0.94	1.04	90

Ratio of HOI	
	Less than 0.50
	0.51-0.80
	0.90-1.00
	1.10-1.40
	1.50 or more

191 ***PNC within 48 hours of delivery***

192 The coverage of PNC within 48 hours of delivery was 78.9% (95% CI 78.7-79.1), 75.1% (95% CI 74.8-
 193 75.3), and 86.0% (95% CI 85.7-86.3) in India, more developed and less developed states in NFHS-5,
 194 respectively, (supplemental table 2). This coverage ranged from 43.2% in Nagaland to 92.1% in
 195 Odisha in the less developed states and 68.2% in West Bengal to 96.3% in Goa in the more
 196 developed states in NFHS-5 (supplemental table 2). The HOI for geographic inequality in PNC within
 197 48 hours of delivery for India was 73.5 in NFHS-5, which improved by 34.6% (95% CI 34.2 to 35.1)
 198 between NFHS-4 to NFHS-5. The HOI was substantially higher for the more developed states 82.6
 199 than the less developed states 69.4 in NFHS-5 (table 3 and supplemental table 3). HOI ranged from
 200 17.2 to 90.5 in the states in NFHS-4, and 37.5 to 95.6 in the states in NFHS-5 (Figure and
 201 supplemental table 3). The highest gains in HOI were made in Arunachal Pradesh (128.6%; 95% CI
 202 122.1 to 135.2) and Nagaland (118.0%; 95% CI 108.5 to 127.5), with the HOI for the states at 51.9
 203 and 37.5 in NFHS-5, respectively (supplemental table 3).

204 Considering WI (Table 3), HOI ranged from 62.0 for WI I to 85.0 for WI V in India, and the
 205 corresponding range was from 61.2 to 83.0 and 67.4 to 88.3 for less and more developed states in
 206 NFHS-5, respectively. The HOI ratio of WI V to state was 1 or more in all the states, except for Sikkim
 207 and Tamil Nadu. The HOI ratio of WI I to WI V was <1 in 28 (93.3%) states and was <0.60 in 4 (13.3%)
 208 states in NFHS-5. Among the 27 states with WI I to state HOI ratio at >0.70, 2 states had the WI I to
 209 WI V HOI ratio at <0.70.

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211 **Table 3: Human opportunity index (HOI) by wealth index quartile (WI) and ratio between WI I and average HOI, WI V and average HOI and**
212 **between WI I and V for post-natal care in 48 hours of delivery for India and its states, National Family Health Survey-5**
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	PNC with 48 hours of delivery								
	Average HOI	HOI by WI					HOI Ratio		
		I	II	III	IV	V	WI I: average	WI V: average	WI I: WI V
India	73.5	62.0	70.7	77.1	81.3	85.0	0.84	1.16	0.73
Less developed states	69.4	61.2	68.7	73.6	77.4	83.0	0.88	1.20	0.74
Arunachal Pradesh	51.9	41.5	52.6	53.2	53.6	59.6	0.80	1.15	0.70
Assam	64.7	56.8	67.4	72.7	74.4	72.0	0.88	1.11	0.79
Bihar	59.6	54.0	61.8	65.8	69.0	75.8	0.91	1.27	0.71
Chhattisgarh	85.3	81.8	85.5	85.2	89.4	87.8	0.96	1.03	0.93
Jharkhand	70.9	65.8	74.6	74.5	81.4	81.4	0.93	1.15	0.81
Madhya Pradesh	82.8	78.7	81.5	84.4	85.7	86.7	0.95	1.05	0.91
Manipur	57.7	38.1	59.2	72.7	78.1	79.0	0.66	1.37	0.48
Meghalaya	53.4	49.3	55.6	59.3	54.9	56.3	0.92	1.05	0.88
Mizoram	63.9	28.2	55.0	72.2	72.1	77.3	0.44	1.21	0.36
Nagaland	37.5	27.2	38.8	55.2	59.8	57.5	0.73	1.53	0.47
Odisha	90.7	87.6	90.7	92.9	92.9	92.9	0.97	1.02	0.94
Rajasthan	82.6	78.2	80.8	82.3	83.4	85.2	0.95	1.03	0.92
Sikkim	70.4	66.9	69.3	71.4	70.6	57.4	0.95	0.82	1.17
Tripura	64.2	56.4	63.0	72.9	79.1	82.8	0.88	1.29	0.68
Uttar Pradesh	73.2	66.0	72.6	73.6	77.3	82.8	0.90	1.13	0.80
Uttarakhand	81.5	71.1	73.6	80.9	85.4	87.3	0.87	1.07	0.81
More developed states	82.6	67.4	77.2	83.0	85.3	88.3	0.82	1.07	0.76
Andhra Pradesh	90.4	67.6	87.2	91.1	90.3	92.1	0.75	1.02	0.73
Goa	95.6	100.0	90.6	89.8	96.6	98.7	1.05	1.03	1.01
Gujarat	87.1	85.7	85.4	85.8	86.3	89.3	0.98	1.03	0.96
Haryana	88.7	64.2	76.7	88.7	88.7	92.2	0.72	1.04	0.70
Himachal Pradesh	87.3	71.3	78.7	88.3	88.3	92.1	0.82	1.05	0.77
Jammu and Kashmir	77.2	64.7	72.9	78.1	80.3	82.5	0.84	1.07	0.78

	PNC with 48 hours of delivery								
	Average HOI	HOI by WI					HOI Ratio		
		I	II	III	IV	V	WI I: average	WI V: average	WI I: WI V
Karnataka	83.6	76.3	80.7	84.7	85.5	83.8	0.91	1.00	0.91
Kerala	91.5	81.6	83.9	88.3	92.1	91.7	0.89	1.00	0.89
Maharashtra	80.8	66.9	78.3	80.7	83.3	86.0	0.83	1.06	0.78
Delhi	85.1	31.2	59.7	76.4	80.3	87.2	0.37	1.02	0.36
Punjab	85.4	69.4	75.0	96.6	83.1	86.6	0.81	1.01	0.80
Tamil Nadu	90.4	84.0	90.4	90.3	90.1	89.4	0.93	0.99	0.94
Telangana	85.4	78.1	83.1	83.5	84.4	88.2	0.91	1.03	0.89
West Bengal	63.8	56.2	62.0	67.6	76.4	80.4	0.88	1.26	0.70

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

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217 **Continuum of care (CoC)**

218 The coverage of CoC was 45.6% (95% CI 45.4-45.9), 36.5% (95% CI 36.3-36.8), and 62.5% (95% CI
219 62.2-62.9) in India, less developed and more developed states in NFHS-5, respectively (supplemental
220 table 2). The coverage ranged from 9.4% in Nagaland to 69.4% in Odisha in the less developed
221 states, and 50.2% in Punjab to 90.1% in Goa in the more developed states in NFHS-5 (supplemental
222 table 2). The HOI for geographic inequality in CoC for India was 37.1, which improved by 52.2% (95%
223 CI 51.1 to 53.0) between NFHS-4 to NFHS-5. The HOI was substantially higher for the more
224 developed states at 56.3 than the less developed states at 29.7 in NFHS-5 (table 4 and supplemental
225 table 3). HOI ranged from 4.4 to 79.0 in the states in NFHS-4, and 6.5 to 88.8 in the states in NFHS-5
226 (Figure and supplemental table 3). The highest gains in HOI were made in Arunachal Pradesh
227 (167.1%; 95% CI 154.4 to 179.8) and Uttarakhand (147.4%; 95% CI 139.3 to 155.5), with the HOI for
228 the states at 21.9 and 43.3 in NFHS-5, respectively (supplemental table 3).

229 Considering WI (Table 4), HOI ranged from 21.7 for WI I to 56.5 for WI V for India, and the
230 corresponding range was 19.8 to 48.8 and 39.3 to 62.7 for less and more developed states in NFHS-
231 5, respectively. The HOI ratio of WI V to state was 1 or more in 27 states. The HOI ratio of WI I to WI
232 V was <1 in 28 (93.3%) states and was <0.60 in 18 (60.0%) states in NFHS-5. Among the 12 states
233 with WI I to state HOI ratio at >0.70, 3 states the WI I to WI V HOI ratio at <0.70.

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Table 4: Human opportunity index (HOI) by wealth index quartile (WI) and ratio between WI I and average HOI, WI V and average HOI and between WI I and V for continuum of care based on the maternal services for India and its states, National Family Health Survey-5.

	Average HOI	HOI by WI					HOI Ratio		
		I	II	III	IV	V	WI I: average	WI V: average	WI I: WI V
India	37.1	21.7	32.3	41.9	49.2	56.5	0.58	1.52	0.38
Less developed states	29.7	19.8	27.9	34.5	40.2	48.8	0.67	1.64	0.41
Arunachal Pradesh	21.9	12.4	20.9	22.8	26.0	32.8	0.57	1.50	0.38
Assam	31.0	22.9	32.1	40.3	49.0	44.3	0.74	1.43	0.52
Bihar	15.3	9.5	15.1	21.0	28.4	38.6	0.62	2.52	0.25
Chhattisgarh	43.3	37.3	39.2	47.9	50.7	53.4	0.86	1.23	0.70
Jharkhand	24.1	16.7	27.8	31.6	41.5	45.9	0.69	1.90	0.36
Madhya Pradesh	41.2	31.7	39.0	46.5	50.7	53.2	0.77	1.29	0.60
Manipur	41.5	19.8	41.3	60.2	68.0	67.1	0.48	1.62	0.30
Meghalaya	20.5	14.1	21.7	27.6	34.7	28.1	0.69	1.37	0.50
Mizoram	36.6	6.7	27.6	40.4	49.5	57.3	0.18	1.57	0.12
Nagaland	6.5	2.2	5.9	12.2	17.4	35.6	0.34	5.48	0.06
Odisha	64.8	53.2	68.2	71.9	75.1	77.3	0.82	1.19	0.69
Rajasthan	44.2	38.0	39.8	42.3	45.2	52.0	0.86	1.18	0.73
Sikkim	48.3	47.6	49.0	45.6	50.3	37.6	0.99	0.78	1.27
Tripura	35.3	19.5	37.4	39.8	56.2	51.2	0.55	1.45	0.38
Uttar Pradesh	27.9	19.2	24.9	28.5	31.7	43.7	0.69	1.57	0.44
Uttarakhand	43.3	24.5	28.2	38.5	51.2	59.2	0.57	1.37	0.41
More developed states	56.3	39.3	50.0	55.5	59.8	62.7	0.70	1.11	0.63
Andhra Pradesh	59.3	32.4	53.6	59.6	60.5	64.9	0.55	1.09	0.50
Goa	88.8	100.0	71.9	86.4	87.2	91.6	1.13	1.03	1.09
Gujarat	61.2	49.8	56.9	60.0	64.0	69.9	0.81	1.14	0.71
Haryana	51.2	23.3	35.5	45.0	47.2	60.3	0.46	1.18	0.39
Himachal Pradesh	54.3	31.8	39.5	51.0	59.7	65.1	0.59	1.20	0.49
Jammu and Kashmir	59.5	40.2	53.9	62.3	66.1	66.0	0.68	1.11	0.61
Karnataka	52.6	36.3	47.1	53.9	59.9	56.4	0.69	1.07	0.64

	Average HOI	HOI by WI					HOI Ratio		
		I	II	III	IV	V	WI I: average	WI V: average	WI I: WI V
Kerala	72.9	68.0	69.1	70.1	74.5	71.6	0.93	0.98	0.95
Maharashtra	54.5	33.5	49.9	51.8	60.3	65.9	0.61	1.21	0.51
Delhi	65.3	1.6	28.0	47.9	55.4	68.8	0.02	1.05	0.02
Punjab	46.9	28.7	31.5	95.8	41.8	50.1	0.61	1.07	0.57
Tamil Nadu	82.0	75.6	81.9	81.7	82.6	79.1	0.92	0.96	0.96
Telangana	54.9	35.9	51.0	52.2	56.2	57.0	0.65	1.04	0.63
West Bengal	47.3	37.7	45.6	52.3	61.3	65.6	0.80	1.39	0.57

Ratio of HOI	
	Less than 0.50
	0.51-0.99
	0.90-1.09
	1.10-1.49
	1.50 or more

239 Discussion

240 This analysis of coverage of maternal health services for livebirths over a decade between NFHS-4
241 and NFHS-5 has highlighted significant improvements in the geographic inequity for coverage of
242 these services at the state-level in India, and has identified the inequities that remain to be
243 addressed to achieve the ENAP 2025 coverage targets for these services. The geographic inequity
244 for the coverage of 4+ANC visits lags significantly behind that of institutional delivery with SBA and
245 PNC within 48 hours of delivery, contributing to the CoC inequity in NFHS-5. The HOI ratio for CoC at
246 0.38 highlights the extent of inequity between the women belonging to the lowest and the highest
247 wealth index quintiles in India.

248 A policy aiming at equitable access would require progress towards two objectives: first,
249 expanding the coverage by ensuring that as many women as possible get the opportunity; and
250 second, by allocating new opportunities first to the vulnerable population who are at a disadvantage
251 due to their circumstances.(29) We utilised HOI,(25) as a tool to measure the distribution of
252 opportunities and equitable access to maternal health services. The HOI not only carries information
253 about the coverage rate of the service but also how fairly the available services are distributed
254 among women of different backgrounds, in this case of different wealth index quintiles.(30) In
255 terms of expanding coverage to ensure that as many women as possible get the opportunity, the
256 coverage of 4+ ANC visits was for 4 of 7 women, and that for institutional delivery with SBA was 6
257 out of 7 women, and for PNC within 48 hours of delivery was 4 out of 5 women in NFHS-5. The
258 differential increase over the decade between the coverages of these three maternal health services
259 can possibly be explained by how the national programs to reduce maternal and neonatal mortality
260 were implemented during this period. The program to address ANC services was launched in 2016
261 after NFHS-4, and is aimed to guarantee a minimum package of ANC services to women in their
262 2nd/3rd trimesters of pregnancy at designated government health facilities.(31) There is no
263 monetary incentive either to the health worker or to the pregnant women under this program. The
264 likely impact of this program on HOI for 4+ ANC visits coverage will be documented in the next round

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3 265 of NFHS (round 6). However, given the extent of low coverage of 4+ ANC visits in most of the less
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5 266 developed states and some of the more developed states, major inputs are needed to address the
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7 267 barriers for improved ANC utilisation to achieve the ENAP 2025 target for 4+ ANC visits.(32-34) The
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9 268 increased coverage for institutional deliveries with SBA between the two surveys resulted in nearly
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11 269 doubling of HOI over this period, and near universality of this service in the more developed states.
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13 270 Two programs – the *Janani Suraksha Yojana* (JSY) and the *Janani Shishu Suraksha Karyakaram* (JSSK)
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15 271 - initiated to increase the coverage of institutional deliveries in India have contributed to the
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17 272 exponential increase in access to institutional delivery.(35, 36) The JSY was initiated in 2005 and was
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19 273 a large-scale national program that offered conditional cash transfer and support services to poor
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21 274 pregnant women to use institutional delivery care facilities, especially in the states with lower
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23 275 coverage.(35) The JSSK, initiated in 2011, provided free and cashless delivery along with some other
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25 276 benefits to pregnant women to eliminate out-of-pocket expenses in order to increase the
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27 277 institutional deliveries.(37) The PNC coverage was estimated at 61% HOI at 73.5 for India in NFHS-5
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29 278 with a wide variation at the state-level. The increased PNC coverage also resulted in 34.6% increase
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31 279 in HOI for PNC coverage between NFHS-4 and NFHS-5. According to the Indian PNC guidelines,(38)
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33 280 the health workers are paid INR 250 (USD 3.5) for PNC visits, and are expected to undertake 6-7 PNC
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35 281 visits at home from 1st to 42nd day of delivery for counselling the mother on various issues and
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37 282 enabling referral if needed. Considering all the three maternal health services together, the CoC
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39 283 coverage remained at 62.5% in NFHS-5 with only 19.5% change between the two surveys even in the
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41 284 more developed states. Only 45% CoC coverage in NFHS-5 for India translates into 5 out of every 11
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43 285 woman and newborn not having received all the three MNCH services, which is the basic premise of
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45 286 the ENAP and INAP to address neonatal and maternal mortality.(19, 21)
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48 287 With regards to the policy objective of allocating new opportunities to the vulnerable
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50 288 population who are at a disadvantage due to their circumstances, socio-economic inequities in
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52 289 maternal health services in India have been reported previously(16, 39-45) but the use of HOI to
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54 290 measure inequity has not been attempted. For all the maternal health services, the women
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belonging to the lowest WI quintile had low HOI compared to those in the highest WI quintile, and the difference was starker for ANC services and in the less developed states. Though the within-district inequalities in intervention coverages are reducing in most states, the pace of reduction has not been the same for every woman. The state of Delhi with the national capital had the one of the least HOI ratio for the women belonging to the lowest WI quintile. The extent of HOI ratio for the lowest to the highest WI quintile and that to average HOI between the maternal health services within states highlights the specificity needed in targeting women with the respective interventions to achieve 2025 coverage targets. One of the challenges in achieving equity in maternal health services in India is the dependence on NFHS for retrospective situational analysis rather than for monitoring and evaluation, because the routine health information management system (HMIS) does not allow for tracking of CoC for maternal health services per woman.(46) Real time tracking of women for utilisation of these services at the district-level is needed to reduce inequity in the coverage of these services. India has a Mother and Child Tracking System (MCTS) in place since 2009 to follow a mother-child dyad through the CoC, but it is known to be fraught with several issues.(47-49) Clearly, it is important that strategies to improve the MCTS, within digital health, are looked into urgently if India were to reach every woman and newborn to achieve the SDG targets of reduced maternal and neonatal mortality at the district-level.(50-52) High quality timely data for evidence-informed decision making to reduce inequity at the district level can also be obtained through continuous surveys.(53) Furthermore, incentivisation of services is currently only for institutional delivery and for PNC services. With poor coverage of ANC services resulting in poor coverage of CoC, it may be worth considering incentivising the CoC rather than individual maternal health services to address inequity.

It is important to note that we considered only the inequity in coverage and not in the quality of contact with the health system during service utilisation in this analysis. There is a growing literature documenting increased coverage but poor quality of contact for these services,(4) including from India from pregnancy to delivery,(4, 49, 54-64) and also of poor quality of health care

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317 being a major driver of excess mortality across conditions, including neonatal mortality.(65-68)

318 Health system redesign has been suggested for equity in maternal and new born health, by moving

319 all childbirth care services to hospitals in all countries, combined with improvements in the quality of

320 care provided in these facilities, transportation from home to hospital, and continuity of care

321 through hub-and-spoke arrangements.(69) While commenting on the scope of health system re-

322 design is beyond the scope of the analysis undertaken for this paper, more discussion is needed and

323 more options need to be rigorously tried and tested to develop sustainable district health systems

324 which are fit for purpose and respond to continuity of care needs of women and their babies.(70)

325

326 **CONCLUSION**

327 In conclusion, the findings of this assessment are encouraging but also emphasise the need for

328 improved targeting of women to reduce the remaining inequity gap. It will be important for the

329 national program to monitor the CoC coverage in real time in addition to the three maternal health

330 services individually to monitor and track inequity at the level of every woman.

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332 **Ethics approval**

333 No ethics approval was required for this analysis as we utilised the de-identified data available in
334 public domain.

336 **Authors' contributions**

337 RD and GAK conceptualized the study; GAK and MM had full access to data in the study and
338 performed data analysis; RD and GAK take full responsibility for the integrity of data and accuracy of
339 the data analysis, and had final responsibility for the decision to submit for publication; RD drafted
340 the manuscript; all authors contributed to the interpretation and approved of the final version of the
341 manuscript.

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346 **Declaration of interests**

347 The authors have no conflict of interest.

349 **Data availability statement sharing**

350 All data generated or analysed during this study are included in this published article and its
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355

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554 **FIGURE LEGEND**

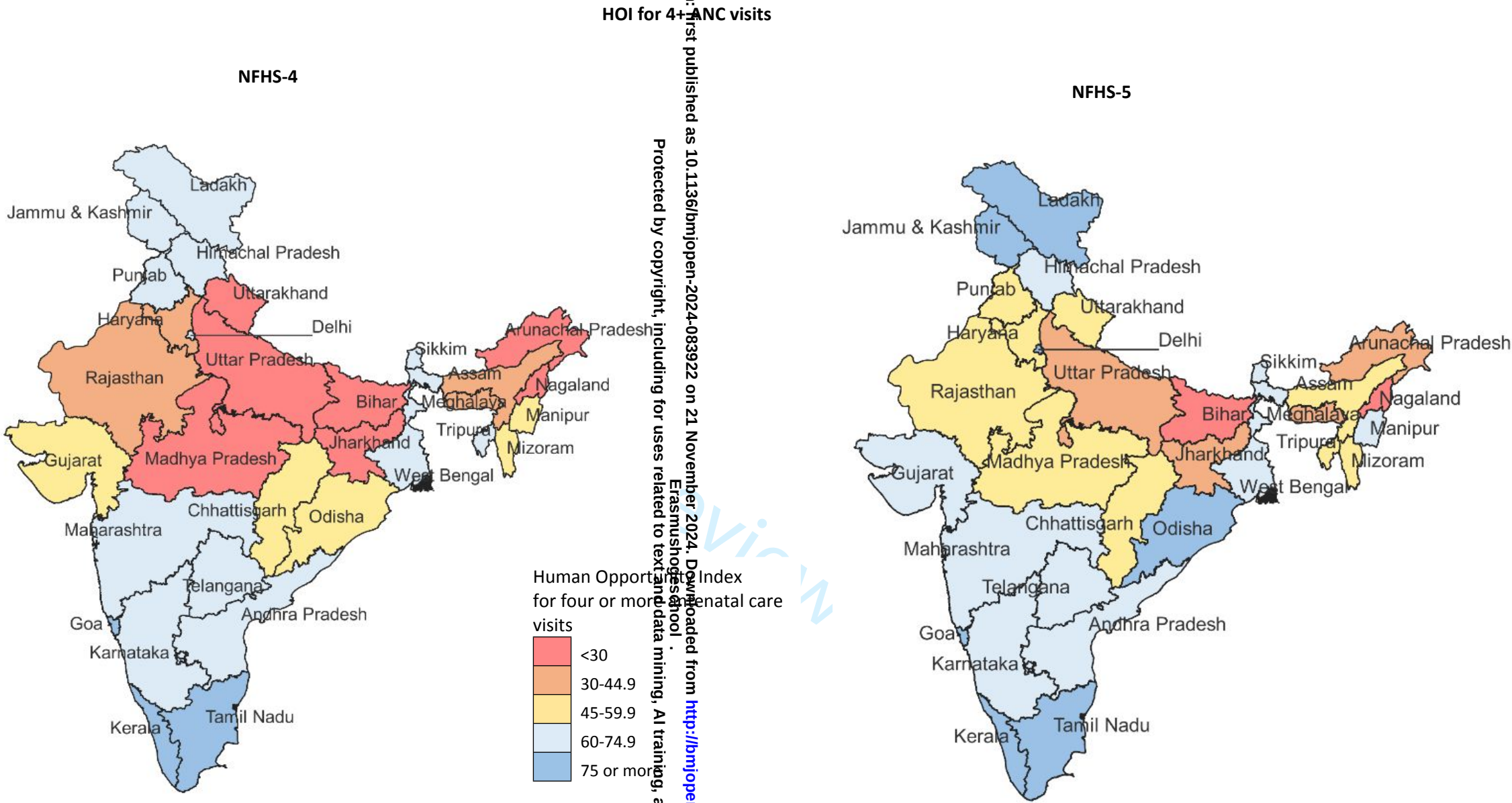
555 **Figure.** Human Opportunity Index (HOI) for 4+ antenatal care visits, institutional delivery with skilled
556 birth attendant, post-natal care within 48 hours of delivery, and continuum of care in NFHS-4 in
557 2015-16 and NFHS-5 in 2019-2021 for each state of India.

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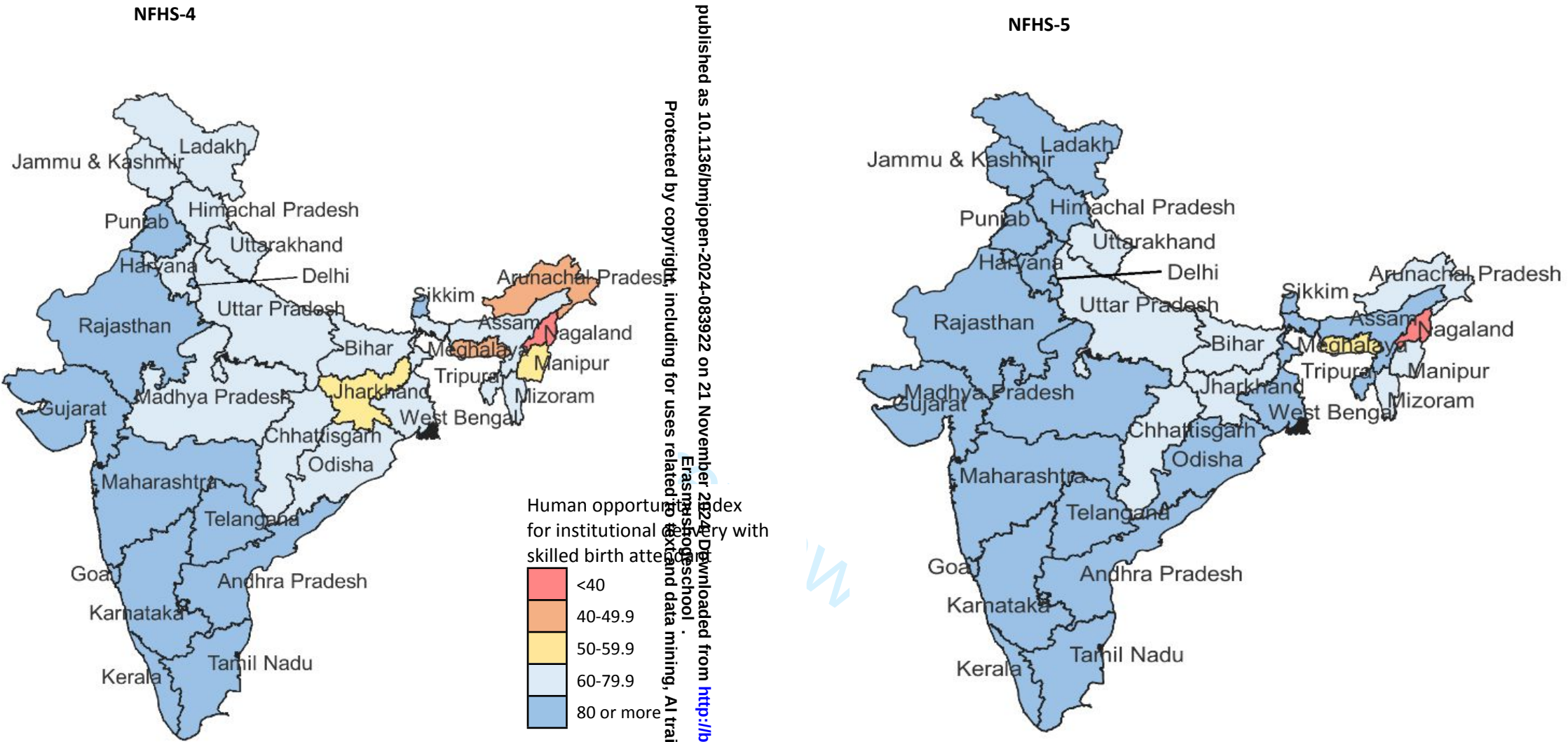
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Figure. Human Opportunity Index (HOI) 4+ ANC visits, institutional delivery with skilled birth attendant (SBA), post-natal care within 48 hours of delivery, and continuum of care in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.



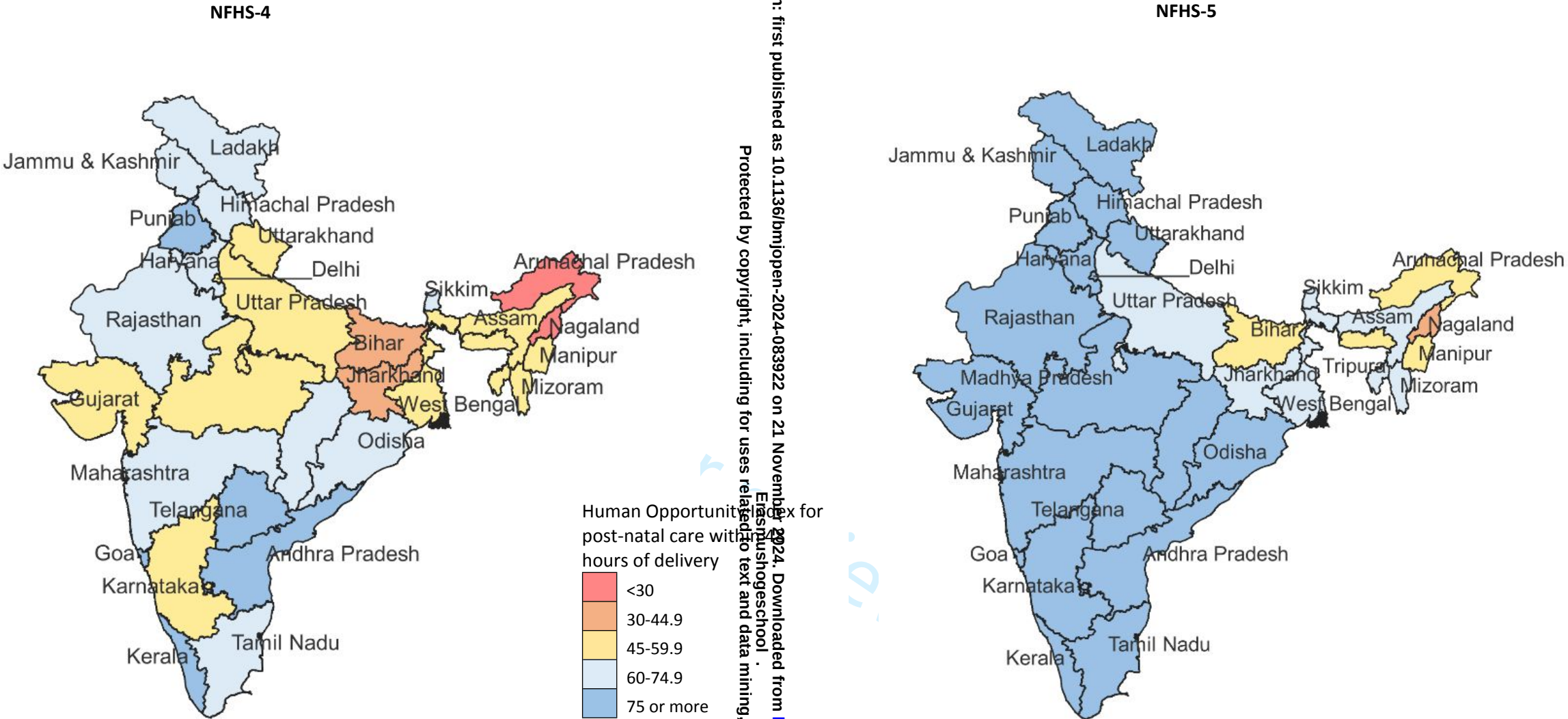
HOI for institutional delivery with SBA



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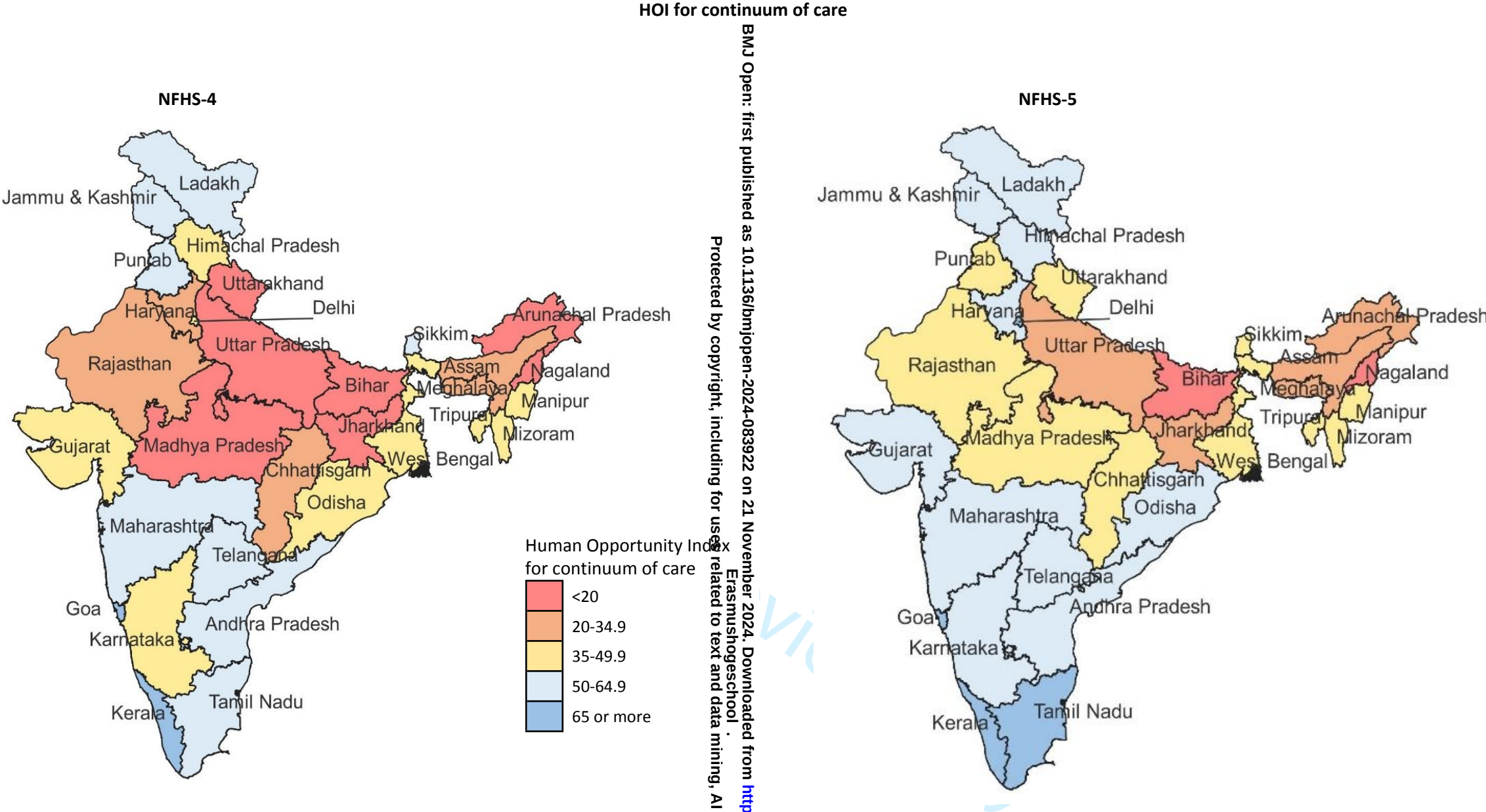
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HOI for post-natal care within 48 hours of delivery



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Trends over a decade in geographical inequality of opportunity in access to maternal care services from the National Family Health Surveys in India

Supplementary file

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Supplementary Table 1. Number of districts by state in the National Family Health Survey (NFHS) rounds 4 and 5.

	Number of districts	
	NFHS-4	NFHS-5
India	628	695
Less developed	363	395
Arunachal Pradesh	16	20
Assam	27	33
Bihar	38	38
Chhattisgarh	18	27
Jharkhand	24	24
Madhya Pradesh	50	51
Manipur	9	9
Meghalaya	7	11
Mizoram	8	8
Nagaland	11	11
Odisha	30	30
Rajasthan	33	33
Sikkim	4	4
Tripura	4	8
Uttar Pradesh	71	75
Uttarakhand	13	13
More developed	265	300
Andhra Pradesh	13	13
Delhi	9	11
Goa	2	2
Gujarat	26	33
Haryana	21	22
Himachal Pradesh	12	12
Jammu & Kashmir ⁵	22	22
Karnataka	30	30
Kerala	14	14
Maharashtra	35	36
Punjab	20	22
Tamil Nadu	32	32
Telangana	10	31
West Bengal	19	20

Supplementary Table 2. Coverage of four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), and post-natal care within 48 hours of delivery, and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) 4 and NFHS 5 for India and its states. CI denotes confidence interval.

State	Four of more ANC visits			Institutional delivery with SBA*			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4 N=188,506 % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [†] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [†] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [†] % of N	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)
India	46.4 (46.2-46.7)	57.0 (56.8-57.3)	22.8 (22.1-23.5)	75.5 (75.3-75.7)	85.0 (84.9-85.2)	12.6 (12.2-12.9)	61.4 (61.2 - 61.6)	78.9 (78.7-79.1)	28.5 (28.0-29.0)	32.9 (32.7-33.1)	45.6 (45.4-45.9)	38.6 (37.6-39.6)
Less developed	36.0 (35.7-36.3)	48.0 (47.7-48.3)	33.3 (32.3-34.3)	70.6 (70.3-70.8)	80.9 (80.7-81.2)	14.6 (14.1-15.1)	57.0 (56.7-57.2)	75.1 (74.8-75.3)	31.8 (31.1-32.4)	24.8 (24.6- 25.1)	36.5 (36.3-36.8)	47.2 (45.7-48.6)
Arunachal Pradesh	24.6 (23.3- 26.0)	37.2 (35.8-38.6)	51.2 (45.1-57.4)	52.7 (51.1-54.2)	80.6 (79.4-81.7)	52.9 (49.8-56.1)	27.5 (26.1-28.9)	55.4 (53.9-56.8)	101.5 (95.7-107.2)	11.8 (10.8- 12.8)	25.3 (24.1-26.6)	114.7(104.4-124.4)
Assam	45.4 (44.3- 46.4)	50.9 (49.8-51.9)	12.1 (9.5-14.7)	72.5 (71.5-73.4)	84.8 (84.1-85.5)	16.7 (15.6-18.4)	56.9 (55.8-57.9)	67.8 (66.8-68.7)	19.1 (17.1-21.2)	29.9 (20.9-30.9)	35.5 (34.5-36.5)	18.7 (15.1-22.4)
Bihar	14.6 (14.1 -15.2)	25.5 (24.7-26.2)	74.7 (70.0-79.3)	66.0 (65.3-66.7)	75.1 (74.4-75.8)	11.3 (10.5-15.0)	47.8 (47.1-48.6)	65.4 (64.6-66.2)	36.8 (35.0-38.7)	9.0 (8.6- 9.4)	17.8 (17.2-18.4)	97.8 (91.5-104.1)
Chhattisgarh	56.9 (55.7 - 58.0)	61.2 (60.0-62.4)	7.6 (5.3-9.9)	71.8 (70.7-72.8)	82.1 (81.2-83.0)	14.3 (13.6-16.0)	67.2 (66.0-68.3)	87.2 (86.3-87.9)	29.8 (28.0-31.5)	37.6 (36.4-38.7)	47.3 (46.1-48.5)	25.8 (22.4-29.2)
Jharkhand	29.9 (29.0 - 30.9)	38.6 (37.5-39.7)	29.1 (25.4-32.8)	63.8 (62.8-64.8)	74.5 (73.5-75.5)	16.8 (15.0-18.5)	46.8 (45.8-47.8)	74.0 (73.0-75.0)	58.1 (55.6-60.6)	17.0 (16.2-17.8)	27.0 (26.0-28.0)	58.8 (53.3-64.4)
Madhya Pradesh	34.9 (34.1-35.6)	57.0 (56.1-57.9)	63.3 (60.9-65.7)	75.9 (75.2-76.5)	86.6 (86.0-87.2)	14.1 (13.2-15.0)	55.9 (55.1-56.6)	85.1 (84.4-85.7)	52.2 (50.8-53.7)	23.1 (22.4 -23.7)	46.1 (45.2-47.0)	99.6 (96.2-102.9)
Manipur	65.1 (63.7-66.5)	68.7 (66.8-70.4)	5.5 (2.9-8.2)	67.9 (66.5-69.3)	70.9 (69.1-72.6)	4.4 (1.9-6.9)	62.8 (61.4-64.2)	64.9 (62.9-66.7)	3.3 (0.5-6.2)	49.2 (47.7 -50.7)	50.9 (48.9-52.8)	3.5 (-0.3-7.2)
Meghalaya	50.1 (48.4-51.9)	50.3 (48.8-51.7)	0.4 (-3.5-4.3)	56.0 (54.3-57.8)	58.6 (57.2-60.0)	4.5 (1.2-8.1)	58.0 (56.3-59.8)	58.3 (56.8-59.7)	0.5 (-2.8-3.8)	32.1 (30.4 -33.7)	23.9 (22.7-25.1)	-25.5 (-31.1 to -20.0)
Mizoram	56.4 (54.8-58.0)	52.4 (50.2-54.7)	-7.1 (-10.6 to -3.6)	78.1 (76.7-79.4)	79.3 (77.4-81.0)	1.1 (-0.5- 3.6)	62.8 (61.2-64.3)	68.1 (65.9-70.1)	8.4 (5.4-11.5)	41.5 (39.9 -43.1)	42.1 (39.9-44.4)	1.4 (-3.3-6.2)
Nagaland	13.5 (12.3-14.7)	15.6 (14.1-17.2)	15.6 (5.2-25.9)	33.8 (32.2-35.5)	42.5 (40.5-44.6)	15.7 (10.0-31.4)	22.6 (21.2-24.1)	43.2 (41.2-45.3)	91.2 (83.3-99.0)	7.6 (6.7- 8.6)	9.4 (8.3-10.7)	23.7 (9.3-38.1)
Odisha	64.7 (63.7-65.7)	80.0 (79.1-80.9)	23.6 (22.0-25.3)	83.3 (82.5-84.0)	90.1 (89.4-90.7)	8.8 (7.1-9.2)	77.4 (76.5-78.3)	92.1 (91.5-92.7)	19.0 (17.8-20.2)	47.8 (46.8 -48.8)	69.4 (68.4-70.5)	45.2 (42.8-47.6)
Rajasthan	38.3 (37.5-39.2)	56.5 (55.6-57.5)	47.5 (44.9-50.1)	85.0 (84.4-85.6)	95.0 (94.5-95.4)	11.8 (11.0-12.6)	65.2 (64.3-66.0)	85.2 (84.5-85.9)	30.7 (28.3-32.1)	29.1 (28.2 -29.9)	49.4 (48.5-50.4)	69.8 (66.5-73.0)
Sikkim	74.9 (71.9-77.6)	65.4 (61.4-69.2)	-12.7 (-17.0 to -8.3)	95.2 (93.6-96.4)	96.3 (94.4-97.5)	1.1 (-0.5-2.8)	75.0 (72.0-77.7)	73.5 (69.7-76.9)	-2.1 (-6.3-2.3)	56.0 (52.7-59.2)	52.0 (47.9-56.1)	-7.1 (-13.7 to -0.6)
Tripura	63.5 (60.7-66.2)	54.0 (51.7-56.2)	-15.0 (-19.7 to -10.3)	80.3 (77.9-82.5)	86.8 (85.2-88.3)	8.8 (5.1-11.1)	61.2 (58.4-64.0)	68.6 (66.4-70.7)	12.1 (7.2-17.0)	45.9 (43.0 -48.7)	39.7 (37.5-42.0)	-13.5 (-20.2 to -6.8)
Uttar Pradesh	27.4 (26.9-27.9)	41.5 (40.9-42.1)	51.5 (49.3-53.7)	68.1 (67.5-68.6)	81.1 (80.6-81.5)	19.1 (18.2-20.0)	59.1 (58.6 - 59.7)	76.9 (76.4-77.4)	30.1 (29.1-31.2)	20.0 (19.5 -20.4)	31.1 (30.5-31.7)	55.5 (52.8-58.2)
Uttarakhand	29.7 (28.3-31.1)	60.6 (58.8-62.3)	104.0 (98.7-109.4)	67.9 (66.5-69.2)	80.1 (78.6-81.5)	18.0 (15.7-20.3)	56.9 (55.4-58.4)	84.2 (82.8-85.4)	48.0 (45.2-50.8)	20.5 (19.3 -21.7)	47.7 (45.9-49.5)	132.7 (125.5-139.9)
More developed	71.3 (70.9-71.7)	73.7 (73.4-74.1)	3.4 (2.6-4.1)	87.2 (86.9-87.5)	92.6 (92.4-92.8)	5.8 (5.8-6.6)	71.9 (71.5-72.3)	86.0 (85.7-86.3)	19.6 (19.0-20.3)	52.3 (51.9- 52.7)	62.5 (62.2-62.9)	19.5 (18.4-20.6)
Andhra Pradesh	75.7 (73.9 - 77.4)	69.3 (67.2-71.2)	-8.5 (-11.0 to -5.9)	89.5 (88.2-90.7)	95.7 (94.8-96.5)	6.6 (5.5-8.4)	79.3 (77.6 – 80.9)	90.8 (89.5-91.9)	14.5 (12.3-16.7)	57.8 (55.7– 59.8)	62.2 (60.1-64.3)	7.6 (3.8-11.5)
Delhi	71.4 (68.8 - 73.8)	79.9 (78.2-81.4)	11.9 (8.3-15.6)	88.0 (86.1-89.7)	91.7 (90.5-92.7)	3.8 (2.1-6.3)	63.3 (60.6 - 66.0)	87.2 (85.8-88.5)	37.8 (33.3-42.1)	46.6 (43.9 - 49.4)	69.6 (67.7-71.4)	49.4 (43.2-55.5)
Goa	87.6 (83.7 - 90.7)	93.2 (89.8-95.4)	6.4 (2.2-10.5)	96.8 (94.4-98.2)	98.8 (96.7-99.5)	2.0 (0.1-4.0)	91.4 (87.9 - 93.9)	96.3 (93.5-97.9)	5.4 (2.0-8.7)	80.7 (76.2 - 84.5)	90.1 (86.3-92.9)	11.6 (6.3-17.0)
Gujarat	66.4 (65.2 - 67.6)	77.7 (76.7-78.6)	17.0 (15.1-19.0)	83.9 (82.9-84.8)	90.3 (89.6-90.9)	8.6 (6.4-8.8)	62.9 (61.7 - 64.2)	89.4 (88.6-90.0)	42.1 (40.1-44.2)	42.3 (41.0- 43.5)	66.3 (65.3-67.4)	56.7 (53.5-60.0)
Haryana	45.4 (44.1 - 46.7)	60.8 (59.4-62.1)	33.9 (30.7-37.1)	82.1 (81.1-83.1)	93.4 (92.6-94.0)	12.5 (12.5-15.0)	68.3 (67.0 - 69.5)	91.3 (90.5-92.0)	33.7 (31.8-35.5)	34.3 (33.1 - 35.6)	55.6 (54.3-57.0)	62.1 (58.0-66.2)
Himachal Pradesh	66.2 (64.3 - 68.1)	71.8 (69.8-73.6)	8.5 (5.3-11.7)	75.9 (74.1-77.6)	84.3 (82.7-85.8)	11.2 (8.6-13.6)	73.6 (71.8 - 75.4)	88.9 (87.5-90.2)	20.8 (18.2-23.4)	49.5 (47.4 - 51.5)	59.3 (57.2-.61.3)	19.8 (15.2-24.4)
Jammu & Kashmir [§]	79.5 (78.5 - 80.5)	80.7 (79.6-81.7)	1.5 (0.1-2.9)	83.2 (82.2-84.1)	91.0 (90.2-91.7)	9.4 (8.2-10.6)	73.0 (71.9 - 74.1)	80.3 (79.2-81.3)	10.0 (8.4-11.6)	61.8 (60.6 - 63.0)	65.1 (63.8-66.4)	5.3 (3.2-7.5)
Karnataka	73.5 (72.3 - 74.6)	70.8 (69.6-71.9)	-3.7 (-5.4 to -2.0)	90.7 (90.0-91.5)	92.5 (91.8-93.1)	2.6 (1.1-2.9)	60.5 (59.2 - 61.7)	86.4 (85.5-87.2)	42.8 (40.6-45.0)	44.6 (43.3 - 45.9)	59.1 (57.9-60.3)	32.5 (29.4-35.6)
Kerala	90.3 (89.0 - 91.5)	82.2 (80.6-83.7)	-9.0 (-10.6 to -7.4)	99.9 (99.6-100.0)	99.8 (99.5-99.9)	-0.1 (-0.3-0.1)	86.3 (84.7 - 87.7)	92.8 (91.7-93.8)	7.5 (5.7-9.3)	78.4 (76.6 - 80.1)	77.9 (76.2-79.5)	-0.6 (-3.1-1.8)
Maharashtra	72.3 (71.3 - 73.3)	71.3 (70.3-72.3)	-1.4 (-3.0- 0.2)	86.7 (85.9-87.5)	91.0 (90.3-91.6)	5.0 (4.0-5.9)	76.9 (75.9 - 77.9)	84.1 (83.3-84.9)	9.4 (8.0-10.7)	54.4 (53.2 - 55.5)	60.2 (59.1-61.3)	10.7 (8.3-13.0)
Punjab	68.2 (66.7 - 69.6)	58.3 (56.8-59.7)	-14.5 (-16.8 to -12.2)	92.0 (91.2-92.8)	94.1 (93.4-94.7)	2.3 (1.3-3.2)	88.4 (87.4 - 89.3)	87.1 (86.1-88.0)	-1.5 (-2.7 to -0.3)	59.1 (57.6 - 60.6)	50.2 (48.7-51.6)	-15.1 (-17.8 to -12.3)
Tamil Nadu	80.7 (79.7 - 81.7)	91.6 (90.8-92.3)	13.5 (12.2-14.8)	98.8 (98.5-99.1)	99.5 (99.3-99.7)	0.7 (0.4-1.0)	72.4 (71.3 - 73.5)	92.2 (91.4-92.9)	27.3 (25.7-29.0)	60.8 (59.6 - 62.0)	84.9 (84.0-85.9)	39.6 (37.5-41.8)
Telangana	73.1 (71.0 - 75.1)	69.7 (68.5-70.9)	-4.7 (-7.6 to -1.7)	87.2 (85.6-88.7)	91.4 (90.6-92.1)	4.8 (3.0-6.6)	81.7 (79.8 - 83.4)	86.6 (85.7-87.5)	6.0 (3.7-8.2)	57.6 (55.3– 59.9)	56.9 (55.6-58.2)	-1.2 (-5.3-2.9)
West Bengal	74.2 (72.9 - 75.5)	75.7 (74.4-76.9)	2.0 (0.1-3.9)	77.0 (75.8-78.2)	91.2 (90.4-91.9)	18.4 (16.8-20.1)	63.1 (61.7 - 64.5)	68.2 (66.9-69.5)	8.1 (5.6-10.5)	47.4 (46.0 - 48.9)	52.0 (50.6-53.4)	9.7 (6.3-13.1)

*Includes doctor, auxiliary nurse midwife, nurse, midwife, and lady health visitor

[†]Data missing on 101 women for institutional delivery with SBA, PNC within 48 hours of delivery, and continuum of care in NFHS-5

[§]Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh

Supplementary Table 3. Human Opportunity Index for geographic inequality for four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), post-natal care within 48 hours of delivery and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) rounds 4 and 5 for India and its states. CI denotes confidence interval.

	Human Opportunity Index											
	Four of more ANC visits			Institutional delivery with SBA			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)
India	35.8	48.4	35.2 (34.5 to 35.9)	68.9	80.4	16.7 (16.4 to 17.0)	54.6	73.5	34.6 (34.2 to 35.1)	24.4	37.1	52.2 (51.1 to 53.0)
Less developed states	27.9	40.7	45.9 (44.9 to 46.9)	64.5	76.2	18.1 (17.7 to 18.6)	50.6	69.4	37.2 (36.6 to 37.8)	18.5	29.7	60.5 (59.2 to 61.9)
Arunachal Pradesh	20.2	34.3	69.8 (62.7 to 76.9)	47.0	77.5	64.9 (51.1 to 68.5)	22.7	51.9	128.6 (122.1 to 135.2)	8.2	21.9	167.1 (154.4 to 179.8)
Assam	40.7	45.6	12.0 (9.2 to 14.9)	66.5	82.3	23.8 (22.1 to 25.4)	51.1	64.7	26.6 (24.3 to 28.9)	24.9	31.0	24.5 (20.3 to 28.7)
Bihar	12.8	22.9	78.9 (73.9 to 83.9)	61.0	72.1	18.2 (16.1 to 19.6)	43.1	59.6	38.3 (36.2 to 40.3)	7.7	15.3	98.7 (91.8 to 105.6)
Chhattisgarh	52.0	57.2	10.0 (7.5 to 12.5)	68.6	78.5	14.4 (12.1 to 16.2)	63.0	85.3	35.4 (33.5 to 37.3)	33.1	43.3	30.8 (27.0 to 34.6)
Jharkhand	25.0	36.0	44.0 (39.7 to 48.3)	59.5	70.4	18.3 (16.7 to 20.3)	43.2	70.9	64.1 (61.4 to 66.8)	13.8	24.1	74.6 (68.3 to 81.0)
Madhya Pradesh	29.4	52.2	77.6 (74.8 to 80.3)	70.8	84.1	18.8 (17.1 to 19.8)	51.3	82.8	61.4 (59.8 to 63.0)	19.1	41.2	115.7 (111.9 to 119.5)
Manipur	54.9	61.2	11.5 (8.2 to 14.8)	58.0	62.0	6.9 (3.3 to 10.0)	54.4	57.7	6.1 (2.7 to 9.4)	39.2	41.5	5.9 (1.3 to 10.4)
Meghalaya	44.3	45.4	2.5 (-1.9 to 6.9)	49.6	52.5	5.8 (1.9 to 9.8)	52.0	53.4	2.7 (-1.1 to 6.4)	26.4	20.5	-22.3 (-28.8 to -15.9)
Mizoram	52.4	46.6	-11.1 (-14.8 to -7.3)	72.1	72.4	0.4 (-2.0 to 2.9)	59.0	63.9	8.3 (5.0 to 11.6)	37.9	36.6	-3.4 (-8.5 to 1.6)
Nagaland	8.3	11.3	36.1 (22.3 to 50.0)	26.2	37.4	42.7 (35.0 to 49.7)	17.2	37.5	118.0 (108.5 to 127.5)	4.4	6.5	47.7 (28.0 to 67.5)
Odisha	59.2	76.2	28.7 (26.8 to 30.6)	79.2	87.3	10.2 (9.1 to 11.4)	74.4	90.7	21.9 (20.6 to 23.2)	42.6	64.8	52.1 (49.4 to 54.8)
Rajasthan	33.0	51.2	55.2 (52.2 to 58.1)	81.8	93.9	14.8 (13.3 to 15.7)	61.2	82.6	35.0 (33.4 to 36.5)	24.6	44.2	79.7 (76.0 to 83.3)
Sikkim	71.3	60.1	-15.7 (-20.5 to -10.9)	94.4	95.2	0.8 (-0.9 to 2.6)	71.9	70.4	-2.1 (-6.7 to 2.5)	52.1	48.3	-7.3 (-14.4 to -0.2)
Tripura	60.4	50.4	-16.6 (-21.6 to -11.5)	76.4	83.5	9.5 (5.1 to 12.7)	58.2	64.2	10.3 (5.1 to 15.5)	42.9	35.3	-17.7 (-24.8 to -10.6)
Uttar Pradesh	21.9	38.1	74.0 (71.4 to 76.6)	64.0	78.0	21.9 (20.1 to 22.8)	53.5	73.2	36.8 (35.6 to 38.0)	15.6	27.9	78.8 (75.6 to 82.1)
Uttarakhand	25.9	55.7	115.1 (109.0 to 121.1)	65.2	78.5	20.4 (19.2 to 22.8)	54.3	81.5	50.1 (47.1 to 53.1)	17.5	43.3	147.4 (139.3 to 155.5)
More developed states	65.2	68.2	4.6 (3.9 to 5.3)	82.8	90.1	8.8 (7.4 to 9.2)	66.2	82.6	24.8 (24.1 to 25.4)	45.7	56.3	23.2 (22.2 to 24.2)
Andhra Pradesh	74.3	68.3	-8.1 (-10.8 to -5.4)	88.0	95.4	8.4 (7.1 to 10.0)	77.6	90.4	16.5 (14.2 to 18.8)	56.1	59.3	5.7 (1.7 to 9.7)
Goa	86.0	92.4	7.4 (3.0 to 11.9)	96.7	98.5	1.9 (0.2 to 3.9)	90.5	95.6	5.6 (2.1 to 9.2)	79.0	88.8	12.4 (6.7 to 18.1)
Gujarat	59.7	73.1	22.4 (20.2 to 24.7)	80.1	87.5	9.2 (7.8 to 10.6)	59.9	87.1	45.4 (43.2 to 47.6)	36.7	61.2	66.8 (63.1 to 70.4)
Haryana	37.3	56.6	51.7 (47.9 to 55.5)	75.6	90.5	19.7 (18.1 to 21.3)	61.3	88.7	44.7 (42.5 to 46.9)	27.2	51.2	88.2 (83.3 to 93.1)
Himachal Pradesh	61.7	67.1	8.8 (5.2 to 12.3)	72.7	82.5	13.5 (10.1 to 16.2)	69.8	87.3	25.1 (22.2 to 27.9)	45.4	54.3	19.6 (14.6 to 24.6)
Jammu & Kashmir*	71.9	76.3	6.1 (4.4 to 7.8)	77.8	87.9	13.0 (11.1 to 14.4)	67.1	77.2	15.1 (13.2 to 16.9)	53.3	59.5	11.6 (9.1 to 14.2)
Karnataka	69.3	65.1	-6.1(-7.9 to -4.2)	88.4	90.3	2.1 (1.1 to 3.1)	55.3	83.6	51.2 (48.8 to 53.6)	39.6	52.6	32.8 (29.4 to 36.3)
Kerala	88.9	77.3	-13.0 (-14.8 to -11.3)	99.8	99.7	-0.1 (-0.3 to 0.1)	84.2	91.5	8.7 (6.7 to 10.6)	75.7	72.9	-3.7 (-6.3 to -1.1)
Maharashtra	69.3	66.7	-3.8(-5.5 to -2.0)	83.9	88.2	5.1 (4.0 to 6.2)	74.2	80.8	8.9 (7.4 to 10.4)	50.0	54.5	9.0 (6.4 to 11.6)
Delhi	68.8	75.3	9.4 (5.5 to 13.3)	86.0	90.2	4.9 (2.6 to 7.2)	59.1	85.1	44.0 (39.3 to 48.7)	42.7	65.3	52.9 (46.2 to 59.7)
Punjab	64.6	54.7	-15.3 (-17.8 to -12.8)	91.1	92.9	2.0 (1.0 to 3.0)	86.9	85.4	-1.7 (-3.0 to -0.4)	55.5	46.9	-15.5 (-18.5 to -12.5)
Tamil Nadu	77.5	89.6	15.6 (14.2 to 17.0)	98.4	99.2	0.8 (0.5 to 1.1)	68.4	90.4	32.2 (30.4 to 33.9)	56.4	82.0	45.4 (43.0 to 47.7)
Telangana	71.8	68.2	-5.0 (-8.0 to -2.0)	85.6	90.4	5.6 (3.7 to 7.6)	79.9	85.4	6.9 (4.5 to 9.3)	55.7	54.9	-1.4 (-5.7 to 2.8)
West Bengal	69.4	72.2	4.0 (1.9 to 6.2)	71.3	89.2	25.1 (23.3 to 27.1)	58.0	63.8	10.7 (7.3 to 12.7)	42.0	47.3	12.6 (8.8 to 16.4)

*Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh.

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Revision

Population-level trends over a decade in geographical inequality for opportunity in access to maternal care services: findings from the National Family Health Surveys in India

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ABSTRACT

Objectives: To examine the trends in geographical inequality of opportunity in maternal health services in India considering the Every Newborn Action Plan (ENAP) 2025 coverage targets.

Setting: India

Participants: Women in the National Family Health Survey (NFHS) - NFHS-4 (2014-15) and NFHS-5 (2019-21).

Primary and secondary measures: District-level coverages of 4+ antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), postnatal care (PNC) services within 48 hours of delivery, Continuum of care (CoC) services for women with most recent livebirths were considered. Human Opportunity Index (HOI) documented the opportunities for equitable access of these services, ranging from 0 (high inequality) to 100 (universal access). HOI was compared between the survey rounds and wealth index quintiles (WI) that the women belonged to.

Results: Coverages of 4+ ANC visits, institutional delivery, PNC, and CoC in India increased by 22.8% (95% CI 22.1-23.5), 12.6% (12.2-12.9), 28.5% (28.0-29.0), and 38.6% (37.6-39.6) between NFHS-4 and NFHS-5, respectively. The HOI for 4+ ANC visits was 48.4 in NFHS-5, ranging from 11.3 to 92.4 in states and from 31.1 to 70.5 for WI I to V. The HOI for institutional delivery was 80.4 in NFHS-5, ranging from 37.4 to 99.7 in the states and from 21.0 to 100 for WI I to V. The HOI for PNC services was 73.5 in NFHS-5, ranging from 37.5 to 95.6 in the states and from 61.2 to 88.3 for WI I to V. The HOI for CoC was 37.1, ranging from 6.5 to 88.8 in the states and from 19.8 to 62.7 for WI I to V for CoC in NFHS-5.

Conclusion: Though significant improvements in the geographic inequity of maternal health services have been made in India, the geographic inequity for 4+ANC visits coverage lags significantly behind resulting in CoC coverage inequity to achieve the ENAP targets for these services.

Keywords: Antenatal care services, continuum of care, human opportunity index, India, inequity, institutional delivery, NFHS, postnatal care, wealth index.

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STRENGTHS AND LIMITATIONS OF THE STUDY

- District-level inequity estimated in the coverages of maternal health services for India using large-scale demographic surveys.
- Human opportunity index is used to measure not only the distribution of coverage of maternal health services but also how fairly the available services are distributed among women by geography and by wealth index.
- Socio-economic inequities in maternal health services in India have been reported previously but the use of Human Opportunity Index to measure inequity has not been attempted.
- Quality of services not captured in the assessment.

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INTRODUCTION

With the Sustainable Development Goal (SDG) 10, the governments worldwide have committed to act on inequality through multiple, interconnected goals, requiring combined policy action in order to meet an overall commitment to ‘leave no-one behind’.(1) Access to health care for all also intersects with the inequalities related to gender, socio-economic status, education levels, employment status and geographical location, with the most marginalized being the least able to access quality healthcare.(2) Inequality in access to essential health-care services has implications on achieving universal health coverage, including maternal health services among both the general and the most disadvantaged populations.(3) Significant literature on the extent of inequities in maternal health services is available from developing countries including from India, predominately based on the Demographic and Health Surveys (DHS) and focusing on socio-economic inequalities in the use of maternal health services.(4-16)

In the context of Countdown to 2030, SDGs 3.1 and 3.2 which aim to reduce maternal and neonatal mortality by 2030,(3) we examine the trends in geographical inequality of opportunity in access for the coverage of antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), and postnatal care (PNC) visits within 48 hours in India using the National Family Health Survey (NFHS), which is the equivalent of DHS in India.(17) In addition, we also measure geographical inequality in the coverage of continuum of care (CoC), which is recommended as one of the global strategies for maternal health to improve maternal and neonatal outcomes in the developing country setting.(18-20) The maternal health program in India is implemented at the district level,(21) and the Every Newborn Action Plan (ENAP) 2025 provides for maternal care services coverage target indicators based on the district-level coverage of these services in a state.(22) Therefore, we examine define geographic inequality at the district-level in India and its states as these have implications on planning to achieve the ENAP 2025 coverage targets.

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METHODS

We utilized the publicly available data from the two most recent rounds of NFHS conducted post year 2010, NFHS-4 (2014-15) and NFHS-5 (2019-21).^(17, 23) These nationally representative population-based surveys are conducted by the International Institute of Population Sciences, Mumbai, India, with the primary aim to provide estimates of maternal and child health and reproductive health indicators at the district-level for India.^(17, 23) No ethics approval was required for this analysis as we utilised the de-identified data available in public domain.

The NFHS documents data on the most recent livebirth for ever-married women in the last 5 years from the time of data collection. The NFHS-4 documented data for livebirths born between 2011 and early 2016 whereas the NFHS-5 documented data on livebirths born between 2016 and early 2021. We defined the CoC for this analysis as a woman having reported four or more ANC visits and institutional delivery with SBA and PNC within 48 hours of delivery for her most recent livebirth in the last 5 years. We calculated the coverage of 4 or more ANC visits (4+ ANC visits), institutional delivery with SBA, PNC within 48 hours of delivery, and CoC for the most recent livebirth for NFHS-4 and NFHS-5 for India, and its states and districts.

Data analysis

We utilised the Human Opportunity Index (HOI) to measure the trends in geographical inequality for the opportunity to access maternal care services in India and its states.. The HOI is a measure of the coverage rate of an opportunity discounted by inequality in the distribution across the circumstance groups, where D measures the dissimilarity between access of services for groups defined by circumstance characteristics (such as wealth index, education, distance, etc) and the average access coverage for the same service for the population as a whole; C is average access coverage of services the population as a whole and is estimated as :^(24, 25)

$$HOI = (1 - D) \times C$$

. The HOI value ranges from 0 (high inequality) to 100 (universal access). In this analysis, D is the index of geographical inequality at the district-level within each state compared with the average

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111 coverage of a particular maternal service for a given state. The HOI for coverage of each of the three
112 maternal care services and CoC for India and its states was estimated using the district level
113 coverage of these services in NFHS-4 and NFHS-5, and the change in HOI between NFHS-4 and NFHS-
114 5 was assessed. The number of districts in each state in NFHS-4 and NFHS-5 are shown in
115 supplemental table 1.

116 In addition, we explored the geographical inequality within each of the wealth index (WI)
117 quintile in NFHS-5. The WI quintile is provided in the NFHS dataset at the household level which is
118 based on the number and kinds of consumer goods each household owns calculated using principal
119 component analysis.(17, 26) We calculated HOI for India and states for each WI quintile for each
120 maternal health service and CoC. We report the ratio of state average HOI with WI I and WI V, and the
121 ratio of HOI WI I to WI V for each maternal health service and CoC.

122 The states of India were grouped based on its development status for this analysis. The
123 Empowered Action Group of states as categorized by the government of India (Bihar, Chhattisgarh,
124 Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Uttarakhand, and the north-eastern
125 states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) were
126 grouped as ‘less developed’ and the remaining states were categorised as “more developed.”(27, 28)
127 Delhi, Jammu and Kashmir including Ladakh were considered as a state for this analysis. The other
128 Union Territories were excluded as there are no districts in these Union Territories to undertake this
129 analysis. We have reported 95% confidence interval for all estimates as relevant and all the analyses
130 were carried out using STATA version 13.1 and Microsoft Excel 2016.

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132 **Patient and Public Involvement statement:** Patients were not involved in planning of this analysis.

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RESULTS

A total of 188,506 ever-married women provided data on 249,020 livebirths in NFHS-4 and 174,796 ever-married women provided data on 195,277 livebirths in NFHS-5. The coverages for 4+ ANC visits, institutional delivery with SBA, and PNC in 48 hours, and CoC for NFHS-4 and NFHS-5 for India, grouping of states, and individual states are shown in supplemental table 2.

4+ ANC visits

The coverage of 4+ ANC visits for India was 57.0% (95% CI 56.8 to 57.3) in NFHS-5. The percent change in coverage of 4+ ANC visits from NFHS-4 to NFHS-5 was estimated at 22.8% (95% CI 22.1 to 23.5) for India, 33.3% (95% CI 32.3 to 34.3) for less developed, and 3.4% (95% CI 2.6 to 4.1) for more developed states (supplemental table 2). This coverage ranged from 15.6% in Nagaland to 80.0% in Odisha in the less developed states, and 58.3% in Punjab to 93.2% in Goa in the more developed states in NFHS-5 (supplemental table 2). The HOI for geographic inequality in 4+ ANC visits for India was 48.4 in NFHS-5, an improvement of 35.2% (95% CI 34.5 to 35.9) between NFHS-4 to NFHS-5 (supplemental table 2), and was substantially higher for the more developed states at 68.2 than the less developed states at 40.7 in NFHS-5 (table 1 and supplemental table 3). HOI ranged from 8.3 to 88.9 in the states in NFHS-4, and 11.3 to 92.4 in the states in NFHS-5 (Figure 1 and supplemental table 3). Three and 6 states from the less and more developed states showed a reduction in HOI between NFHS-4 to NFHS-5, respectively (supplemental table 3). The highest gains in HOI were made in the state of Uttarakhand (115.1%; 95% CI 109.0 to 121.1) between NFHS-4 to NFHS-5, with the HOI for the state at 55.7 in NFHS-5.

Considering WI (table 1), HOI ranged from 33.8 for WI I to 64.4 for WI V for India, and the corresponding range was 31.1 to 57.0 and 58.6 to 70.5 for less and more developed states in NFHS-5, respectively. The HOI ratio of WI V to average was 1 or more in all states except Sikkim, Tamil Nadu and Kerala. Substantial variations were seen in HOI ratio of WI I to V, ranging from 0.16 to 1.41, with this ratio being <1 in 27 (90.0%) states in NFHS-5, and the lowest HOI ratio between WI I

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160 and V was seen in Mizoram at 0.16 (supplemental table 4). Among the 20 states with WI I to state
161 HOI ratio at >0.70, 15 states had the W1 I to WI V HOI ratio at <0.70 (supplemental table 4).
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Table 1: Overall Human opportunity index (HOI) and by wealth index quintile (WI) for four or more antenatal care visits and the ratio between WI I and overall HOI, WI V and overall HOI for India and its states, National Family Health Survey 5.

	Overall HOI	Four or more ANC visits					HOI Ratio	
		HOI by WI					WI 1: Overall HOI	WI 5: Overall HOI
		1	2	3	4	5		
India	48.4	33.8	44.0	53.1	59.3	64.4	0.70	1.33
Less developed states	40.7	31.1	38.9	45.4	50.1	57.0	0.76	1.40
Arunachal Pradesh	34.3	20.2	31.6	37.0	44.2	47.3	0.59	1.38
Assam	45.6	38.9	46.4	53.3	60.1	61.0	0.85	1.35
Bihar	22.9	15.6	22.9	30.2	37.4	49.2	0.68	2.15
Chhattisgarh	57.2	54.3	53.4	60.9	60.5	61.0	0.95	1.07
Jharkhand	36.0	28.6	38.5	41.9	51.8	56.0	0.79	1.56
Madhya Pradesh	52.2	44.6	49.3	56.1	59.1	62.3	0.85	1.19
Manipur	61.2	36.7	64.6	78.7	84.9	91.3	0.60	1.49
Meghalaya	45.4	36.8	45.8	50.0	61.5	55.5	0.81	1.22
Mizoram	46.6	11.0	37.8	49.9	61.5	69.9	0.24	1.50
Nagaland	11.3	5.4	10.1	20.8	26.9	20.0	0.48	1.77
Odisha	76.2	69.3	78.6	79.1	81.6	82.4	0.91	1.08
Rajasthan	51.2	45.7	45.9	49.6	52.2	59.0	0.89	1.15
Sikkim	60.1	66.9	61.1	59.1	61.3	47.6	1.11	0.79
Tripura	50.4	41.7	52.8	56.6	64.6	51.2	0.83	1.02
Uttar Pradesh	38.1	30.4	35.0	38.9	41.4	50.9	0.80	1.34
Uttarakhand	55.7	35.2	44.2	51.8	62.6	69.1	0.63	1.24
More developed states	68.2	58.6	65.1	67.1	70.1	70.5	0.86	1.03
Andhra Pradesh	68.3	45.5	64.2	64.8	66.5	69.2	0.67	1.01
Goa	92.4	100.0	81.2	89.8	92.5	93.5	1.08	1.01
Gujarat	73.1	63.2	69.1	72.4	75.9	80.5	0.86	1.10

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		Four or more ANC visits						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4	5	WI 1: Overall HOI	WI 5: Overall HOI
Haryana	56.6	33.5	44.8	49.7	53.3	64.5	0.59	1.14
Himachal Pradesh	67.1	52.1	53.4	62.3	74.2	74.8	0.78	1.11
Jammu and Kashmir	76.3	60.2	75.8	76.7	80.6	79.5	0.79	1.04
Karnataka	65.1	51.8	60.3	65.4	71.2	69.5	0.80	1.07
Kerala	77.3	71.3	87.6	76.0	78.6	74.8	0.92	0.97
Maharashtra	66.7	49.9	63.3	65.1	71.2	73.8	0.75	1.11
Delhi	75.3	26.6	45.1	62.2	68.6	78.8	0.35	1.05
Punjab	54.7	31.2	41.6	47.1	50.7	57.6	0.57	1.05
Tamil Nadu	89.6	88.3	89.1	89.1	90.3	87	0.99	0.97
Telangana	68.2	53.5	63.9	64.8	70	68.1	0.78	1.00
West Bengal	72.2	66.5	72.1	75.0	78.7	78	0.92	1.08

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

169 ***Institutional delivery with SBA***

170 The coverage of institutional delivery with SBA for India was 85.0% (95% CI 84.9 to 85.2) in NFHS-5.
171 The percent change from NFHS-4 to NFHS-5 was estimated at 12.6% (95% CI 12.2 to 12.9) for India,
172 14.6% (95% CI 14.1 to 15.1) for less developed and 6.2% (95% CI 5.8 to 6.6) for more developed
173 states (supplemental table 2). This coverage ranged from 58.6% in Meghalaya to 96.3% in Sikkim in
174 less developed states and 84.3% in Himachal Pradesh to 99.8% in Kerala in more developed states in
175 NFHS-5 (supplemental table 2). The HOI for geographic inequality for institutional delivery with SBA
176 for India was 80.4, 90.1 and 76.2 for India, more developed and less developed states in NFHS-5,
177 respectively (table 2 and supplemental table 3). HOI ranged from 26.2 to 99.8 in the states in NFHS-
178 4, and 37.4 to 99.7 in the states in NFHS-5 (Figure 2 and supplemental table 3). The highest gains in
179 HOI between NHFS-4 and NFHS-5 were made in Arunachal Pradesh state (64.9%; 95% CI 61.3 to
180 68.5), with the HOI for the state at 77.5 in NHFS-5 (supplemental table 3).

181 Considering WI (table 2), HOI ranged from 65.1 for WI I to 93.7 for WI V for India, and the
182 corresponding range was 63.6 to 92.0 and 76.5 to 95.1 for less and more developed states in NFHS-
183 5, respectively. The WI V to average HOI ratio was 1 or more in all the states except Sikkim. The HOI
184 ratio of WI I to WI V was <1 in 28 (93.3 %) states and was <0.60 in 6 (20.0 %) states in NFHS-5
185 (supplemental table 4). Among the 26 states with W1 1 to state HOI ratio being >0.70, 6 states had
186 the W1 I to WI V HOI ratio at <0.70 (supplemental table 4).

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188 **Table 2: Overall Human opportunity index (HOI) by wealth index quartile (WI) for institutional delivery with skilled birth attendant (SBA)**
189 **and the ratio between WI I and overall HOI, WI V and overall HOI for India and its states, National Family Health Survey-5.**
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		Institutional delivery with SBA						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4	5	WI 1: Overall HOI	WI 5: Overall HOI
India	80.4	65.1	78.8	86.0	90.2	93.7	0.81	1.17
Less developed states	76.2	63.6	76.6	83.5	87.8	92.0	0.83	1.21
Arunachal Pradesh	77.5	56.0	77.6	86.7	92.0	96.0	0.72	1.24
Assam	82.3	72.1	87.0	91.7	94.8	95.5	0.88	1.16
Bihar	72.1	63.9	76.6	81.2	82.9	88.7	0.89	1.23
Chhattisgarh	78.5	68.0	80.1	85.9	90.3	94.3	0.87	1.20
Jharkhand	70.4	60.7	77.1	83.8	91.3	94.7	0.86	1.35
Madhya Pradesh	84.1	75.4	84.8	90.0	91.7	90.3	0.90	1.07
Manipur	62.0	37.7	65.1	78.7	88.2	93.7	0.61	1.51
Meghalaya	52.5	38.8	57.6	72.6	82.5	82.2	0.74	1.57
Mizoram	72.4	26.4	59.1	80.5	92.8	95.8	0.36	1.32
Nagaland	37.4	26.2	37.9	57.1	64.7	74.9	0.70	2.00
Odisha	87.3	77.6	91.6	93.9	95.5	95.6	0.89	1.10
Rajasthan	93.9	89.2	91.8	94.1	94.8	97.1	0.95	1.03
Sikkim	95.2	88.5	94.5	94.8	97.3	94.2	0.93	0.99
Tripura	83.5	71.8	88.8	91.9	94.0	90.6	0.86	1.09
Uttar Pradesh	78.0	68.3	76.4	79.4	82.8	90.1	0.88	1.16
Uttarakhand	78.5	62.1	62.7	75.0	85.7	91.9	0.79	1.17
More developed states	90.1	76.5	85.8	90.1	92.6	95.1	0.85	1.06
Andhra Pradesh	95.4	73.9	93.0	94.2	95.9	98.7	0.77	1.03
Goa	98.5	100.0	90.6	100.0	98.5	98.7	1.02	1.00
Gujarat	87.5	75.3	85.9	88.8	92.1	91.1	0.86	1.04

		Institutional delivery with SBA					
	Overall HOI	HOI by WI					HOI Ratio
		1	2	3	4	5	WI 1: Overall HOI WI 5: Overall HOI
Haryana	90.5	64.7	77.0	86.8	91.1	96.0	0.711.06
Himachal Pradesh	82.5	54.1	68.1	80.8	86.5	90.6	0.661.10
Jammu and Kashmir	87.9	71.5	82.7	88.6	94.7	96.6	0.811.10
Karnataka	90.3	83.8	85.6	90.6	93.8	93.2	0.931.03
Kerala	99.7	100.0	100.0	99.5	99.8	99.6	1.001.00
Maharashtra	88.2	69.5	85.4	89.0	92.3	95.0	0.791.08
Delhi	90.2	21.9	68.7	82.7	83.0	91.6	0.241.02
Punjab	92.9	79.4	80.7	96.5	90.5	94.6	0.851.02
Tamil Nadu	99.2	95.6	97.9	99.2	99.5	100.0	0.961.01
Telangana	90.4	75.5	88.9	90.0	90.4	91.4	0.841.01
West Bengal	89.2	83.7	90.6	93.8	94.6	93.1	0.941.04

Ratio of HOI	
	Less than 0.50
	0.51-0.8
	0.90-1.0
	1.10-1.4
	1.50 or more

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3 193 ***PNC within 48 hours of delivery***
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5 194 The coverage of PNC within 48 hours of delivery was 78.9% (95% CI 78.7-79.1) in NFHS-5. The
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7 195 percent change from NFHS-4 to NFHS-5 was estimated at 28.5% (95% CI 28.0-29.0) for India, 31.8%
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9 196 (95 % CI 31.1-32.4) for less developed and 19.6% (95% CI 19.0-20.3) for more developed states
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11 197 (supplemental table 2). This coverage ranged from 43.2% in Nagaland to 92.1% in Odisha in the less
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13 198 developed states and 68.2% in West Bengal to 96.3% in Goa in the more developed states in NFHS-5
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15 199 (supplemental table 2). The HOI for geographic inequality in PNC within 48 hours of delivery for India
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17 200 was 73.5 in NFHS-5, which improved by 34.6% (95% CI 34.2 to 35.1) between NFHS-4 to NFHS-5. The
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19 201 HOI was substantially higher for the more developed states 82.6 than the less developed states 69.4
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21 202 in NFHS-5 (table 3 and supplemental table 3). HOI ranged from 17.2 to 90.5 in the states in NFHS-4,
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23 203 and 37.5 to 95.6 in the states in NFHS-5 (Figure 3 and supplemental table 3). The highest gains in HOI
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25 204 were made in Arunachal Pradesh (128.6%; 95% CI 122.1 to 135.2) and Nagaland (118.0%; 95% CI
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27 205 108.5 to 127.5), with the HOI for the states at 51.9 and 37.5 in NFHS-5, respectively (supplemental
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29 206 table 3).

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34 207 Considering WI (Table 3), HOI ranged from 62.0 for WI I to 85.0 for WI V in India, and the
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36 208 corresponding range was from 61.2 to 83.0 and 67.4 to 88.3 for less and more developed states in
37
38 209 NFHS-5, respectively. The HOI ratio of WI V to state was 1 or more in all the states, except for Sikkim
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40 210 and Tamil Nadu. The HOI ratio of WI I to WI V was <1 in 28 (93.3%) states and was <0.60 in 4 (13.3%)
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42 211 states in NFHS-5 (supplemental table 4). Among the 27 states with WI I to state HOI ratio at >0.70, 2
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44 212 states had the WI I to WI V HOI ratio at <0.70 (supplemental table 4).
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214 **Table 3: Overall Human opportunity index (HOI) by wealth index quartile (WI) for post-natal care in 48 hours of delivery and the ratio**
 215 **between WI I and overall HOI, WI V and overall HOI for India and its states, National Family Health Survey 25.**

	Overall HOI	PNC within 48 hours of delivery					HOI Ratio	
		HOI by WI					WI 1:	WI 5:
		1	2	3	4		Overall HOI	Overall HOI
India	73.5	62.0	70.7	77.1	81.3	88.3	0.84	1.16
Less developed states	69.4	61.2	68.7	73.6	77.4	83.8	0.88	1.20
Arunachal Pradesh	51.9	41.5	52.6	53.2	53.6	55.9	0.80	1.15
Assam	64.7	56.8	67.4	72.7	74.4	77.2	0.88	1.11
Bihar	59.6	54.0	61.8	65.8	69.0	75.4	0.91	1.27
Chhattisgarh	85.3	81.8	85.5	85.2	89.4	88.8	0.96	1.03
Jharkhand	70.9	65.8	74.6	74.5	81.4	84.4	0.93	1.15
Madhya Pradesh	82.8	78.7	81.5	84.4	85.7	86.7	0.95	1.05
Manipur	57.7	38.1	59.2	72.7	78.1	79.0	0.66	1.37
Meghalaya	53.4	49.3	55.6	59.3	54.9	56.3	0.92	1.05
Mizoram	63.9	28.2	55.0	72.2	72.1	75.3	0.44	1.21
Nagaland	37.5	27.2	38.8	55.2	59.8	55.5	0.73	1.53
Odisha	90.7	87.6	90.7	92.9	92.9	99.9	0.97	1.02
Rajasthan	82.6	78.2	80.8	82.3	83.4	85.2	0.95	1.03
Sikkim	70.4	66.9	69.3	71.4	70.6	57.4	0.95	0.82
Tripura	64.2	56.4	63.0	72.9	79.1	82.8	0.88	1.29
Uttar Pradesh	73.2	66.0	72.6	73.6	77.3	82.8	0.90	1.13
Uttarakhand	81.5	71.1	73.6	80.9	85.4	85.3	0.87	1.07
More developed states	82.6	67.4	77.2	83.0	85.3	88.3	0.82	1.07
Andhra Pradesh	90.4	67.6	87.2	91.1	90.3	92.1	0.75	1.02
Goa	95.6	100.0	90.6	89.8	96.6	98.7	1.05	1.03
Gujarat	87.1	85.7	85.4	85.8	86.3	89.3	0.98	1.03
Haryana	88.7	64.2	76.7	88.7	88.7	92.2	0.72	1.04

		PNC within 48 hours of delivery						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4		WI 1: Overall HOI	WI 5: Overall HOI
Himachal Pradesh	87.3	71.3	78.7	88.3	88.3	92.1	0.82	1.05
Jammu and Kashmir	77.2	64.7	72.9	78.1	80.3	88.3	0.84	1.07
Karnataka	83.6	76.3	80.7	84.7	85.5	88.3	0.91	1.00
Kerala	91.5	81.6	83.9	88.3	92.1	91.5	0.89	1.00
Maharashtra	80.8	66.9	78.3	80.7	83.3	88.3	0.83	1.06
Delhi	85.1	31.2	59.7	76.4	80.3	82.2	0.37	1.02
Punjab	85.4	69.4	75.0	96.6	83.1	88.3	0.81	1.01
Tamil Nadu	90.4	84.0	90.4	90.3	90.1	88.3	0.93	0.99
Telangana	85.4	78.1	83.1	83.5	84.4	88.3	0.91	1.03
West Bengal	63.8	56.2	62.0	67.6	76.4	88.3	0.88	1.26

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

217 ***Continuum of care (CoC)***

218 The coverage of CoC was 45.6% (95% CI 45.4-45.9) in NFHS-5. The percent change from NFHS-4 to
219 NFHS-5 was estimated at 38.6% (95% CI 37.6-39.6) for India, 47.2% (95% CI 45.7-48.6.) for less
220 developed and 19.5% (95% CI 18.4-20.6) for more developed states (supplemental table 2). The
221 coverage ranged from 9.4% in Nagaland to 69.4% in Odisha in the less developed states, and 50.2%
222 in Punjab to 90.1% in Goa in the more developed states in NFHS-5 (supplemental table 2). The HOI
223 for geographic inequality in CoC for India was 37.1, which improved by 52.2% (95% CI 51.1 to 53.0)
224 between NFHS-4 to NFHS-5. The HOI was substantially higher for the more developed states at 56.3
225 than the less developed states at 29.7 in NFHS-5 (table 4 and supplemental table 3). HOI ranged
226 from 4.4 to 79.0 in the states in NFHS-4, and 6.5 to 88.8 in the states in NFHS-5 (Figure 4 and
227 supplemental table 3). The highest gains in HOI were made in Arunachal Pradesh (167.1%; 95% CI
228 154.4 to 179.8) and Uttarakhand (147.4%; 95% CI 139.3 to 155.5), with the HOI for the states at 21.9
229 and 43.3 in NFHS-5, respectively (supplemental table 3).

230 Considering WI (Table 4), HOI ranged from 21.7 for WI I to 56.5 for WI V for India, and the
231 corresponding range was 19.8 to 48.8 and 39.3 to 62.7 for less and more developed states in NFHS-
232 5, respectively. The HOI ratio of WI V to state was 1 or more in 27 states. The HOI ratio of WI I to WI
233 V was <1 in 28 (93.3%) states and was <0.60 in 18 (60.0%) states in NFHS-5 (supplemental table 4).
234 Among the 12 states with WI I to state HOI ratio at >0.70, 3 states the WI I to WI V HOI ratio at <0.70
235 (supplemental table 4).

236 **Table 4: Overall Human opportunity index (HOI) by wealth index quartile (WI) for continuum of care and the ratio between WI I and overall**
237 **HOI, WI V and overall HOI based on the maternal services for India and its states, National Family Health Survey-5.**

		Continuum of care							
	Overall HOI	HOI by WI					HOI Ratio		
		1	2	3	4		WI 1: Overall HOI	WI 5: Overall HOI	
India	37.1	21.7	32.3	41.9	49.2		0.58	1.52	
Less developed states	29.7	19.8	27.9	34.5	40.2		0.67	1.64	
Arunachal Pradesh	21.9	12.4	20.9	22.8	26.0		0.57	1.50	
Assam	31.0	22.9	32.1	40.3	49.0		0.74	1.43	
Bihar	15.3	9.5	15.1	21.0	28.4		0.62	2.52	
Chhattisgarh	43.3	37.3	39.2	47.9	50.7		0.86	1.23	
Jharkhand	24.1	16.7	27.8	31.6	41.5		0.69	1.90	
Madhya Pradesh	41.2	31.7	39.0	46.5	50.7		0.77	1.29	
Manipur	41.5	19.8	41.3	60.2	68.0		0.48	1.62	
Meghalaya	20.5	14.1	21.7	27.6	34.7		0.69	1.37	
Mizoram	36.6	6.7	27.6	40.4	49.5		0.18	1.57	
Nagaland	6.5	2.2	5.9	12.2	17.4		0.34	5.48	
Odisha	64.8	53.2	68.2	71.9	75.1		0.82	1.19	
Rajasthan	44.2	38.0	39.8	42.3	45.2		0.86	1.18	
Sikkim	48.3	47.6	49.0	45.6	50.3		0.99	0.78	
Tripura	35.3	19.5	37.4	39.8	56.2		0.55	1.45	
Uttar Pradesh	27.9	19.2	24.9	28.5	31.7		0.69	1.57	
Uttarakhand	43.3	24.5	28.2	38.5	51.2		0.57	1.37	
More developed states	56.3	39.3	50.0	55.5	59.8		0.70	1.11	
Andhra Pradesh	59.3	32.4	53.6	59.6	60.5		0.55	1.09	
Goa	88.8	100.0	71.9	86.4	87.2		1.13	1.03	
Gujarat	61.2	49.8	56.9	60.0	64.0		0.81	1.14	

		Continuum of care						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4	5	WI 1: Overall HOI	WI 5: Overall HOI
Haryana	51.2	23.3	35.5	45.0	47.2	50.3	0.46	1.18
Himachal Pradesh	54.3	31.8	39.5	51.0	59.7	54.3	0.59	1.20
Jammu and Kashmir	59.5	40.2	53.9	62.3	66.1	59.5	0.68	1.11
Karnataka	52.6	36.3	47.1	53.9	59.9	52.6	0.69	1.07
Kerala	72.9	68.0	69.1	70.1	74.5	72.9	0.93	0.98
Maharashtra	54.5	33.5	49.9	51.8	60.3	54.5	0.61	1.21
Delhi	65.3	1.6	28.0	47.9	55.4	65.3	0.02	1.05
Punjab	46.9	28.7	31.5	95.8	41.8	46.9	0.61	1.07
Tamil Nadu	82.0	75.6	81.9	81.7	82.6	82.0	0.92	0.96
Telangana	54.9	35.9	51.0	52.2	56.2	54.9	0.65	1.04
West Bengal	47.3	37.7	45.6	52.3	61.3	47.3	0.80	1.39

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

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DISCUSSION

This analysis of coverage of maternal health services for livebirths over a decade between NFHS-4 and NFHS-5 has highlighted significant improvements in the geographic inequity for coverage of these services at the state-level in India, and has identified the inequities that remain to be addressed to achieve the ENAP 2025 coverage targets for these services. The geographic inequity for the coverage of 4+ANC visits lags significantly behind that of institutional delivery with SBA and PNC within 48 hours of delivery, contributing to the CoC inequity in NFHS-5. The HOI ratio for CoC at 0.38 highlights the extent of inequity between the women belonging to the lowest and the highest wealth index quintiles in India.

A policy aiming at equitable access would require progress towards two objectives: first, expanding the coverage by ensuring that as many women as possible get the opportunity; and second, by allocating new opportunities first to the vulnerable population who are at a disadvantage due to their circumstances.(29) We utilised HOI,(25) as a tool to measure the distribution of opportunities and equitable access to maternal health services. The HOI not only carries information about the coverage rate of the service but also how fairly the available services are distributed among women of different backgrounds, in this case of different wealth index quintiles.(30) In terms of expanding coverage to ensure that as many women as possible get the opportunity, the coverage of 4+ ANC visits was for 4 of 7 women, and that for institutional delivery with SBA was 6 out of 7 women, and for PNC within 48 hours of delivery was 4 out of 5 women in NFHS-5. The differential increase over the decade between the coverages of these three maternal health services can possibly be explained by how the national programs to reduce maternal and neonatal mortality were implemented during this period. The program to address ANC services was launched in 2016 after NFHS-4, and is aimed to guarantee a minimum package of ANC services to women in their 2nd/3rd trimesters of pregnancy at designated government health facilities.(31) There is no monetary incentive either to the health worker or to the pregnant women under this program. The likely impact of this program on HOI for 4+ ANC visits coverage will be documented in the next round

of NFHS (round 6). However, given the extent of low coverage of 4+ ANC visits in most of the less developed states and some of the more developed states, major inputs are needed to address the barriers for improved ANC utilisation to achieve the ENAP 2025 target for 4+ ANC visits.(32-34) The increased coverage for institutional deliveries with SBA between the two surveys resulted in nearly doubling of HOI over this period, and near universality of this service in the more developed states. Two programs – the *Janani Suraksha Yojana* (JSY) and the *Janani Shishu Suraksha Karyakaram* (JSSK) - initiated to increase the coverage of institutional deliveries in India have contributed to the exponential increase in access to institutional delivery.(35, 36) The JSY was initiated in 2005 and was a large-scale national program that offered conditional cash transfer and support services to poor pregnant women to use institutional delivery care facilities, especially in the states with lower coverage.(35) The JSSK, initiated in 2011, provided free and cashless delivery along with some other benefits to pregnant women to eliminate out-of-pocket expenses in order to increase the institutional deliveries.(37) The PNC coverage was estimated at 61% HOI at 73.5 for India in NFHS-5 with a wide variation at the state-level. The increased PNC coverage also resulted in 34.6% increase in HOI for PNC coverage between NFHS-4 and NFHS-5. According to the Indian PNC guidelines,(38) the health workers are paid INR 250 (USD 3.5) for PNC visits, and are expected to undertake 6-7 PNC visits at home from 1st to 42nd day of delivery for counselling the mother on various issues and enabling referral if needed. Considering all the three maternal health services together, the CoC coverage remained at 62.5% in NFHS-5 with only 19.5% change between the two surveys even in the more developed states. Only 45% CoC coverage in NFHS-5 for India translates into 5 out of every 11 woman and newborn not having received all the three MNCH services, which is the basic premise of the ENAP and INAP to address neonatal and maternal mortality.(19, 21)

With regards to the policy objective of allocating new opportunities to the vulnerable population who are at a disadvantage due to their circumstances, socio-economic inequities in maternal health services in India have been reported previously, (16, 39-45) but the use of HOI to measure inequity has not been attempted. For all the maternal health services, the women

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3 291 belonging to the lowest WI quintile had low HOI compared to those in the highest WI quintile, and
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5 292 the difference was starker for ANC services and in the less developed states. Though the within-
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7 293 district inequalities in intervention coverages are reducing in most states, the pace of reduction has
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9 294 not been the same for every woman. The state of Delhi with the national capital had the one of the
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11 295 least HOI ratio for the women belonging to the lowest WI quintile. The extent of HOI ratio for the
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13 296 lowest to the highest WI quintile and that to average HOI between the maternal health services
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15 297 within states highlights the specificity needed in targeting women with the respective interventions
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17 298 to achieve 2025 coverage targets. One of the challenges in achieving equity in maternal health
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19 299 services in India is the dependence on NFHS for retrospective situational analysis rather than for
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21 300 monitoring and evaluation, because the routine health information management system (HMIS)
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23 301 does not allow for tracking of CoC for maternal health services per woman.(46) Real time tracking of
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25 302 women for utilisation of these services at the district-level is needed to reduce inequity in the
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27 303 coverage of these services. India has a Mother and Child Tracking System (MCTS) in place since 2009
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29 304 to follow a mother-child dyad through the CoC, but it is known to be fraught with several issues.(47-
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31 305 49) Clearly, it is important that strategies to improve the MCTS, within digital health, are looked into
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33 306 urgently if India were to reach every woman and newborn to achieve the SDG targets of reduced
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35 307 maternal and neonatal mortality at the district-level.(50-52) High quality timely data for evidence-
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37 308 informed decision making to reduce inequity at the district level can also be obtained through
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39 309 continuous surveys.(53) Furthermore, incentivisation of services is currently only for institutional
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41 310 delivery and for PNC services. With poor coverage of ANC services resulting in poor coverage of CoC,
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43 311 it may be worth considering incentivising the CoC rather than individual maternal health services to
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45 312 address inequity.

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52 313 The major strength of this analysis is the utilisation of HOI to indicate not only inequity in the
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54 314 coverage rate of the services but also how fairly the available services are distributed among women
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56 315 by geography and wealth index quintiles. This, we believe, allows for understanding the women
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58 316 who need to be targeted to reduce the inequity in the maternal health care in India. The inclusion of
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CoC is another strength as it brings the woman to the centre stage as against the individual maternal health care services. Some limitations of the analysis presented should be taken into account. The data on service utilisation is documented in the NFHS are self-reported by women, which may be subject to recall bias. We believe this bias to be of less concern as women self-report accurately indicators related to concrete and observable actions performed on them as opposed to information or advice they were offered.(54, 55) We only considered the inequity in coverage and not in the quality of contact with the health system during service utilisation in this analysis as such data are not available in the NFHS. There is a growing literature documenting increased coverage but poor quality of contact for these services,(4) including from India from pregnancy to delivery,(4, 49, 56-66) and also of poor quality of health care being a major driver of excess mortality across conditions, including neonatal mortality.(67-70) Health system redesign has been suggested for equity in maternal and new born health, by moving all childbirth care services to hospitals in all countries, combined with improvements in the quality of care provided in these facilities, transportation from home to hospital, and continuity of care through hub-and-spoke arrangements.(71) While commenting on the scope of health system re-design is beyond the scope of the analysis undertaken for this paper, more discussion is needed and more options need to be rigorously tried and tested to develop sustainable district health systems which are fit for purpose and respond to continuity of care needs of women and their babies.(72)

CONCLUSION

In conclusion, the findings of this assessment of coverage of maternal health services for livebirths over a decade are encouraging as significant reductions in geographic inequity are documented. However, the findings also emphasise the need for improved targeting of women to reduce the remaining inequity gap to achieve the ENAP targets, in particular for the coverage of 4+ANC visits. It will be important for the national program to monitor the CoC coverage in real time in addition to

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342 the three maternal health services individually to monitor and track inequity at the district level for
343 every pregnant woman to ensure that inequity by wealth index is also addressed in India.
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Ethics approval

No ethics approval was required for this analysis as we utilised the de-identified data available in public domain.

Authors' contributions

RD and GAK conceptualized the study; GAK and MM had full access to data in the study and performed data analysis; RD and GAK take full responsibility for the integrity of data and accuracy of the data analysis, and had final responsibility for the decision to submit for publication; RD drafted the manuscript; all authors contributed to the interpretation and approved of the final version of the manuscript. RD is the guarantor.

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Declaration of interests

The authors have no conflict of interest.

Data availability statement sharing

All data generated or analysed during this study are included in this published article and its supplementary information files.

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FIGURE LEGENDS

Figure 1. Human Opportunity Index for 4+ antenatal care visits in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

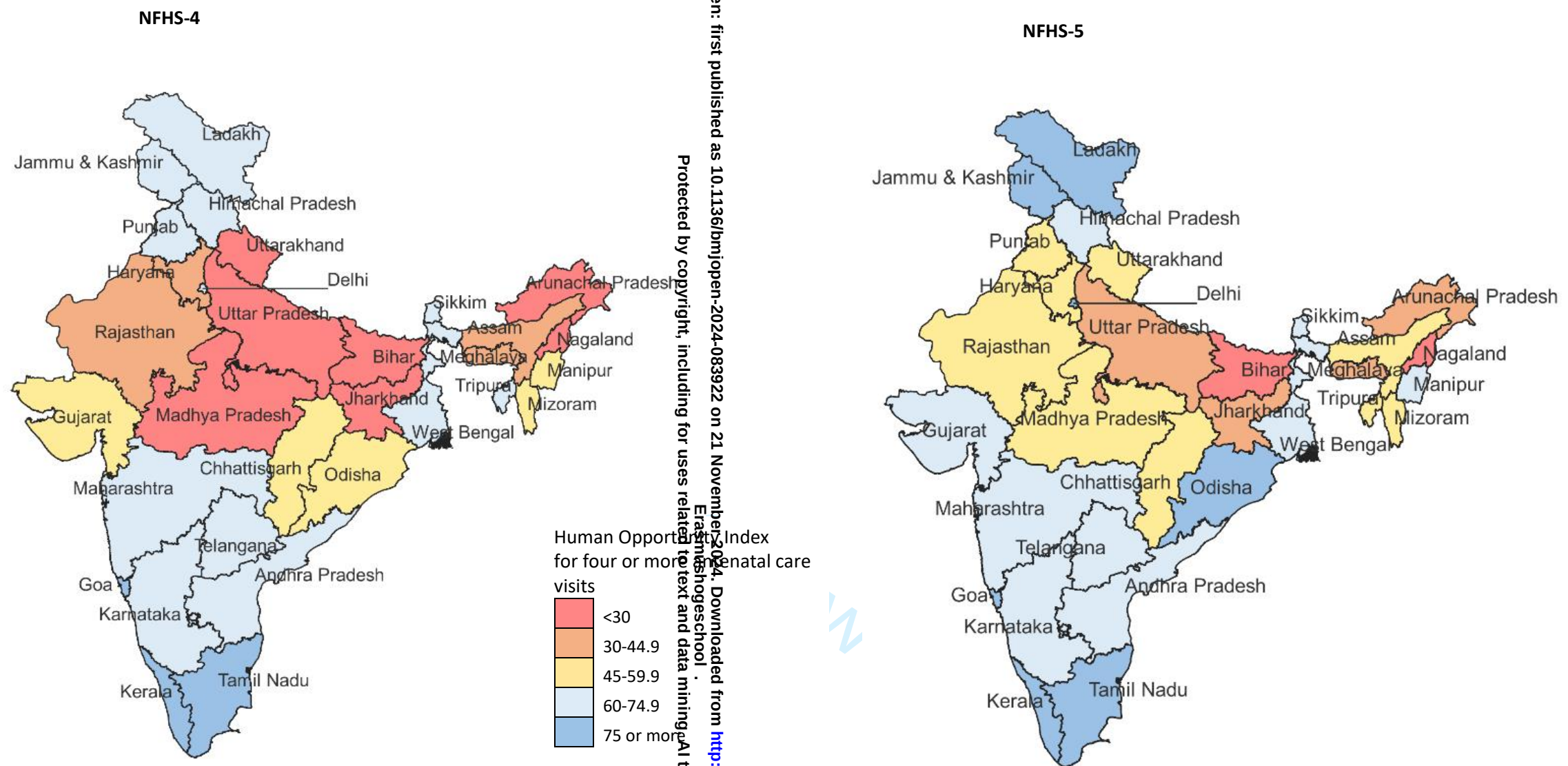
Figure 2. Human Opportunity Index for institutional delivery with skilled birth attendant in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

Figure 3. Human Opportunity Index for post-natal care within 48 hours of delivery in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

Figure 4. Human Opportunity Index for continuum of care in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

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Figure 1. Human Opportunity Index for 4+ antenatal care visits in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.



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Figure 2. Human Opportunity Index for institutional delivery with skilled birth attendant in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

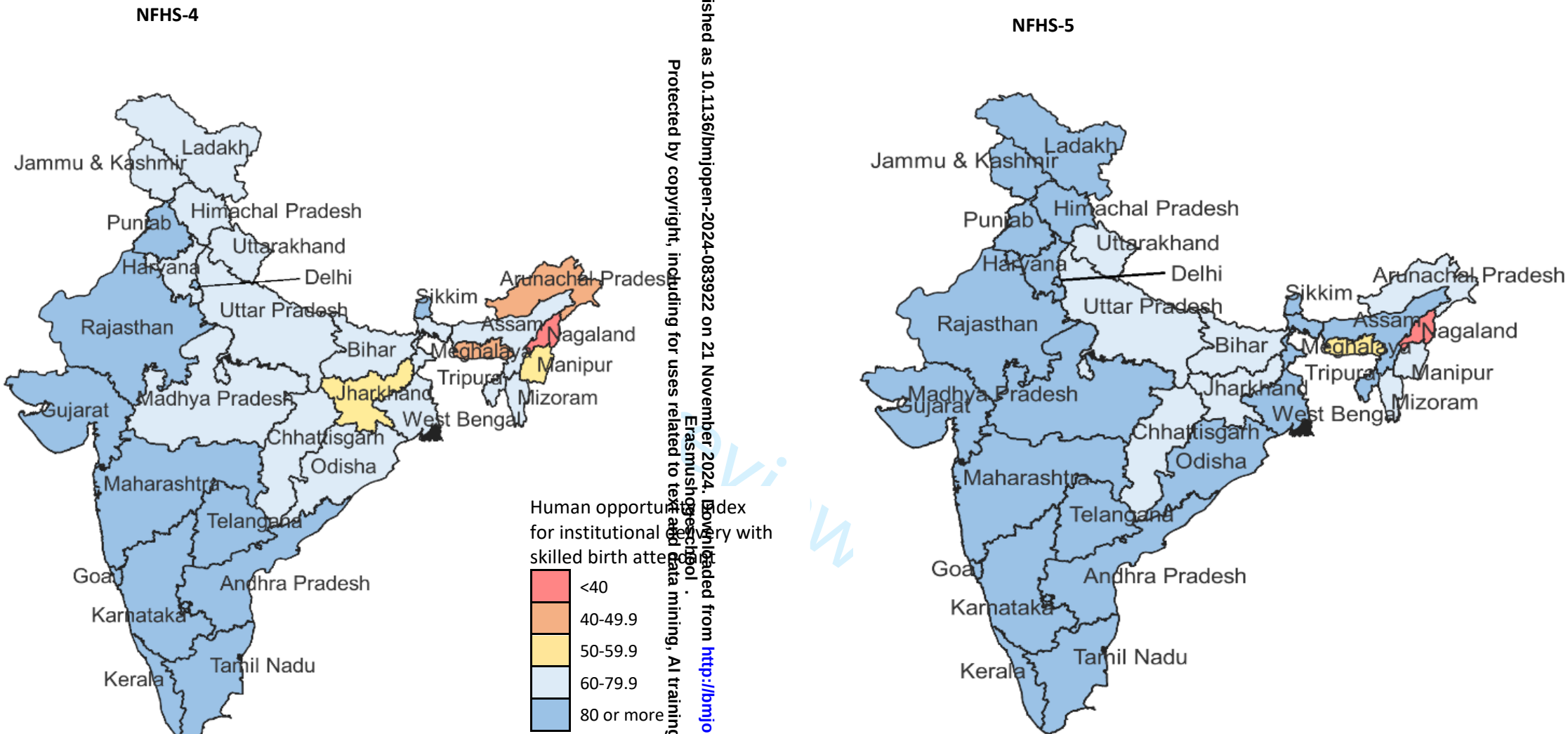


Figure 3. Human Opportunity Index for post-natal care within 48 hours of delivery in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

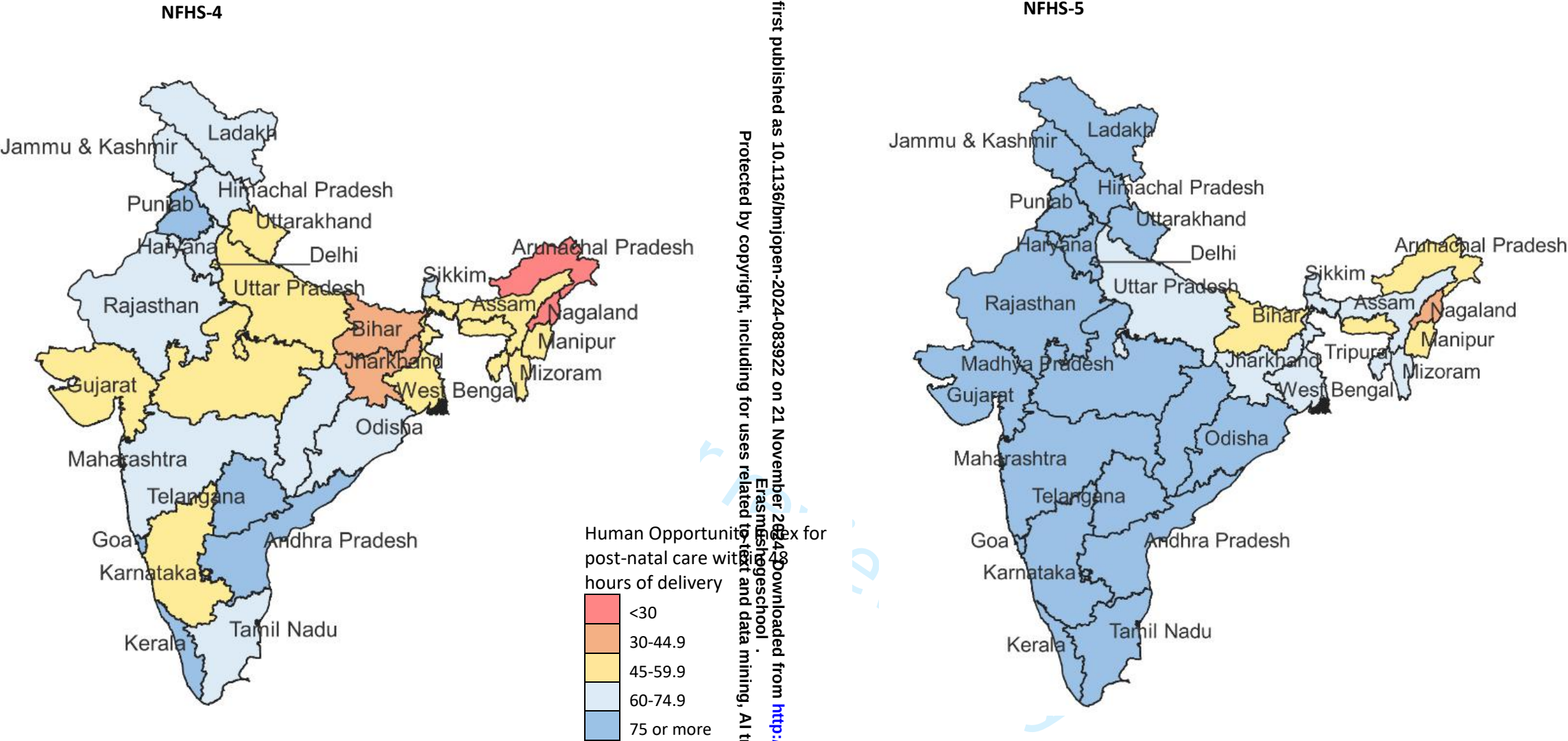
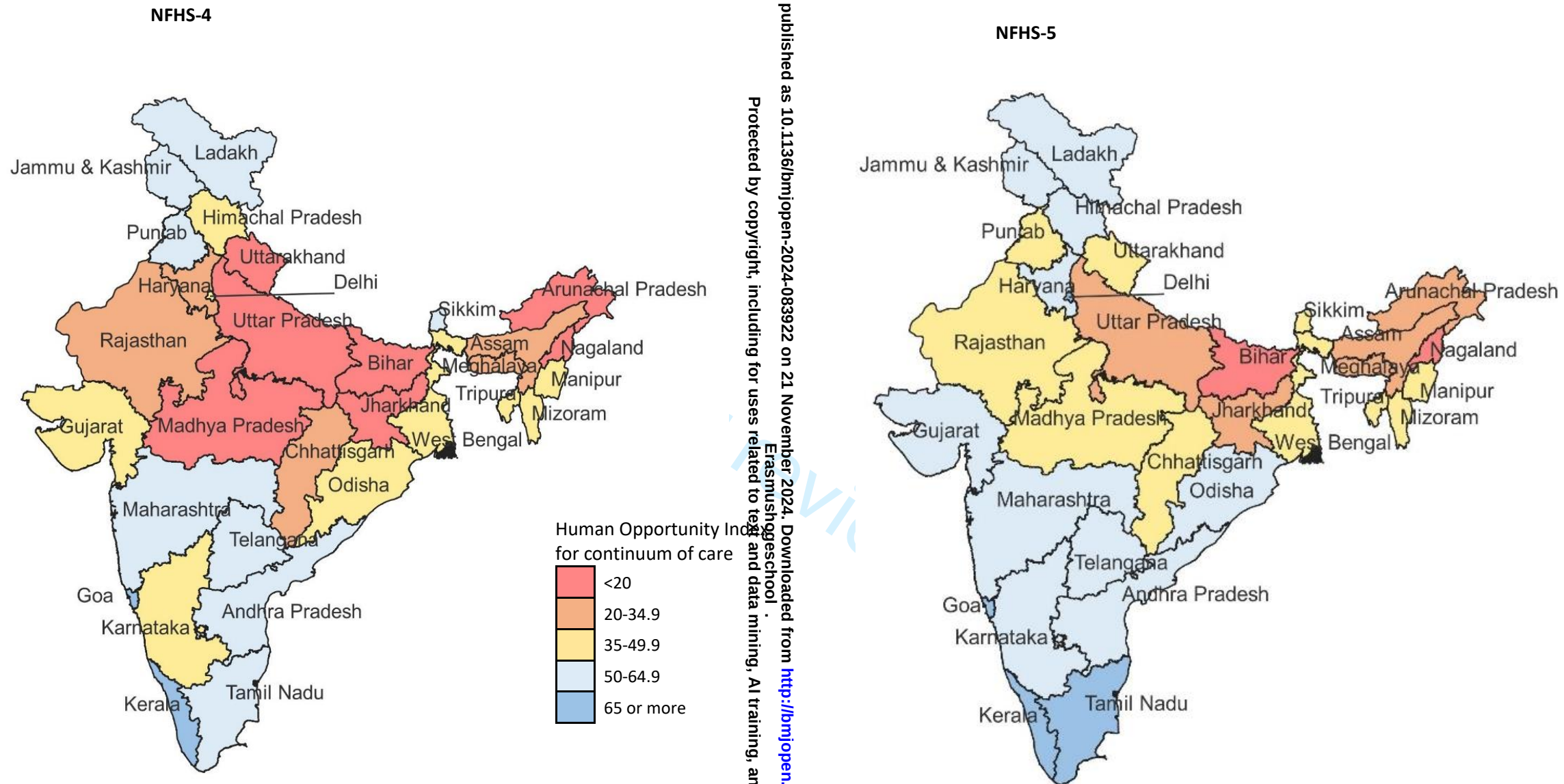


Figure 4. Human Opportunity Index for continuum of care in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.



Population level trends over a decade in geographical inequality for
opportunity in access to maternal care services: findings from the National Family Health Surveys in India

Supplementary file

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Supplementary Table 1. Number of districts by state in the National Family Health Survey (NFHS) rounds 4 and 5.

	Number of districts	
	NFHS-4	NFHS-5
India	628	695
Less developed	363	395
Arunachal Pradesh	16	20
Assam	27	33
Bihar	38	38
Chhattisgarh	18	27
Jharkhand	24	24
Madhya Pradesh	50	51
Manipur	9	9
Meghalaya	7	11
Mizoram	8	8
Nagaland	11	11
Odisha	30	30
Rajasthan	33	33
Sikkim	4	4
Tripura	4	8
Uttar Pradesh	71	75
Uttarakhand	13	13
More developed	265	300
Andhra Pradesh	13	13
Delhi	9	11
Goa	2	2
Gujarat	26	33
Haryana	21	22
Himachal Pradesh	12	12
Jammu & Kashmir [§]	22	22
Karnataka	30	30
Kerala	14	14
Maharashtra	35	36
Punjab	20	22
Tamil Nadu	32	32
Telangana	10	31
West Bengal	19	20

Supplementary Table 2. Coverage of four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), and post-natal care within 48 hours of delivery, and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) 4 and NFHS 5 for India and its states. CI denotes confidence interval.

State	Sample size		Four of more ANC visits			Institutional delivery with SBA*			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4 (N)	NFHS-5 (N)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)
India	188,506[†]	174,796	46.4 (46.2-46.7)	57.0 (56.8-57.3)	22.8 (22.1-23.5)	75.5 (75.3-75.7)	85.0 (84.9-85.2)	12.2 (12.2-12.9)	61.4 (61.2 - 61.6)	78.9 (78.7-79.1)	28.5 (28.0-29.0)	32.9 (32.7-33.1)	45.6 (45.4-45.9)	38.6 (37.6-39.6)
Less developed	132,809	113,519	36.0 (35.7-36.3)	48.0 (47.7-48.3)	33.3 (32.3-34.3)	70.6 (70.3-70.8)	80.9 (80.7-81.2)	14.4 (14.1-15.1)	57.0 (56.7-57.2)	75.1 (74.8-75.3)	31.8 (31.1-32.4)	24.8 (24.6- 25.1)	36.5 (36.3-36.8)	47.2 (45.7-48.6)
Arunachal Pradesh	3,858	4,570	24.6 (23.3- 26.0)	37.2 (35.8-38.6)	51.2 (45.1-57.4)	52.7 (51.1-54.2)	80.6 (79.4-81.7)	52.9 (49.8-56.1)	27.5 (26.1-28.9)	55.4 (53.9-56.8)	101.5 (95.7-107.2)	11.8 (10.8- 12.8)	25.3 (24.1-26.6)	114.7 (104.4-124.4)
Assam	8,534	9,247	45.4 (44.3- 46.4)	50.9 (49.8-51.9)	12.1 (9.5-14.7)	72.5 (71.5-73.4)	84.8 (84.1-85.5)	17.0 (15.6-18.4)	56.9 (55.8-57.9)	67.8 (66.8-68.7)	19.1 (17.1-21.2)	29.9 (20.9-30.9)	35.5 (34.5-36.5)	18.7 (15.1-22.4)
Bihar	16,822	13,874	14.6 (14.1 -15.2)	25.5 (24.7-26.2)	74.7 (70.0-79.3)	66.0 (65.3-66.7)	75.1 (74.4-75.8)	13.8 (11.5-16.0)	47.8 (47.1-48.6)	65.4 (64.6-66.2)	36.8 (35.0-38.7)	9.0 (8.6- 9.4)	17.8 (17.2-18.4)	97.8 (91.5-104.1)
Chhattisgarh	6,805	6,526	56.9 (55.7 - 58.0)	61.2 (60.0-62.4)	7.6 (5.3-9.9)	71.8 (70.7-72.8)	82.1 (81.2-83.0)	14.4 (13.7-15.0)	67.2 (66.0-68.3)	87.2 (86.3-87.9)	29.8 (28.0-31.5)	37.6 (36.4-38.7)	47.3 (46.1-48.5)	25.8 (22.4-29.2)
Jharkhand	8,947	7,465	29.9 (29.0 - 30.9)	38.6 (37.5-39.7)	29.1 (25.4-32.8)	63.8 (62.8-64.8)	74.5 (73.5-75.5)	16.8 (15.0-18.5)	46.8 (45.8-47.8)	74.0 (73.0-75.0)	58.1 (55.6-60.6)	17.0 (16.2-17.8)	27.0 (26.0-28.0)	58.8 (53.3-64.4)
Madhya Pradesh	17,406	11,700	34.9 (34.1-35.6)	57.0 (56.1-57.9)	63.3 (60.9-65.7)	75.9 (75.2-76.5)	86.6 (86.0-87.2)	14.4 (12.1-16.6)	55.9 (55.1-56.6)	85.1 (84.4-85.7)	52.2 (50.8-53.7)	23.1 (22.4 -23.7)	46.1 (45.2-47.0)	99.6 (96.2-102.9)
Manipur	4,429	2,511	65.1 (63.7-66.5)	68.7 (66.8-70.4)	5.5 (2.9-8.2)	67.9 (66.5-69.3)	70.9 (69.1-72.6)	6.9 (5.1-8.6)	62.8 (61.4-64.2)	64.9 (62.9-66.7)	3.3 (0.5-6.2)	49.2 (47.7 -50.7)	50.9 (48.9-52.8)	3.5 (-0.3-7.2)
Meghalaya	3,119	4,602	50.1 (48.4-51.9)	50.3 (48.8-51.7)	0.4 (-3.5-4.3)	56.0 (54.3-57.8)	58.6 (57.2-60.0)	1.1 (-1.1-3.1)	58.0 (56.3-59.8)	58.3 (56.8-59.7)	0.5 (-2.8-3.8)	32.1 (30.4 -33.7)	23.9 (22.7-25.1)	-25.5 (-31.1 to -20.0)
Mizoram	3,681	1,896	56.4 (54.8-58.0)	52.4 (50.2-54.7)	-7.1 (-10.6 to -3.6)	78.1 (76.7-79.4)	79.3 (77.4-81.0)	-1.6 (-5.1-1.9)	62.8 (61.2-64.3)	68.1 (65.9-70.1)	8.4 (5.4-11.5)	41.5 (39.9 -43.1)	42.1 (39.9-44.4)	1.4 (-3.3-6.2)
Nagaland	3,136	2,205	13.5 (12.3-14.7)	15.6 (14.1-17.2)	15.6 (5.2-25.9)	33.8 (32.2-35.5)	42.5 (40.5-44.6)	28.1 (20.3-35.4)	22.6 (21.2-24.1)	43.2 (41.2-45.3)	91.2 (83.3-99.0)	7.6 (6.7- 8.6)	9.4 (8.3-10.7)	23.7 (9.3-38.1)
Odisha	9,015	7,141	64.7 (63.7-65.7)	80.0 (79.1-80.9)	23.6 (22.0-25.3)	83.3 (82.5-84.0)	90.1 (89.4-90.7)	8.1 (7.1-9.2)	77.4 (76.5-78.3)	92.1 (91.5-92.7)	19.0 (17.8-20.2)	47.8 (46.8 -48.8)	69.4 (68.4-70.5)	45.2 (42.8-47.6)
Rajasthan	11,950	10,831	38.3 (37.5-39.2)	56.5 (55.6-57.5)	47.5 (44.9-50.1)	85.0 (84.4-85.6)	95.0 (94.5-95.4)	11.8 (10.0-13.6)	65.2 (64.3-66.0)	85.2 (84.5-85.9)	30.7 (28.3-32.1)	29.1 (28.2 -29.9)	49.4 (48.5-50.4)	69.8 (66.5-73.0)
Sikkim	899	569	74.9 (71.9-77.6)	65.4 (61.4-69.2)	-12.7 (-17.0 to -8.3)	95.2 (93.6-96.4)	96.3 (94.4-97.5)	1.2 (-1.5-2.8)	75.0 (72.0-77.7)	73.5 (69.7-76.9)	-2.1 (-6.3-2.3)	56.0 (52.7-59.2)	52.0 (47.9-56.1)	-7.1 (-13.7 to -0.6)
Tripura	1,169	1,860	63.5 (60.7-66.2)	54.0 (51.7-56.2)	-15.0 (-19.7 to -10.3)	80.3 (77.9-82.5)	86.8 (85.2-88.3)	8.1 (5.1-11.1)	61.2 (58.4-64.0)	68.6 (66.4-70.7)	12.1 (7.2-17.0)	45.9 (43.0 -48.7)	39.7 (37.5-42.0)	-13.5 (-20.2 to -6.8)
Uttar Pradesh	28,741	25,556	27.4 (26.9-27.9)	41.5 (40.9-42.1)	51.5 (49.3-53.7)	68.1 (67.5-68.6)	81.1 (80.6-81.5)	19.1 (17.2-21.0)	59.1 (58.6 - 59.7)	76.9 (76.4-77.4)	30.1 (29.1-31.2)	20.0 (19.5 -20.4)	31.1 (30.5-31.7)	55.5 (52.8-58.2)
Uttarakhand	4,298	2,966	29.7 (28.3-31.1)	60.6 (58.8-62.3)	104.0 (98.7-109.4)	67.9 (66.5-69.2)	80.1 (78.6-81.5)	18.8 (17.7-20.3)	56.9 (55.4-58.4)	84.2 (82.8-85.4)	48.0 (45.2-50.8)	20.5 (19.3 -21.7)	47.7 (45.9-49.5)	132.7 (125.5-139.9)
More developed	55,697	61,277	71.3 (70.9-71.7)	73.7 (73.4-74.1)	3.4 (2.6-4.1)	87.2 (86.9-87.5)	92.6 (92.4-92.8)	6.2 (5.8-6.6)	71.9 (71.5-72.3)	86.0 (85.7-86.3)	19.6 (19.0-20.3)	52.3 (51.9- 52.7)	62.5 (62.2-62.9)	19.5 (18.4-20.6)
Andhra Pradesh	4,055	2,092	75.7 (73.9 - 77.4)	69.3 (67.2-71.2)	-8.5 (-11.0 to -5.9)	89.5 (88.2-90.7)	95.7 (94.8-96.5)	6.9 (5.5-8.4)	79.3 (77.6 - 80.9)	90.8 (89.5-91.9)	14.5 (12.3-16.7)	57.8 (55.7- 59.8)	62.2 (60.1-64.3)	7.6 (3.8-11.5)
Delhi	1,258	2,379	71.4	79.9	11.9	88.0	91.7	4.2	63.3	87.2	37.8	46.6	69.6	49.4

State	Sample size		Four of more ANC visits			Institutional delivery with SBA*			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4 (N)	NFHS-5 (N)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)
			(68.8 - 73.8)	(78.2-81.4)	(8.3-15.6)	(86.1-89.7)	(90.5-92.7)	(2.1-6.3)	(60.6 - 66.0)	(85.8-88.5)	(33.3-42.1)	(43.9 - 49.4)	(67.7-71.4)	(43.2-55.5)
Goa	347	322	87.6 (83.7 - 90.7)	93.2 (89.8-95.4)	6.4 (2.2-10.5)	96.8 (94.4-98.2)	98.8 (96.7-99.5)	2.1 (0.1-4.0)	91.4 (87.9 - 93.9)	96.3 (93.5-97.9)	5.4 (2.0-8.7)	80.7 (76.2 - 84.5)	90.1 (86.3-92.9)	11.6 (6.3-17.0)
Gujarat	5,827	7,575	66.4 (65.2 - 67.6)	77.7 (76.7-78.6)	17.0 (15.1-19.0)	83.9 (82.9-84.8)	90.3 (89.6-90.9)	7.6 (4.4-8.8)	62.9 (61.7 - 64.2)	89.4 (88.6-90.0)	42.1 (40.1-44.2)	42.3 (41.0- 43.5)	66.3 (65.3-67.4)	56.7 (53.5-60.0)
Haryana	5,719	5,162	45.4 (44.1 - 46.7)	60.8 (59.4-62.1)	33.9 (30.7-37.1)	82.1 (81.1-83.1)	93.4 (92.6-94.0)	13.3 (11.5-15.0)	68.3 (67.0 - 69.5)	91.3 (90.5-92.0)	33.7 (31.8-35.5)	34.3 (33.1 - 35.6)	55.6 (54.3-57.0)	62.1 (58.0-66.2)
Himachal Pradesh	2,292	2,145	66.2 (64.3 - 68.1)	71.8 (69.8-73.6)	8.5 (5.3-11.7)	75.9 (74.1-77.6)	84.3 (82.7-85.8)	11.1 (8.5-13.6)	73.6 (71.8 - 75.4)	88.9 (87.5-90.2)	20.8 (18.2-23.4)	49.5 (47.4 - 51.5)	59.3 (57.2-.61.3)	19.8 (15.2-24.4)
Jammu & Kashmir [§]	6,280	5,367	79.5 (78.5 - 80.5)	80.7 (79.6-81.7)	1.5 (0.1-2.9)	83.2 (82.2-84.1)	91.0 (90.2-91.7)	9.4 (8.2-10.6)	73.0 (71.9 - 74.1)	80.3 (79.2-81.3)	10.0 (8.4-11.6)	61.8 (60.6 - 63.0)	65.1 (63.8-66.4)	5.3 (3.2-7.5)
Karnataka	5,876	6,389	73.5 (72.3 - 74.6)	70.8 (69.6-71.9)	-3.7 (-5.4 to -2.0)	90.7 (90.0-91.5)	92.5 (91.8-93.1)	2.0 (1.1-2.9)	60.5 (59.2 - 61.7)	86.4 (85.5-87.2)	42.8 (40.6-45.0)	44.6 (43.3 - 45.9)	59.1 (57.9-60.3)	32.5 (29.4-35.6)
Kerala	2,128	2,360	90.3 (89.0 - 91.5)	82.2 (80.6-83.7)	-9.0 (-10.6 to -7.4)	99.9 (99.6-100.0)	99.8 (99.5-99.9)	-0.1 (-1.3-0.1)	86.3 (84.7 - 87.7)	92.8 (91.7-93.8)	7.5 (5.7-9.3)	78.4 (76.6 - 80.1)	77.9 (76.2-79.5)	-0.6 (-3.1-1.8)
Maharashtra	7,143	7,415	72.3 (71.3 - 73.3)	71.3 (70.3-72.3)	-1.4 (-3.0- 0.2)	86.7 (85.9-87.5)	91.0 (90.3-91.6)	5.0 (4.0-5.9)	76.9 (75.9 - 77.9)	84.1 (83.3-84.9)	9.4 (8.0-10.7)	54.4 (53.2 - 55.5)	60.2 (59.1-61.3)	10.7 (8.3-13.0)
Punjab	4,132	4,520	68.2 (66.7 - 69.6)	58.3 (56.8-59.7)	-14.5 (-16.8 to -12.2)	92.0 (91.2-92.8)	94.1 (93.4-94.7)	2.3 (1.4-3.2)	88.4 (87.4 - 89.3)	87.1 (86.1-88.0)	-1.5 (-2.7 to -0.3)	59.1 (57.6 - 60.6)	50.2 (48.7-51.6)	-15.1 (-17.8 to -12.3)
Tamil Nadu	6,181	5,228	80.7 (79.7 - 81.7)	91.6 (90.8-92.3)	13.5 (12.2-14.8)	98.8 (98.5-99.1)	99.5 (99.3-99.7)	0.7 (0.1-1.0)	72.4 (71.3 - 73.5)	92.2 (91.4-92.9)	27.3 (25.7-29.0)	60.8 (59.6 - 62.0)	84.9 (84.0-85.9)	39.6 (37.5-41.8)
Telangana	NA	5,429	73.1 (71.0 - 75.1)	69.7 (68.5-70.9)	-4.7 (-7.6 to -1.7)	87.2 (85.6-88.7)	91.4 (90.6-92.1)	4.8 (3.8-5.6)	81.7 (79.8 - 83.4)	86.6 (85.7-87.5)	6.0 (3.7-8.2)	57.6 (55.3- 59.9)	56.9 (55.6-58.2)	-1.2 (-5.3-2.9)
West Bengal	4,459	4,894	74.2 (72.9 - 75.5)	75.7 (74.4-76.9)	2.0 (0.1-3.9)	77.0 (75.8-78.2)	91.2 (90.4-91.9)	18.4 (16.8-20.1)	63.1 (61.7 - 64.5)	68.2 (66.9-69.5)	8.1 (5.6-10.5)	47.4 (46.0 - 48.9)	52.0 (50.6-53.4)	9.7 (6.3-13.1)

*Includes doctor, auxiliary nurse midwife, nurse, midwife, and lady health visitor
†Data missing on 101 women for institutional delivery with SBA, PNC within 48 hours of delivery, and continuum of care in NFHS-5
§Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh

Supplementary Table 3. Human Opportunity Index for geographic inequality for four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), post-natal care within 48 hours of delivery and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) rounds 4 and 5 for India and its states. CI denotes confidence interval.

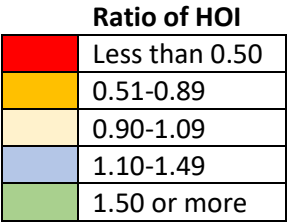
	Human Opportunity Index											
	Four of more ANC visits			Institutional delivery with SBA			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)
India	35.8	48.4	35.2 (34.5 to 35.9)	68.9	80.4	16.7 (16.8 to 17.0)	54.6	73.5	34.6 (34.2 to 35.1)	24.4	37.1	52.2 (51.1 to 53.0)
Less developed states	27.9	40.7	45.9 (44.9 to 46.9)	64.5	76.2	18.1 (17.7 to 18.6)	50.6	69.4	37.2 (36.6 to 37.8)	18.5	29.7	60.5 (59.2 to 61.9)
Arunachal Pradesh	20.2	34.3	69.8 (62.7 to 76.9)	47.0	77.5	64.9 (51.1 to 68.5)	22.7	51.9	128.6 (122.1 to 135.2)	8.2	21.9	167.1 (154.4 to 179.8)
Assam	40.7	45.6	12.0 (9.2 to 14.9)	66.5	82.3	23.8 (22.1 to 25.4)	51.1	64.7	26.6 (24.3 to 28.9)	24.9	31.0	24.5 (20.3 to 28.7)
Bihar	12.8	22.9	78.9 (73.9 to 83.9)	61.0	72.1	18.2 (16.6 to 19.6)	43.1	59.6	38.3 (36.2 to 40.3)	7.7	15.3	98.7 (91.8 to 105.6)
Chhattisgarh	52.0	57.2	10.0 (7.5 to 12.5)	68.6	78.5	14.4 (12.2 to 16.2)	63.0	85.3	35.4 (33.5 to 37.3)	33.1	43.3	30.8 (27.0 to 34.6)
Jharkhand	25.0	36.0	44.0 (39.7 to 48.3)	59.5	70.4	18.3 (16.7 to 20.3)	43.2	70.9	64.1 (61.4 to 66.8)	13.8	24.1	74.6 (68.3 to 81.0)
Madhya Pradesh	29.4	52.2	77.6 (74.8 to 80.3)	70.8	84.1	18.8 (17.7 to 19.8)	51.3	82.8	61.4 (59.8 to 63.0)	19.1	41.2	115.7 (111.9 to 119.5)
Manipur	54.9	61.2	11.5 (8.2 to 14.8)	58.0	62.0	6.9 (3.3 to 10.0)	54.4	57.7	6.1 (2.7 to 9.4)	39.2	41.5	5.9 (1.3 to 10.4)
Meghalaya	44.3	45.4	2.5 (-1.9 to 6.9)	49.6	52.5	5.8 (1.9 to 9.8)	52.0	53.4	2.7 (-1.1 to 6.4)	26.4	20.5	-22.3 (-28.8 to -15.9)
Mizoram	52.4	46.6	-11.1 (-14.8 to -7.3)	72.1	72.4	0.4 (-2.0 to 2.9)	59.0	63.9	8.3 (5.0 to 11.6)	37.9	36.6	-3.4 (-8.5 to 1.6)
Nagaland	8.3	11.3	36.1 (22.3 to 50.0)	26.2	37.4	42.7 (35.2 to 49.7)	17.2	37.5	118.0 (108.5 to 127.5)	4.4	6.5	47.7 (28.0 to 67.5)
Odisha	59.2	76.2	28.7 (26.8 to 30.6)	79.2	87.3	10.2 (9.1 to 11.4)	74.4	90.7	21.9 (20.6 to 23.2)	42.6	64.8	52.1 (49.4 to 54.8)
Rajasthan	33.0	51.2	55.2 (52.2 to 58.1)	81.8	93.9	14.8 (13.3 to 15.7)	61.2	82.6	35.0 (33.4 to 36.5)	24.6	44.2	79.7 (76.0 to 83.3)
Sikkim	71.3	60.1	-15.7 (-20.5 to -10.9)	94.4	95.2	0.8 (-0.9 to 2.6)	71.9	70.4	-2.1 (-6.7 to 2.5)	52.1	48.3	-7.3 (-14.4 to -0.2)
Tripura	60.4	50.4	-16.6 (-21.6 to -11.5)	76.4	83.5	9.5 (5.5 to 12.7)	58.2	64.2	10.3 (5.1 to 15.5)	42.9	35.3	-17.7 (-24.8 to -10.6)
Uttar Pradesh	21.9	38.1	74.0 (71.4 to 76.6)	64.0	78.0	21.9 (20.1 to 22.8)	53.5	73.2	36.8 (35.6 to 38.0)	15.6	27.9	78.8 (75.6 to 82.1)
Uttarakhand	25.9	55.7	115.1 (109.0 to 121.1)	65.2	78.5	20.4 (19.2 to 22.8)	54.3	81.5	50.1 (47.1 to 53.1)	17.5	43.3	147.4 (139.3 to 155.5)
More developed states	65.2	68.2	4.6 (3.9 to 5.3)	82.8	90.1	8.6 (7.4 to 9.2)	66.2	82.6	24.8 (24.1 to 25.4)	45.7	56.3	23.2 (22.2 to 24.2)
Andhra Pradesh	74.3	68.3	-8.1 (-10.8 to -5.4)	88.0	95.4	8.2 (7.1 to 10.0)	77.6	90.4	16.5 (14.2 to 18.8)	56.1	59.3	5.7 (1.7 to 9.7)
Goa	86.0	92.4	7.4 (3.0 to 11.9)	96.7	98.5	1.9 (1.2 to 3.9)	90.5	95.6	5.6 (2.1 to 9.2)	79.0	88.8	12.4 (6.7 to 18.1)
Gujarat	59.7	73.1	22.4 (20.2 to 24.7)	80.1	87.5	9.2 (8.0 to 10.6)	59.9	87.1	45.4 (43.2 to 47.6)	36.7	61.2	66.8 (63.1 to 70.4)
Haryana	37.3	56.6	51.7 (47.9 to 55.5)	75.6	90.5	19.7 (18.3 to 21.3)	61.3	88.7	44.7 (42.5 to 46.9)	27.2	51.2	88.2 (83.3 to 93.1)
Himachal Pradesh	61.7	67.1	8.8 (5.2 to 12.3)	72.7	82.5	13.5 (10.9 to 16.2)	69.8	87.3	25.1 (22.2 to 27.9)	45.4	54.3	19.6 (14.6 to 24.6)
Jammu & Kashmir*	71.9	76.3	6.1 (4.4 to 7.8)	77.8	87.9	13.0 (11.1 to 14.4)	67.1	77.2	15.1 (13.2 to 16.9)	53.3	59.5	11.6 (9.1 to 14.2)
Karnataka	69.3	65.1	-6.1 (-7.9 to -4.2)	88.4	90.3	2.1 (1.1 to 3.1)	55.3	83.6	51.2 (48.8 to 53.6)	39.6	52.6	32.8 (29.4 to 36.3)
Kerala	88.9	77.3	-13.0 (-14.8 to -11.3)	99.8	99.7	-0.1 (-0.3 to 0.1)	84.2	91.5	8.7 (6.7 to 10.6)	75.7	72.9	-3.7 (-6.3 to -1.1)
Maharashtra	69.3	66.7	-3.8 (-5.5 to -2.0)	83.9	88.2	5.1 (4.0 to 6.2)	74.2	80.8	8.9 (7.4 to 10.4)	50.0	54.5	9.0 (6.4 to 11.6)
Delhi	68.8	75.3	9.4 (5.5 to 13.3)	86.0	90.2	4.9 (2.6 to 7.2)	59.1	85.1	44.0 (39.3 to 48.7)	42.7	65.3	52.9 (46.2 to 59.7)
Punjab	64.6	54.7	-15.3 (-17.8 to -12.8)	91.1	92.9	2.0 (1.0 to 3.0)	86.9	85.4	-1.7 (-3.0 to -0.4)	55.5	46.9	-15.5 (-18.5 to -12.5)
Tamil Nadu	77.5	89.6	15.6 (14.2 to 17.0)	98.4	99.2	0.8 (0.5 to 1.1)	68.4	90.4	32.2 (30.4 to 33.9)	56.4	82.0	45.4 (43.0 to 47.7)
Telangana	71.8	68.2	-5.0 (-8.0 to -2.0)	85.6	90.4	5.6 (3.7 to 7.6)	79.9	85.4	6.9 (4.5 to 9.3)	55.7	54.9	-1.4 (-5.7 to 2.8)
West Bengal	69.4	72.2	4.0 (1.9 to 6.2)	71.3	89.2	25.1 (23.3 to 27.1)	58.0	63.8	10.7 (7.3 to 12.7)	42.0	47.3	12.6 (8.8 to 16.4)

*Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh.

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Supplementary Table 4. Ratio of Human opportunity index (HOI) between wealth index quintiles I and V for the maternal services for India and its states, National Family Health Survey-5.

	Ratio of HOI between wealth index quintiles I and V			
	Four of more antenatal care visits	Institutional delivery with skilled birth attendant	Post-natal care within 48 hours of delivery	Continuum of care
India	0.52	0.69	0.73	0.38
Less developed states	0.55	0.69	0.74	0.41
Arunachal Pradesh	0.43	0.58	0.70	0.38
Assam	0.63	0.75	0.79	0.54
Bihar	0.32	0.72	0.71	0.25
Chhattisgarh	0.89	0.72	0.93	0.70
Jharkhand	0.51	0.64	0.81	0.33
Madhya Pradesh	0.72	0.83	0.91	0.60
Manipur	0.40	0.40	0.48	0.33
Meghalaya	0.66	0.47	0.88	0.55
Mizoram	0.16	0.28	0.36	0.12
Nagaland	0.27	0.35	0.47	0.08
Odisha	0.84	0.81	0.94	0.69
Rajasthan	0.77	0.92	0.92	0.73
Sikkim	1.41	0.94	1.17	0.22
Tripura	0.81	0.79	0.68	0.39
Uttar Pradesh	0.60	0.76	0.80	0.40
Uttarakhand	0.51	0.68	0.81	0.40
More developed states	0.83	0.80	0.76	0.40
Andhra Pradesh	0.66	0.75	0.73	0.39
Goa	1.07	1.01	1.01	0.73
Gujarat	0.79	0.83	0.96	0.39
Haryana	0.52	0.67	0.70	0.39
Himachal Pradesh	0.70	0.60	0.77	0.40
Jammu and Kashmir	0.76	0.74	0.78	0.61
Karnataka	0.75	0.90	0.91	0.64
Kerala	0.95	1.00	0.89	0.96
Maharashtra	0.68	0.73	0.78	0.51
Delhi	0.34	0.24	0.36	0.02
Punjab	0.54	0.84	0.80	0.57
Tamil Nadu	1.01	0.96	0.94	0.96
Telangana	0.78	0.83	0.89	0.63
West Bengal	0.85	0.90	0.70	0.51



Population level Trends over a decade in geographical inequality of opportunity in access to maternal care services: findings from the National Family Health Surveys in India

Supplementary file

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Supplementary Table 1. Number of districts by state in the National Family Health Survey (NFHS) rounds 4 and 5.

	Number of districts	
	NFHS-4	NFHS-5
India	628	695
Less developed	363	395
Arunachal Pradesh	16	20
Assam	27	33
Bihar	38	38
Chhattisgarh	18	27
Jharkhand	24	24
Madhya Pradesh	50	51
Manipur	9	9
Meghalaya	7	11
Mizoram	8	8
Nagaland	11	11
Odisha	30	30
Rajasthan	33	33
Sikkim	4	4
Tripura	4	8
Uttar Pradesh	71	75
Uttarakhand	13	13
More developed	265	300
Andhra Pradesh	13	13
Delhi	9	11
Goa	2	2
Gujarat	26	33
Haryana	21	22
Himachal Pradesh	12	12
Jammu & Kashmir ⁵	22	22
Karnataka	30	30
Kerala	14	14
Maharashtra	35	36
Punjab	20	22
Tamil Nadu	32	32
Telangana	10	31
West Bengal	19	20

Supplementary Table 2. Coverage of four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), and post-natal care within 48 hours of delivery, and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) 4 and NFHS 5 for India and its states. CI denotes confidence interval.

State	Sample size		Four of more ANC visits			Institutional delivery with SBA*			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4 (N)	NFHS-5 (N)	NFHS-4 N=188,506 % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [‡] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [‡] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [‡] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)
India	188,506 [‡]	174,796	46.4 (46.2-46.7)	57.0 (56.8-57.3)	22.8 (22.1-23.5)	75.5 (75.3-75.7)	85.0 (84.9-85.2)	12.2 (12.2-12.9)	61.4 (61.2 - 61.6)	78.9 (78.7-79.1)	28.5 (28.0-29.0)	32.9 (32.7-33.1)	45.6 (45.4-45.9)	38.6 (37.6-39.6)
Less developed	132,809	113,519	36.0 (35.7-36.3)	48.0 (47.7-48.3)	33.3 (32.3-34.3)	70.6 (70.3-70.8)	80.9 (80.7-81.2)	14.4 (14.1-15.1)	57.0 (56.7-57.2)	75.1 (74.8-75.3)	31.8 (31.1-32.4)	24.8 (24.6- 25.1)	36.5 (36.3-36.8)	47.2 (45.7-48.6)
Arunachal Pradesh	3,858	4,570	24.6 (23.3- 26.0)	37.2 (35.8-38.6)	51.2 (45.1-57.4)	52.7 (51.1-54.2)	80.6 (79.4-81.7)	52.2 (49.8-54.1)	27.5 (26.1-28.9)	55.4 (53.9-56.8)	101.5 (95.7-107.2)	11.8 (10.8- 12.8)	25.3 (24.1-26.6)	114.7 (104.4-124.4)
Assam	8,534	9,247	45.4 (44.3- 46.4)	50.9 (49.8-51.9)	12.1 (9.5-14.7)	72.5 (71.5-73.4)	84.8 (84.1-85.5)	17.0 (15.6-18.4)	56.9 (55.8-57.9)	67.8 (66.8-68.7)	19.1 (17.1-21.2)	29.9 (20.9-30.9)	35.5 (34.5-36.5)	18.7 (15.1-22.4)
Bihar	16,822	13,874	14.6 (14.1 -15.2)	25.5 (24.7-26.2)	74.7 (70.0-79.3)	66.0 (65.3-66.7)	75.1 (74.4-75.8)	13.8 (11.5-16.0)	47.8 (47.1-48.6)	65.4 (64.6-66.2)	36.8 (35.0-38.7)	9.0 (8.6- 9.4)	17.8 (17.2-18.4)	97.8 (91.5-104.1)
Chhattisgarh	6,805	6,526	56.9 (55.7 - 58.0)	61.2 (60.0-62.4)	7.6 (5.3-9.9)	71.8 (70.7-72.8)	82.1 (81.2-83.0)	14.4 (13.7-15.0)	67.2 (66.0-68.3)	87.2 (86.3-87.9)	29.8 (28.0-31.5)	37.6 (36.4-38.7)	47.3 (46.1-48.5)	25.8 (22.4-29.2)
Jharkhand	8,947	7,465	29.9 (29.0 - 30.9)	38.6 (37.5-39.7)	29.1 (25.4-32.8)	63.8 (62.8-64.8)	74.5 (73.5-75.5)	16.6 (15.0-18.5)	46.8 (45.8-47.8)	74.0 (73.0-75.0)	58.1 (55.6-60.6)	17.0 (16.2-17.8)	27.0 (26.0-28.0)	58.8 (53.3-64.4)
Madhya Pradesh	17,406	11,700	34.9 (34.1-35.6)	57.0 (56.1-57.9)	63.3 (60.9-65.7)	75.9 (75.2-76.5)	86.6 (86.0-87.2)	14.4 (12.1-16.0)	55.9 (55.1-56.6)	85.1 (84.4-85.7)	52.2 (50.8-53.7)	23.1 (22.4 -23.7)	46.1 (45.2-47.0)	99.6 (96.2-102.9)
Manipur	4,429	2,511	65.1 (63.7-66.5)	68.7 (66.8-70.4)	5.5 (2.9-8.2)	67.9 (66.5-69.3)	70.9 (69.1-72.6)	6.9 (5.1-8.6)	62.8 (61.4-64.2)	64.9 (62.9-66.7)	3.3 (0.5-6.2)	49.2 (47.7 -50.7)	50.9 (48.9-52.8)	3.5 (-0.3-7.2)
Meghalaya	3,119	4,602	50.1 (48.4-51.9)	50.3 (48.8-51.7)	0.4 (-3.5-4.3)	56.0 (54.3-57.8)	58.6 (57.2-60.0)	1.1 (-1.1-3.1)	58.0 (56.3-59.8)	58.3 (56.8-59.7)	0.5 (-2.8-3.8)	32.1 (30.4 -33.7)	23.9 (22.7-25.1)	-25.5 (-31.1 to -20.0)
Mizoram	3,681	1,896	56.4 (54.8-58.0)	52.4 (50.2-54.7)	-7.1 (-10.6 to -3.6)	78.1 (76.7-79.4)	79.3 (77.4-81.0)	-1.6 (-5.1-1.9)	62.8 (61.2-64.3)	68.1 (65.9-70.1)	8.4 (5.4-11.5)	41.5 (39.9 -43.1)	42.1 (39.9-44.4)	1.4 (-3.3-6.2)
Nagaland	3,136	2,205	13.5 (12.3-14.7)	15.6 (14.1-17.2)	15.6 (5.2-25.9)	33.8 (32.2-35.5)	42.5 (40.5-44.6)	26.0 (20.3-31.4)	22.6 (21.2-24.1)	43.2 (41.2-45.3)	91.2 (83.3-99.0)	7.6 (6.7- 8.6)	9.4 (8.3-10.7)	23.7 (9.3-38.1)
Odisha	9,015	7,141	64.7 (63.7-65.7)	80.0 (79.1-80.9)	23.6 (22.0-25.3)	83.3 (82.5-84.0)	90.1 (89.4-90.7)	8.1 (7.1-9.2)	77.4 (76.5-78.3)	92.1 (91.5-92.7)	19.0 (17.8-20.2)	47.8 (46.8 -48.8)	69.4 (68.4-70.5)	45.2 (42.8-47.6)
Rajasthan	11,950	10,831	38.3 (37.5-39.2)	56.5 (55.6-57.5)	47.5 (44.9-50.1)	85.0 (84.4-85.6)	95.0 (94.5-95.4)	11.8 (10.1-13.6)	65.2 (64.3-66.0)	85.2 (84.5-85.9)	30.7 (28.3-32.1)	29.1 (28.2 -29.9)	49.4 (48.5-50.4)	69.8 (66.5-73.0)
Sikkim	899	569	74.9 (71.9-77.6)	65.4 (61.4-69.2)	-12.7 (-17.0 to -8.3)	95.2 (93.6-96.4)	96.3 (94.4-97.5)	1.2 (-1.5-2.8)	75.0 (72.0-77.7)	73.5 (69.7-76.9)	-2.1 (-6.3-2.3)	56.0 (52.7-59.2)	52.0 (47.9-56.1)	-7.1 (-13.7 to -0.6)
Tripura	1,169	1,860	63.5 (60.7-66.2)	54.0 (51.7-56.2)	-15.0 (-19.7 to -10.3)	80.3 (77.9-82.5)	86.8 (85.2-88.3)	8.1 (5.1-11.1)	61.2 (58.4-64.0)	68.6 (66.4-70.7)	12.1 (7.2-17.0)	45.9 (43.0 -48.7)	39.7 (37.5-42.0)	-13.5 (-20.2 to -6.8)
Uttar Pradesh	28,741	25,556	27.4 (26.9-27.9)	41.5 (40.9-42.1)	51.5 (49.3-53.7)	68.1 (67.5-68.6)	81.1 (80.6-81.5)	19.9 (19.2-20.6)	59.1 (58.6 - 59.7)	76.9 (76.4-77.4)	30.1 (29.1-31.2)	20.0 (19.5 -20.4)	31.1 (30.5-31.7)	55.5 (52.8-58.2)
Uttarakhand	4,298	2,966	29.7 (28.3-31.1)	60.6 (58.8-62.3)	104.0 (98.7-109.4)	67.9 (66.5-69.2)	80.1 (78.6-81.5)	18.8 (17.7-20.3)	56.9 (55.4-58.4)	84.2 (82.8-85.4)	48.0 (45.2-50.8)	20.5 (19.3 -21.7)	47.7 (45.9-49.5)	132.7 (125.5-139.9)
More developed	55,697	61,277	71.3 (70.9-71.7)	73.7 (73.4-74.1)	3.4 (2.6-4.1)	87.2 (86.9-87.5)	92.6 (92.4-92.8)	6.2 (5.8-6.6)	71.9 (71.5-72.3)	86.0 (85.7-86.3)	19.6 (19.0-20.3)	52.3 (51.9- 52.7)	62.5 (62.2-62.9)	19.5 (18.4-20.6)
Andhra Pradesh	4,055	2,092	75.7 (73.9 - 77.4)	69.3 (67.2-71.2)	-8.5 (-11.0 to -5.9)	89.5 (88.2-90.7)	95.7 (94.8-96.5)	6.9 (5.5-8.4)	79.3 (77.6 - 80.9)	90.8 (89.5-91.9)	14.5 (12.3-16.7)	57.8 (55.7- 59.8)	62.2 (60.1-64.3)	7.6 (3.8-11.5)
Delhi	1,258	2,379	71.4	79.9	11.9	88.0	91.7	4.2	63.3	87.2	37.8	46.6	69.6	49.4

State	Sample size		Four of more ANC visits			Institutional delivery with SBA*			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4 (N)	NFHS-5 (N)	NFHS-4 N=188,506 % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [†] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [†] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 N=188,506 [†] % of N (95% CI)	NFHS-5 N=174,796 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)
			(68.8 - 73.8)	(78.2-81.4)	(8.3-15.6)	(86.1-89.7)	(90.5-92.7)	(2.1-6.3)	(60.6 - 66.0)	(85.8-88.5)	(33.3-42.1)	(43.9 - 49.4)	(67.7-71.4)	(43.2-55.5)
Goa	347	322	87.6 (83.7 - 90.7)	93.2 (89.8-95.4)	6.4 (2.2-10.5)	96.8 (94.4-98.2)	98.8 (96.7-99.5)	2.1 (0.1-4.0)	91.4 (87.9 - 93.9)	96.3 (93.5-97.9)	5.4 (2.0-8.7)	80.7 (76.2 - 84.5)	90.1 (86.3-92.9)	11.6 (6.3-17.0)
Gujarat	5,827	7,575	66.4 (65.2 - 67.6)	77.7 (76.7-78.6)	17.0 (15.1-19.0)	83.9 (82.9-84.8)	90.3 (89.6-90.9)	7.6 (4.4-8.8)	62.9 (61.7 - 64.2)	89.4 (88.6-90.0)	42.1 (40.1-44.2)	42.3 (41.0- 43.5)	66.3 (65.3-67.4)	56.7 (53.5-60.0)
Haryana	5,719	5,162	45.4 (44.1 - 46.7)	60.8 (59.4-62.1)	33.9 (30.7-37.1)	82.1 (81.1-83.1)	93.4 (92.6-94.0)	13.3 (11.5-15.0)	68.3 (67.0 - 69.5)	91.3 (90.5-92.0)	33.7 (31.8-35.5)	34.3 (33.1 - 35.6)	55.6 (54.3-57.0)	62.1 (58.0-66.2)
Himachal Pradesh	2,292	2,145	66.2 (64.3 - 68.1)	71.8 (69.8-73.6)	8.5 (5.3-11.7)	75.9 (74.1-77.6)	84.3 (82.7-85.8)	11.1 (8.5-13.6)	73.6 (71.8 - 75.4)	88.9 (87.5-90.2)	20.8 (18.2-23.4)	49.5 (47.4 - 51.5)	59.3 (57.2-.61.3)	19.8 (15.2-24.4)
Jammu & Kashmir [§]	6,280	5,367	79.5 (78.5 - 80.5)	80.7 (79.6-81.7)	1.5 (0.1-2.9)	83.2 (82.2-84.1)	91.0 (90.2-91.7)	9.4 (8.2-10.6)	73.0 (71.9 - 74.1)	80.3 (79.2-81.3)	10.0 (8.4-11.6)	61.8 (60.6 - 63.0)	65.1 (63.8-66.4)	5.3 (3.2-7.5)
Karnataka	5,876	6,389	73.5 (72.3 - 74.6)	70.8 (69.6-71.9)	-3.7 (-5.4 to -2.0)	90.7 (90.0-91.5)	92.5 (91.8-93.1)	2.0 (1.1-2.9)	60.5 (59.2 - 61.7)	86.4 (85.5-87.2)	42.8 (40.6-45.0)	44.6 (43.3 - 45.9)	59.1 (57.9-60.3)	32.5 (29.4-35.6)
Kerala	2,128	2,360	90.3 (89.0 - 91.5)	82.2 (80.6-83.7)	-9.0 (-10.6 to -7.4)	99.9 (99.6-100.0)	99.8 (99.5-99.9)	-0.1 (-1.3-0.1)	86.3 (84.7 - 87.7)	92.8 (91.7-93.8)	7.5 (5.7-9.3)	78.4 (76.6 - 80.1)	77.9 (76.2-79.5)	-0.6 (-3.1-1.8)
Maharashtra	7,143	7,415	72.3 (71.3 - 73.3)	71.3 (70.3-72.3)	-1.4 (-3.0- 0.2)	86.7 (85.9-87.5)	91.0 (90.3-91.6)	5.0 (4.0-5.9)	76.9 (75.9 - 77.9)	84.1 (83.3-84.9)	9.4 (8.0-10.7)	54.4 (53.2 - 55.5)	60.2 (59.1-61.3)	10.7 (8.3-13.0)
Punjab	4,132	4,520	68.2 (66.7 - 69.6)	58.3 (56.8-59.7)	-14.5 (-16.8 to -12.2)	92.0 (91.2-92.8)	94.1 (93.4-94.7)	3.2 (1.3-5.2)	88.4 (87.4 - 89.3)	87.1 (86.1-88.0)	-1.5 (-2.7 to -0.3)	59.1 (57.6 - 60.6)	50.2 (48.7-51.6)	-15.1 (-17.8 to -12.3)
Tamil Nadu	6,181	5,228	80.7 (79.7 - 81.7)	91.6 (90.8-92.3)	13.5 (12.2-14.8)	98.8 (98.5-99.1)	99.5 (99.3-99.7)	0.7 (0.1-1.0)	72.4 (71.3 - 73.5)	92.2 (91.4-92.9)	27.3 (25.7-29.0)	60.8 (59.6 - 62.0)	84.9 (84.0-85.9)	39.6 (37.5-41.8)
Telangana	NA	5,429	73.1 (71.0 - 75.1)	69.7 (68.5-70.9)	-4.7 (-7.6 to -1.7)	87.2 (85.6-88.7)	91.4 (90.6-92.1)	4.6 (3.6-5.6)	81.7 (79.8 - 83.4)	86.6 (85.7-87.5)	6.0 (3.7-8.2)	57.6 (55.3- 59.9)	56.9 (55.6-58.2)	-1.2 (-5.3-2.9)
West Bengal	4,459	4,894	74.2 (72.9 - 75.5)	75.7 (74.4-76.9)	2.0 (0.1-3.9)	77.0 (75.8-78.2)	91.2 (90.4-91.9)	18.2 (16.8-19.1)	63.1 (61.7 - 64.5)	68.2 (66.9-69.5)	8.1 (5.6-10.5)	47.4 (46.0 - 48.9)	52.0 (50.6-53.4)	9.7 (6.3-13.1)

*Includes doctor, auxiliary nurse midwife, nurse, midwife, and lady health visitor
[†]Data missing on 101 women for institutional delivery with SBA, PNC within 48 hours of delivery, and continuum of care in NFHS-5
[§]Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh

Supplementary Table 3. Human Opportunity Index for geographic inequality for four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), post-natal care within 48 hours of delivery and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) rounds 4 and 5 for India and its states. CI denotes confidence interval.

	Human Opportunity Index											
	Four of more ANC visits			Institutional delivery with SBA			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)
India	35.8	48.4	35.2 (34.5 to 35.9)	68.9	80.4	16.7 (16.4 to 17.0)	54.6	73.5	34.6 (34.2 to 35.1)	24.4	37.1	52.2 (51.1 to 53.0)
Less developed states	27.9	40.7	45.9 (44.9 to 46.9)	64.5	76.2	18.1 (17.7 to 18.6)	50.6	69.4	37.2 (36.6 to 37.8)	18.5	29.7	60.5 (59.2 to 61.9)
Arunachal Pradesh	20.2	34.3	69.8 (62.7 to 76.9)	47.0	77.5	64.9 (51.1 to 68.5)	22.7	51.9	128.6 (122.1 to 135.2)	8.2	21.9	167.1 (154.4 to 179.8)
Assam	40.7	45.6	12.0 (9.2 to 14.9)	66.5	82.3	23.8 (22.1 to 25.4)	51.1	64.7	26.6 (24.3 to 28.9)	24.9	31.0	24.5 (20.3 to 28.7)
Bihar	12.8	22.9	78.9 (73.9 to 83.9)	61.0	72.1	18.2 (16.1 to 19.6)	43.1	59.6	38.3 (36.2 to 40.3)	7.7	15.3	98.7 (91.8 to 105.6)
Chhattisgarh	52.0	57.2	10.0 (7.5 to 12.5)	68.6	78.5	14.4 (12.2 to 16.2)	63.0	85.3	35.4 (33.5 to 37.3)	33.1	43.3	30.8 (27.0 to 34.6)
Jharkhand	25.0	36.0	44.0 (39.7 to 48.3)	59.5	70.4	18.3 (16.7 to 20.3)	43.2	70.9	64.1 (61.4 to 66.8)	13.8	24.1	74.6 (68.3 to 81.0)
Madhya Pradesh	29.4	52.2	77.6 (74.8 to 80.3)	70.8	84.1	18.8 (17.1 to 19.8)	51.3	82.8	61.4 (59.8 to 63.0)	19.1	41.2	115.7 (111.9 to 119.5)
Manipur	54.9	61.2	11.5 (8.2 to 14.8)	58.0	62.0	6.9 (3.3 to 10.0)	54.4	57.7	6.1 (2.7 to 9.4)	39.2	41.5	5.9 (1.3 to 10.4)
Meghalaya	44.3	45.4	2.5 (-1.9 to 6.9)	49.6	52.5	5.8 (1.9 to 9.8)	52.0	53.4	2.7 (-1.1 to 6.4)	26.4	20.5	-22.3 (-28.8 to -15.9)
Mizoram	52.4	46.6	-11.1 (-14.8 to -7.3)	72.1	72.4	0.4 (-2.0 to 2.9)	59.0	63.9	8.3 (5.0 to 11.6)	37.9	36.6	-3.4 (-8.5 to 1.6)
Nagaland	8.3	11.3	36.1 (22.3 to 50.0)	26.2	37.4	42.7 (35.0 to 49.7)	17.2	37.5	118.0 (108.5 to 127.5)	4.4	6.5	47.7 (28.0 to 67.5)
Odisha	59.2	76.2	28.7 (26.8 to 30.6)	79.2	87.3	10.2 (9.1 to 11.4)	74.4	90.7	21.9 (20.6 to 23.2)	42.6	64.8	52.1 (49.4 to 54.8)
Rajasthan	33.0	51.2	55.2 (52.2 to 58.1)	81.8	93.9	14.8 (13.3 to 15.7)	61.2	82.6	35.0 (33.4 to 36.5)	24.6	44.2	79.7 (76.0 to 83.3)
Sikkim	71.3	60.1	-15.7 (-20.5 to -10.9)	94.4	95.2	0.6 (-0.9 to 2.6)	71.9	70.4	-2.1 (-6.7 to 2.5)	52.1	48.3	-7.3 (-14.4 to -0.2)
Tripura	60.4	50.4	-16.6 (-21.6 to -11.5)	76.4	83.5	9.5 (5.1 to 12.7)	58.2	64.2	10.3 (5.1 to 15.5)	42.9	35.3	-17.7 (-24.8 to -10.6)
Uttar Pradesh	21.9	38.1	74.0 (71.4 to 76.6)	64.0	78.0	21.9 (20.1 to 22.8)	53.5	73.2	36.8 (35.6 to 38.0)	15.6	27.9	78.8 (75.6 to 82.1)
Uttarakhand	25.9	55.7	115.1 (109.0 to 121.1)	65.2	78.5	20.4 (19.2 to 22.8)	54.3	81.5	50.1 (47.1 to 53.1)	17.5	43.3	147.4 (139.3 to 155.5)
More developed states	65.2	68.2	4.6 (3.9 to 5.3)	82.8	90.1	8.6 (7.4 to 9.2)	66.2	82.6	24.8 (24.1 to 25.4)	45.7	56.3	23.2 (22.2 to 24.2)
Andhra Pradesh	74.3	68.3	-8.1 (-10.8 to -5.4)	88.0	95.4	8.2 (6.7 to 10.0)	77.6	90.4	16.5 (14.2 to 18.8)	56.1	59.3	5.7 (1.7 to 9.7)
Goa	86.0	92.4	7.4 (3.0 to 11.9)	96.7	98.5	1.9 (0.2 to 3.9)	90.5	95.6	5.6 (2.1 to 9.2)	79.0	88.8	12.4 (6.7 to 18.1)
Gujarat	59.7	73.1	22.4 (20.2 to 24.7)	80.1	87.5	9.2 (7.8 to 10.6)	59.9	87.1	45.4 (43.2 to 47.6)	36.7	61.2	66.8 (63.1 to 70.4)
Haryana	37.3	56.6	51.7 (47.9 to 55.5)	75.6	90.5	19.7 (18.1 to 21.3)	61.3	88.7	44.7 (42.5 to 46.9)	27.2	51.2	88.2 (83.3 to 93.1)
Himachal Pradesh	61.7	67.1	8.8 (5.2 to 12.3)	72.7	82.5	13.5 (10.1 to 16.2)	69.8	87.3	25.1 (22.2 to 27.9)	45.4	54.3	19.6 (14.6 to 24.6)
Jammu & Kashmir*	71.9	76.3	6.1 (4.4 to 7.8)	77.8	87.9	13.0 (11.1 to 14.4)	67.1	77.2	15.1 (13.2 to 16.9)	53.3	59.5	11.6 (9.1 to 14.2)
Karnataka	69.3	65.1	-6.1 (-7.9 to -4.2)	88.4	90.3	2.1 (1.1 to 3.1)	55.3	83.6	51.2 (48.8 to 53.6)	39.6	52.6	32.8 (29.4 to 36.3)
Kerala	88.9	77.3	-13.0 (-14.8 to -11.3)	99.8	99.7	-0.1 (-0.3 to 0.1)	84.2	91.5	8.7 (6.7 to 10.6)	75.7	72.9	-3.7 (-6.3 to -1.1)
Maharashtra	69.3	66.7	-3.8 (-5.5 to -2.0)	83.9	88.2	5.1 (4.0 to 6.2)	74.2	80.8	8.9 (7.4 to 10.4)	50.0	54.5	9.0 (6.4 to 11.6)
Delhi	68.8	75.3	9.4 (5.5 to 13.3)	86.0	90.2	4.9 (2.6 to 7.2)	59.1	85.1	44.0 (39.3 to 48.7)	42.7	65.3	52.9 (46.2 to 59.7)
Punjab	64.6	54.7	-15.3 (-17.8 to -12.8)	91.1	92.9	2.0 (1.0 to 3.0)	86.9	85.4	-1.7 (-3.0 to -0.4)	55.5	46.9	-15.5 (-18.5 to -12.5)
Tamil Nadu	77.5	89.6	15.6 (14.2 to 17.0)	98.4	99.2	0.8 (0.5 to 1.1)	68.4	90.4	32.2 (30.4 to 33.9)	56.4	82.0	45.4 (43.0 to 47.7)
Telangana	71.8	68.2	-5.0 (-8.0 to -2.0)	85.6	90.4	5.6 (3.7 to 7.6)	79.9	85.4	6.9 (4.5 to 9.3)	55.7	54.9	-1.4 (-5.7 to 2.8)
West Bengal	69.4	72.2	4.0 (1.9 to 6.2)	71.3	89.2	25.1 (23.3 to 27.1)	58.0	63.8	10.7 (7.3 to 12.7)	42.0	47.3	12.6 (8.8 to 16.4)

*Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh.

Supplementary Table 4. Ratio of Human opportunity index (HOI) between wealth index quintiles I and V for the maternal services for India and its states, National Family Health Survey-5.

	Ratio of HOI between wealth index quintiles I and V			
	Four of more antenatal care visits	Institutional delivery with skilled birth attendant	Post-natal care within 48 hours of delivery	Continuum of care
India	0.52	0.69	0.73	0.33
Less developed states	0.55	0.69	0.74	0.43
Arunachal Pradesh	0.43	0.58	0.70	0.33
Assam	0.63	0.75	0.79	0.52
Bihar	0.32	0.72	0.71	0.27
Chhattisgarh	0.89	0.72	0.93	0.70
Jharkhand	0.51	0.64	0.81	0.43
Madhya Pradesh	0.72	0.83	0.91	0.60
Manipur	0.40	0.40	0.48	0.33
Meghalaya	0.66	0.47	0.88	0.58
Mizoram	0.16	0.28	0.36	0.16
Nagaland	0.27	0.35	0.47	0.27
Odisha	0.84	0.81	0.94	0.69
Rajasthan	0.77	0.92	0.92	0.73
Sikkim	1.41	0.94	1.17	1.27
Tripura	0.81	0.79	0.68	0.73
Uttar Pradesh	0.60	0.76	0.80	0.58
Uttarakhand	0.51	0.68	0.81	0.43
More developed states	0.83	0.80	0.76	0.73
Andhra Pradesh	0.66	0.75	0.73	0.58
Goa	1.07	1.01	1.01	0.96
Gujarat	0.79	0.83	0.96	0.73
Haryana	0.52	0.67	0.70	0.43
Himachal Pradesh	0.70	0.60	0.77	0.43
Jammu and Kashmir	0.76	0.74	0.78	0.61
Karnataka	0.75	0.90	0.91	0.64
Kerala	0.95	1.00	0.89	0.95
Maharashtra	0.68	0.73	0.78	0.51
Delhi	0.34	0.24	0.36	0.16
Punjab	0.54	0.84	0.80	0.57
Tamil Nadu	1.01	0.96	0.94	0.96
Telangana	0.78	0.83	0.89	0.63
West Bengal	0.85	0.90	0.70	0.57

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

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Population-level trends over a decade in geographical inequality for opportunity in access to maternal care services: a cross-sectional analysis from the National Family Health Surveys in India

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Revision 3

**Population-level trends over a decade in geographical inequality for
opportunity in access to maternal care services: a cross-sectional analysis
from the National Family Health Surveys in India**

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24 **ABSTRACT**

25 **Objectives:** To examine the trends in geographical inequality of opportunity in maternal health

26 services in India considering the Every Newborn Action Plan (ENAP) 2025 coverage targets.

27 **Setting:** India

28 **Participants:** Women in the National Family Health Survey (NFHS) - NFHS-4 (2014-15) and NFHS-5

29 (2019-21).

30 **Primary and secondary measures:** District-level coverages of 4+ antenatal care (ANC) visits,

31 institutional delivery with skilled birth attendant (SBA), postnatal care (PNC) services within 48 hours

32 of delivery, Continuum of care (CoC) services for women with most recent livebirths were

33 considered. Human Opportunity Index (HOI) documented the opportunities for equitable access of

34 these services, ranging from 0 (high inequality) to 100 (universal access). HOI was compared

35 between the survey rounds and wealth index quintiles (WI) that the women belonged to.

36 **Results:** Coverages of 4+ ANC visits, institutional delivery, PNC, and CoC in India increased by 22.8%

37 (95% CI 22.1-23.5), 12.6% (12.2-12.9), 28.5% (28.0-29.0), and 38.6% (37.6-39.6) between NFHS-4 and

38 NFHS-5, respectively. The HOI for 4+ ANC visits was 48.4 in NFHS-5, ranging from 11.3 to 92.4 in

39 states and from 31.1 to 70.5 for WI I to V. The HOI for institutional delivery was 80.4 in NFHS-5,

40 ranging from 37.4 to 99.7 in the states and from 21.0 to 100 for WI I to V. The HOI for PNC services

41 was 73.5 in NFHS-5, ranging from 37.5 to 95.6 in the states and from 61.2 to 88.3 for WI I to V. The

42 HOI for CoC was 37.1, ranging from 6.5 to 88.8 in the states and from 19.8 to 62.7 for WI I to V for

43 CoC in NFHS-5.

44 **Conclusion:** Though significant improvements in the geographic inequity of maternal health services

45 have been made in India, the geographic inequity for 4+ANC visits coverage lags significantly behind

46 resulting in CoC coverage inequity to achieve the ENAP targets for these services.

47

48 **Keywords:** Antenatal care services, continuum of care, human opportunity index, India, inequity,

49 institutional delivery, NFHS, postnatal care, wealth index.

STRENGTHS AND LIMITATIONS OF THE STUDY

- District-level inequity estimated in the coverages of maternal health services for India using large-scale demographic surveys.
- Human opportunity index is used to measure not only the distribution of coverage of maternal health services but also how fairly the available services are distributed among women by geography and by wealth index.
- Socio-economic inequities in maternal health services in India have been reported previously but the use of Human Opportunity Index to measure inequity has not been attempted.
- Quality of services not captured in the assessment.

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60 **INTRODUCTION**

61 With the Sustainable Development Goal (SDG) 10, the governments worldwide have committed to

62 act on inequality through multiple, interconnected goals, requiring combined policy action in order

63 to meet an overall commitment to ‘leave no-one behind’.[1] Access to health care for all also

64 intersects with the inequalities related to gender, socio-economic status, education levels,

65 employment status and geographical location, with the most marginalized being the least able to

66 access quality healthcare.[2] Inequality in access to essential health-care services has implications

67 on achieving universal health coverage, including maternal health services among both the general

68 and the most disadvantaged populations.[3] Significant literature on the extent of inequities in

69 maternal health services is available from developing countries including from India, predominately

70 based on the Demographic and Health Surveys (DHS) and focusing on socio-economic inequalities in

71 the use of maternal health services.[4-16]

72 In the context of Countdown to 2030, SDGs 3.1 and 3.2 which aim to reduce maternal and

73 neonatal mortality by 2030,[3] we examine the trends in geographical inequality of opportunity in

74 access for the coverage of antenatal care (ANC) visits, institutional delivery with skilled birth

75 attendant (SBA), and postnatal care (PNC) visits within 48 hours in India using the National Family

76 Health Survey (NFHS), which is the equivalent of DHS in India.[17] In addition, we also measure

77 geographical inequality in the coverage of continuum of care (CoC), which is recommended as one of

78 the global strategies for maternal health to improve maternal and neonatal outcomes in the

79 developing country setting.[18-20] The maternal health program in India is implemented at the

80 district level,[21] and the Every Newborn Action Plan (ENAP) 2025 provides for maternal care

81 services coverage target indicators based on the district-level coverage of these services in a

82 state.[22] Therefore, we examine define geographic inequality at the district-level in India and its

83 states as these have implications on planning to achieve the ENAP 2025 coverage targets.

84

METHODS

We utilized the publicly available data from the two most recent rounds of NFHS conducted post year 2010, NFHS-4 (2014-15) and NFHS-5 (2019-21).[23 24] These nationally representative population-based surveys are conducted by the International Institute of Population Sciences, Mumbai, India, with the primary aim to provide estimates of maternal and child health and reproductive health indicators at the district-level for India.[23 24] No ethics approval was required for this analysis as we utilised the de-identified data available in public domain.

The NFHS documents data on the most recent livebirth for ever-married women in the last 5 years from the time of data collection. The NFHS-4 documented data for livebirths born between 2011 and early 2016 whereas the NFHS-5 documented data on livebirths born between 2016 and early 2021. We defined the CoC for this analysis as a woman having reported four or more ANC visits and institutional delivery with SBA and PNC within 48 hours of delivery for her most recent livebirth in the last 5 years. We calculated the coverage of 4 or more ANC visits (4+ ANC visits), institutional delivery with SBA, PNC within 48 hours of delivery, and CoC for the most recent livebirth for NFHS-4 and NFHS-5 for India, and its states and districts.

Data analysis

We utilised the Human Opportunity Index (HOI) to measure the trends in geographical inequality for the opportunity to access maternal care services in India and its states. The HOI is a measure of the coverage rate of an opportunity discounted by inequality in the distribution across the circumstance groups, where D measures the dissimilarity between access of services for groups defined by circumstance characteristics (such as wealth index, education, distance, etc) and the average access coverage for the same service for the population as a whole; C is average access coverage of services the population as a whole and is estimated as :[25 26]

$$HOI = (1 - D) \times C$$

The HOI value ranges from 0 (high inequality) to 100 (universal access). In this analysis, D is the index of geographical inequality at the district-level within each state compared with the average

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111 coverage of a particular maternal service for a given state. The HOI for coverage of each of the three
112 maternal care services and CoC for India and its states was estimated using the district level
113 coverage of these services in NFHS-4 and NFHS-5, and the change in HOI between NFHS-4 and NFHS-
114 5 was assessed. The number of districts in each state in NFHS-4 and NFHS-5 are shown in
115 supplemental table 1.

116 In addition, we explored the geographical inequality within each of the wealth index (WI)
117 quintile in NFHS-5. The WI quintile is provided in the NFHS dataset at the household level which is
118 based on the number and kinds of consumer goods each household owns calculated using principal
119 component analysis.[24 27] We calculated HOI for India and states for each WI quintile for each
120 maternal health service and CoC. We report the ratio of state average HOI with WI I and WI V, and the
121 ratio of HOI WI I to WI V for each maternal health service and CoC.

122 The states of India were grouped based on its development status for this analysis. The
123 Empowered Action Group of states as categorized by the government of India (Bihar, Chhattisgarh,
124 Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Uttarakhand, and the north-eastern
125 states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) were
126 grouped as ‘less developed’ and the remaining states were categorised as “more developed.”[28 29]
127 Delhi, Jammu and Kashmir including Ladakh were considered as a state for this analysis. The other
128 Union Territories were excluded as there are no districts in these Union Territories to undertake this
129 analysis. We have reported 95% confidence interval for all estimates as relevant and all the analyses
130 were carried out using STATA version 13.1 and Microsoft Excel 2016.

131

132 **Patient and Public Involvement statement:** Patients were not involved in planning of this analysis.
133

RESULTS

A total of 188,506 ever-married women provided data on 249,020 livebirths in NFHS-4 and 174,796 ever-married women provided data on 195,277 livebirths in NFHS-5. The coverages for 4+ ANC visits, institutional delivery with SBA, and PNC in 48 hours, and CoC for NFHS-4 and NFHS-5 for India, grouping of states, and individual states are shown in supplemental table 2.

4+ ANC visits

The coverage of 4+ ANC visits for India was 57.0% (95% CI 56.8 to 57.3) in NFHS-5. The percent change in coverage of 4+ ANC visits from NFHS-4 to NFHS-5 was estimated at 22.8% (95% CI 22.1 to 23.5) for India, 33.3% (95% CI 32.3 to 34.3) for less developed, and 3.4% (95% CI 2.6 to 4.1) for more developed states (supplemental table 2). This coverage ranged from 15.6% in Nagaland to 80.0% in Odisha in the less developed states, and 58.3% in Punjab to 93.2% in Goa in the more developed states in NFHS-5 (supplemental table 2). The HOI for geographic inequality in 4+ ANC visits for India was 48.4 in NFHS-5, an improvement of 35.2% (95% CI 34.5 to 35.9) between NFHS-4 to NFHS-5 (supplemental table 2), and was substantially higher for the more developed states at 68.2 than the less developed states at 40.7 in NFHS-5 (table 1 and supplemental table 3). HOI ranged from 8.3 to 88.9 in the states in NFHS-4, and 11.3 to 92.4 in the states in NFHS-5 (Figure 1 and supplemental table 3). Three and 6 states from the less and more developed states showed a reduction in HOI between NFHS-4 to NFHS-5, respectively (supplemental table 3). The highest gains in HOI were made in the state of Uttarakhand (115.1%; 95% CI 109.0 to 121.1) between NFHS-4 to NFHS-5, with the HOI for the state at 55.7 in NFHS-5.

Considering WI (table 1), HOI ranged from 33.8 for WI I to 64.4 for WI V for India, and the corresponding range was 31.1 to 57.0 and 58.6 to 70.5 for less and more developed states in NFHS-5, respectively. The HOI ratio of WI V to average was 1 or more in all states except Sikkim, Tamil Nadu and Kerala. Substantial variations were seen in HOI ratio of WI I to V, ranging from 0.16 to 1.41, with this ratio being <1 in 27 (90.0%) states in NFHS-5, and the lowest HOI ratio between WI I

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160 and V was seen in Mizoram at 0.16 (supplemental table 4). Among the 20 states with WI I to state

161 HOI ratio at >0.70, 15 states had the W1 I to WI V HOI ratio at <0.70 (supplemental table 4).

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Table 1: Overall Human opportunity index (HOI) and by wealth index quintile (WI) for four or more antenatal care visits and the ratio between WI I and overall HOI, WI V and overall HOI for India and its states, National Family Health Survey 5.

	Overall HOI	Four or more ANC visits					HOI Ratio	
		HOI by WI					WI 1: Overall HOI	WI 5: Overall HOI
		1	2	3	4	5		
India	48.4	33.8	44.0	53.1	59.3	64.4	0.70	1.33
Less developed states	40.7	31.1	38.9	45.4	50.1	57.0	0.76	1.40
Arunachal Pradesh	34.3	20.2	31.6	37.0	44.2	47.3	0.59	1.38
Assam	45.6	38.9	46.4	53.3	60.1	61.0	0.85	1.35
Bihar	22.9	15.6	22.9	30.2	37.4	49.2	0.68	2.15
Chhattisgarh	57.2	54.3	53.4	60.9	60.5	61.0	0.95	1.07
Jharkhand	36.0	28.6	38.5	41.9	51.8	56.0	0.79	1.56
Madhya Pradesh	52.2	44.6	49.3	56.1	59.1	62.3	0.85	1.19
Manipur	61.2	36.7	64.6	78.7	84.9	91.3	0.60	1.49
Meghalaya	45.4	36.8	45.8	50.0	61.5	55.5	0.81	1.22
Mizoram	46.6	11.0	37.8	49.9	61.5	69.9	0.24	1.50
Nagaland	11.3	5.4	10.1	20.8	26.9	20.0	0.48	1.77
Odisha	76.2	69.3	78.6	79.1	81.6	82.4	0.91	1.08
Rajasthan	51.2	45.7	45.9	49.6	52.2	59.0	0.89	1.15
Sikkim	60.1	66.9	61.1	59.1	61.3	47.6	1.11	0.79
Tripura	50.4	41.7	52.8	56.6	64.6	51.2	0.83	1.02
Uttar Pradesh	38.1	30.4	35.0	38.9	41.4	50.9	0.80	1.34
Uttarakhand	55.7	35.2	44.2	51.8	62.6	69.1	0.63	1.24
More developed states	68.2	58.6	65.1	67.1	70.1	70.5	0.86	1.03
Andhra Pradesh	68.3	45.5	64.2	64.8	66.5	69.2	0.67	1.01
Goa	92.4	100.0	81.2	89.8	92.5	93.5	1.08	1.01
Gujarat	73.1	63.2	69.1	72.4	75.9	80.5	0.86	1.10

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		Four or more ANC visits						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4	5	WI 1: Overall HOI	WI 5: Overall HOI
Haryana	56.6	33.5	44.8	49.7	53.3	64.5	0.59	1.14
Himachal Pradesh	67.1	52.1	53.4	62.3	74.2	74.8	0.78	1.11
Jammu and Kashmir	76.3	60.2	75.8	76.7	80.6	79.5	0.79	1.04
Karnataka	65.1	51.8	60.3	65.4	71.2	69.5	0.80	1.07
Kerala	77.3	71.3	87.6	76.0	78.6	74.8	0.92	0.97
Maharashtra	66.7	49.9	63.3	65.1	71.2	73.8	0.75	1.11
Delhi	75.3	26.6	45.1	62.2	68.6	78.8	0.35	1.05
Punjab	54.7	31.2	41.6	47.1	50.7	57.6	0.57	1.05
Tamil Nadu	89.6	88.3	89.1	89.1	90.3	87.1	0.99	0.97
Telangana	68.2	53.5	63.9	64.8	70	68.1	0.78	1.00
West Bengal	72.2	66.5	72.1	75.0	78.7	78.1	0.92	1.08

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

169 ***Institutional delivery with SBA***

170 The coverage of institutional delivery with SBA for India was 85.0% (95% CI 84.9 to 85.2) in NFHS-5.
 171 The percent change from NFHS-4 to NFHS-5 was estimated at 12.6% (95% CI 12.2 to 12.9) for India,
 172 14.6% (95% CI 14.1 to 15.1) for less developed and 6.2% (95% CI 5.8 to 6.6) for more developed
 173 states (supplemental table 2). This coverage ranged from 58.6% in Meghalaya to 96.3% in Sikkim in
 174 less developed states and 84.3% in Himachal Pradesh to 99.8% in Kerala in more developed states in
 175 NFHS-5 (supplemental table 2). The HOI for geographic inequality for institutional delivery with SBA
 176 for India was 80.4, 90.1 and 76.2 for India, more developed and less developed states in NFHS-5,
 177 respectively (table 2 and supplemental table 3). HOI ranged from 26.2 to 99.8 in the states in NFHS-
 178 4, and 37.4 to 99.7 in the states in NFHS-5 (Figure 2 and supplemental table 3). The highest gains in
 179 HOI between NHFS-4 and NFHS-5 were made in Arunachal Pradesh state (64.9%; 95% CI 61.3 to
 180 68.5), with the HOI for the state at 77.5 in NHFS-5 (supplemental table 3).

181 Considering WI (table 2), HOI ranged from 65.1 for WI I to 93.7 for WI V for India, and the
 182 corresponding range was 63.6 to 92.0 and 76.5 to 95.1 for less and more developed states in NFHS-
 183 5, respectively. The WI V to average HOI ratio was 1 or more in all the states except Sikkim. The HOI
 184 ratio of WI I to WI V was <1 in 28 (93.3 %) states and was <0.60 in 6 (20.0 %) states in NFHS-5
 185 (supplemental table 4). Among the 26 states with W1 1 to state HOI ratio being >0.70, 6 states had
 186 the W1 I to WI V HOI ratio at <0.70 (supplemental table 4).

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188 **Table 2: Overall Human opportunity index (HOI) by wealth index quartile (WI) for institutional delivery with skilled birth attendant (SBA)**
189 **and the ratio between WI I and overall HOI, WI V and overall HOI for India and its states, National Family Health Survey-5.**
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		Institutional delivery with SBA						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4	5	WI 1: Overall HOI	WI 5: Overall HOI
India	80.4	65.1	78.8	86.0	90.2	93.7	0.81	1.17
Less developed states	76.2	63.6	76.6	83.5	87.8	92.0	0.83	1.21
Arunachal Pradesh	77.5	56.0	77.6	86.7	92.0	96.0	0.72	1.24
Assam	82.3	72.1	87.0	91.7	94.8	95.5	0.88	1.16
Bihar	72.1	63.9	76.6	81.2	82.9	88.7	0.89	1.23
Chhattisgarh	78.5	68.0	80.1	85.9	90.3	94.3	0.87	1.20
Jharkhand	70.4	60.7	77.1	83.8	91.3	94.7	0.86	1.35
Madhya Pradesh	84.1	75.4	84.8	90.0	91.7	90.3	0.90	1.07
Manipur	62.0	37.7	65.1	78.7	88.2	93.7	0.61	1.51
Meghalaya	52.5	38.8	57.6	72.6	82.5	82.2	0.74	1.57
Mizoram	72.4	26.4	59.1	80.5	92.8	95.8	0.36	1.32
Nagaland	37.4	26.2	37.9	57.1	64.7	74.9	0.70	2.00
Odisha	87.3	77.6	91.6	93.9	95.5	95.6	0.89	1.10
Rajasthan	93.9	89.2	91.8	94.1	94.8	97.1	0.95	1.03
Sikkim	95.2	88.5	94.5	94.8	97.3	94.2	0.93	0.99
Tripura	83.5	71.8	88.8	91.9	94.0	90.6	0.86	1.09
Uttar Pradesh	78.0	68.3	76.4	79.4	82.8	90.1	0.88	1.16
Uttarakhand	78.5	62.1	62.7	75.0	85.7	91.9	0.79	1.17
More developed states	90.1	76.5	85.8	90.1	92.6	95.1	0.85	1.06
Andhra Pradesh	95.4	73.9	93.0	94.2	95.9	98.7	0.77	1.03
Goa	98.5	100.0	90.6	100.0	98.5	98.7	1.02	1.00
Gujarat	87.5	75.3	85.9	88.8	92.1	91.1	0.86	1.04

		Institutional delivery with SBA					
	Overall HOI	HOI by WI					HOI Ratio
		1	2	3	4	5	WI 1: Overall HOI WI 5: Overall HOI
Haryana	90.5	64.7	77.0	86.8	91.1	96.0	0.711.06
Himachal Pradesh	82.5	54.1	68.1	80.8	86.5	90.6	0.661.10
Jammu and Kashmir	87.9	71.5	82.7	88.6	94.7	96.6	0.811.10
Karnataka	90.3	83.8	85.6	90.6	93.8	93.2	0.931.03
Kerala	99.7	100.0	100.0	99.5	99.8	99.6	1.001.00
Maharashtra	88.2	69.5	85.4	89.0	92.3	95.0	0.791.08
Delhi	90.2	21.9	68.7	82.7	83.0	91.6	0.241.02
Punjab	92.9	79.4	80.7	96.5	90.5	94.6	0.851.02
Tamil Nadu	99.2	95.6	97.9	99.2	99.5	100.0	0.961.01
Telangana	90.4	75.5	88.9	90.0	90.4	91.4	0.841.01
West Bengal	89.2	83.7	90.6	93.8	94.6	93.1	0.941.04

Ratio of HOI	
	Less than 0.50
	0.51-0.8
	0.90-1.0
	1.10-1.4
	1.50 or more

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193 ***PNC within 48 hours of delivery***

194 The coverage of PNC within 48 hours of delivery was 78.9% (95% CI 78.7-79.1) in NFHS-5. The
195 percent change from NFHS-4 to NFHS-5 was estimated at 28.5% (95% CI 28.0-29.0) for India, 31.8%
196 (95 % CI 31.1-32.4) for less developed and 19.6% (95% CI 19.0-20.3) for more developed states
197 (supplemental table 2). This coverage ranged from 43.2% in Nagaland to 92.1% in Odisha in the less
198 developed states and 68.2% in West Bengal to 96.3% in Goa in the more developed states in NFHS-5
199 (supplemental table 2). The HOI for geographic inequality in PNC within 48 hours of delivery for India
200 was 73.5 in NFHS-5, which improved by 34.6% (95% CI 34.2 to 35.1) between NFHS-4 to NFHS-5. The
201 HOI was substantially higher for the more developed states 82.6 than the less developed states 69.4
202 in NFHS-5 (table 3 and supplemental table 3). HOI ranged from 17.2 to 90.5 in the states in NFHS-4,
203 and 37.5 to 95.6 in the states in NFHS-5 (Figure 3 and supplemental table 3). The highest gains in HOI
204 were made in Arunachal Pradesh (128.6%; 95% CI 122.1 to 135.2) and Nagaland (118.0%; 95% CI
205 108.5 to 127.5), with the HOI for the states at 51.9 and 37.5 in NHFS-5, respectively (supplemental
206 table 3).

207 Considering WI (Table 3), HOI ranged from 62.0 for WI I to 85.0 for WI V in India, and the
208 corresponding range was from 61.2 to 83.0 and 67.4 to 88.3 for less and more developed states in
209 NFHS-5, respectively. The HOI ratio of WI V to state was 1 or more in all the states, except for Sikkim
210 and Tamil Nadu. The HOI ratio of WI I to WI V was <1 in 28 (93.3%) states and was <0.60 in 4 (13.3%)
211 states in NFHS-5 (supplemental table 4). Among the 27 states with WI I to state HOI ratio at >0.70, 2
212 states had the WI I to WI V HOI ratio at <0.70 (supplemental table 4).

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214 **Table 3: Overall Human opportunity index (HOI) by wealth index quartile (WI) for post-natal care in 48 hours of delivery and the ratio**
 215 **between WI I and overall HOI, WI V and overall HOI for India and its states, National Family Health Survey 25.**

	Overall HOI	PNC within 48 hours of delivery					HOI Ratio	
		HOI by WI					WI 1:	WI 5:
		1	2	3	4		Overall HOI	Overall HOI
India	73.5	62.0	70.7	77.1	81.3	88.3	0.84	1.16
Less developed states	69.4	61.2	68.7	73.6	77.4	83.8	0.88	1.20
Arunachal Pradesh	51.9	41.5	52.6	53.2	53.6	55.9	0.80	1.15
Assam	64.7	56.8	67.4	72.7	74.4	77.2	0.88	1.11
Bihar	59.6	54.0	61.8	65.8	69.0	75.4	0.91	1.27
Chhattisgarh	85.3	81.8	85.5	85.2	89.4	88.8	0.96	1.03
Jharkhand	70.9	65.8	74.6	74.5	81.4	84.4	0.93	1.15
Madhya Pradesh	82.8	78.7	81.5	84.4	85.7	86.7	0.95	1.05
Manipur	57.7	38.1	59.2	72.7	78.1	79.0	0.66	1.37
Meghalaya	53.4	49.3	55.6	59.3	54.9	55.3	0.92	1.05
Mizoram	63.9	28.2	55.0	72.2	72.1	75.3	0.44	1.21
Nagaland	37.5	27.2	38.8	55.2	59.8	55.5	0.73	1.53
Odisha	90.7	87.6	90.7	92.9	92.9	99.9	0.97	1.02
Rajasthan	82.6	78.2	80.8	82.3	83.4	85.2	0.95	1.03
Sikkim	70.4	66.9	69.3	71.4	70.6	57.4	0.95	0.82
Tripura	64.2	56.4	63.0	72.9	79.1	82.8	0.88	1.29
Uttar Pradesh	73.2	66.0	72.6	73.6	77.3	82.8	0.90	1.13
Uttarakhand	81.5	71.1	73.6	80.9	85.4	85.3	0.87	1.07
More developed states	82.6	67.4	77.2	83.0	85.3	88.3	0.82	1.07
Andhra Pradesh	90.4	67.6	87.2	91.1	90.3	92.1	0.75	1.02
Goa	95.6	100.0	90.6	89.8	96.6	98.7	1.05	1.03
Gujarat	87.1	85.7	85.4	85.8	86.3	89.3	0.98	1.03
Haryana	88.7	64.2	76.7	88.7	88.7	92.2	0.72	1.04

		PNC within 48 hours of delivery						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4		WI 1: Overall HOI	WI 5: Overall HOI
Himachal Pradesh	87.3	71.3	78.7	88.3	88.3	92.1	0.82	1.05
Jammu and Kashmir	77.2	64.7	72.9	78.1	80.3	88.3	0.84	1.07
Karnataka	83.6	76.3	80.7	84.7	85.5	88.3	0.91	1.00
Kerala	91.5	81.6	83.9	88.3	92.1	91.5	0.89	1.00
Maharashtra	80.8	66.9	78.3	80.7	83.3	88.3	0.83	1.06
Delhi	85.1	31.2	59.7	76.4	80.3	82.2	0.37	1.02
Punjab	85.4	69.4	75.0	96.6	83.1	88.3	0.81	1.01
Tamil Nadu	90.4	84.0	90.4	90.3	90.1	88.3	0.93	0.99
Telangana	85.4	78.1	83.1	83.5	84.4	88.3	0.91	1.03
West Bengal	63.8	56.2	62.0	67.6	76.4	88.3	0.88	1.26

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

217 ***Continuum of care (CoC)***

218 The coverage of CoC was 45.6% (95% CI 45.4-45.9) in NFHS-5. The percent change from NFHS-4 to
 219 NFHS-5 was estimated at 38.6% (95% CI 37.6-39.6) for India, 47.2% (95% CI 45.7-48.6.) for less
 220 developed and 19.5% (95% CI 18.4-20.6) for more developed states (supplemental table 2). The
 221 coverage ranged from 9.4% in Nagaland to 69.4% in Odisha in the less developed states, and 50.2%
 222 in Punjab to 90.1% in Goa in the more developed states in NFHS-5 (supplemental table 2). The HOI
 223 for geographic inequality in CoC for India was 37.1, which improved by 52.2% (95% CI 51.1 to 53.0)
 224 between NFHS-4 to NFHS-5. The HOI was substantially higher for the more developed states at 56.3
 225 than the less developed states at 29.7 in NFHS-5 (table 4 and supplemental table 3). HOI ranged
 226 from 4.4 to 79.0 in the states in NFHS-4, and 6.5 to 88.8 in the states in NFHS-5 (Figure 4 and
 227 supplemental table 3). The highest gains in HOI were made in Arunachal Pradesh (167.1%; 95% CI
 228 154.4 to 179.8) and Uttarakhand (147.4%; 95% CI 139.3 to 155.5), with the HOI for the states at 21.9
 229 and 43.3 in NFHS-5, respectively (supplemental table 3).

230 Considering WI (Table 4), HOI ranged from 21.7 for WI I to 56.5 for WI V for India, and the
 231 corresponding range was 19.8 to 48.8 and 39.3 to 62.7 for less and more developed states in NFHS-
 232 5, respectively. The HOI ratio of WI V to state was 1 or more in 27 states. The HOI ratio of WI I to WI
 233 V was <1 in 28 (93.3%) states and was <0.60 in 18 (60.0%) states in NFHS-5 (supplemental table 4).
 234 Among the 12 states with WI I to state HOI ratio at >0.70, 3 states the WI I to WI V HOI ratio at <0.70
 235 (supplemental table 4).

236 **Table 4: Overall Human opportunity index (HOI) by wealth index quartile (WI) for continuum of care and the ratio between WI I and overall**
237 **HOI, WI V and overall HOI based on the maternal services for India and its states, National Family Health Survey-5.**

		Continuum of care							
	Overall HOI	HOI by WI						HOI Ratio	
		1	2	3	4		WI 1: Overall HOI	WI 5: Overall HOI	
India	37.1	21.7	32.3	41.9	49.2		0.58	1.52	
Less developed states	29.7	19.8	27.9	34.5	40.2		0.67	1.64	
Arunachal Pradesh	21.9	12.4	20.9	22.8	26.0		0.57	1.50	
Assam	31.0	22.9	32.1	40.3	49.0		0.74	1.43	
Bihar	15.3	9.5	15.1	21.0	28.4		0.62	2.52	
Chhattisgarh	43.3	37.3	39.2	47.9	50.7		0.86	1.23	
Jharkhand	24.1	16.7	27.8	31.6	41.5		0.69	1.90	
Madhya Pradesh	41.2	31.7	39.0	46.5	50.7		0.77	1.29	
Manipur	41.5	19.8	41.3	60.2	68.0		0.48	1.62	
Meghalaya	20.5	14.1	21.7	27.6	34.7		0.69	1.37	
Mizoram	36.6	6.7	27.6	40.4	49.5		0.18	1.57	
Nagaland	6.5	2.2	5.9	12.2	17.4		0.34	5.48	
Odisha	64.8	53.2	68.2	71.9	75.1		0.82	1.19	
Rajasthan	44.2	38.0	39.8	42.3	45.2		0.86	1.18	
Sikkim	48.3	47.6	49.0	45.6	50.3		0.99	0.78	
Tripura	35.3	19.5	37.4	39.8	56.2		0.55	1.45	
Uttar Pradesh	27.9	19.2	24.9	28.5	31.7		0.69	1.57	
Uttarakhand	43.3	24.5	28.2	38.5	51.2		0.57	1.37	
More developed states	56.3	39.3	50.0	55.5	59.8		0.70	1.11	
Andhra Pradesh	59.3	32.4	53.6	59.6	60.5		0.55	1.09	
Goa	88.8	100.0	71.9	86.4	87.2		1.13	1.03	
Gujarat	61.2	49.8	56.9	60.0	64.0		0.81	1.14	

		Continuum of care						
	Overall HOI	HOI by WI					HOI Ratio	
		1	2	3	4	5	WI 1: Overall HOI	WI 5: Overall HOI
Haryana	51.2	23.3	35.5	45.0	47.2	50.3	0.46	1.18
Himachal Pradesh	54.3	31.8	39.5	51.0	59.7	54.3	0.59	1.20
Jammu and Kashmir	59.5	40.2	53.9	62.3	66.1	59.5	0.68	1.11
Karnataka	52.6	36.3	47.1	53.9	59.9	52.6	0.69	1.07
Kerala	72.9	68.0	69.1	70.1	74.5	72.9	0.93	0.98
Maharashtra	54.5	33.5	49.9	51.8	60.3	54.5	0.61	1.21
Delhi	65.3	1.6	28.0	47.9	55.4	65.3	0.02	1.05
Punjab	46.9	28.7	31.5	95.8	41.8	46.9	0.61	1.07
Tamil Nadu	82.0	75.6	81.9	81.7	82.6	82.0	0.92	0.96
Telangana	54.9	35.9	51.0	52.2	56.2	54.9	0.65	1.04
West Bengal	47.3	37.7	45.6	52.3	61.3	47.3	0.80	1.39

Ratio of HOI	
	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more

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DISCUSSION

This analysis of coverage of maternal health services for livebirths over a decade between NFHS-4 and NFHS-5 has highlighted significant improvements in the geographic inequity for coverage of these services at the state-level in India, and has identified the inequities that remain to be addressed to achieve the ENAP 2025 coverage targets for these services. The geographic inequity for the coverage of 4+ANC visits lags significantly behind that of institutional delivery with SBA and PNC within 48 hours of delivery, contributing to the CoC inequity in NFHS-5. The HOI ratio for CoC at 0.38 highlights the extent of inequity between the women belonging to the lowest and the highest wealth index quintiles in India.

A policy aiming at equitable access would require progress towards two objectives: first, expanding the coverage by ensuring that as many women as possible get the opportunity; and second, by allocating new opportunities first to the vulnerable population who are at a disadvantage due to their circumstances.[30] We utilised HOI,[26] as a tool to measure the distribution of opportunities and equitable access to maternal health services. The HOI not only carries information about the coverage rate of the service but also how fairly the available services are distributed among women of different backgrounds, in this case of different wealth index quintiles.[31] In terms of expanding coverage to ensure that as many women as possible get the opportunity, the coverage of 4+ ANC visits was for 4 of 7 women, and that for institutional delivery with SBA was 6 out of 7 women, and for PNC within 48 hours of delivery was 4 out of 5 women in NFHS-5. The differential increase over the decade between the coverages of these three maternal health services can possibly be explained by how the national programs to reduce maternal and neonatal mortality were implemented during this period. The program to address ANC services was launched in 2016 after NFHS-4, and is aimed to guarantee a minimum package of ANC services to women in their 2nd/3rd trimesters of pregnancy at designated government health facilities.[32] There is no monetary incentive either to the health worker or to the pregnant women under this program. The likely impact of this program on HOI for 4+ ANC visits coverage will be documented in the next round

of NFHS (round 6). However, given the extent of low coverage of 4+ ANC visits in most of the less developed states and some of the more developed states, major inputs are needed to address the barriers for improved ANC utilisation to achieve the ENAP 2025 target for 4+ ANC visits.[33-35] The increased coverage for institutional deliveries with SBA between the two surveys resulted in nearly doubling of HOI over this period, and near universality of this service in the more developed states. Two programs – the *Janani Suraksha Yojana* (JSY) and the *Janani Shishu Suraksha Karyakaram* (JSSK) - initiated to increase the coverage of institutional deliveries in India have contributed to the exponential increase in access to institutional delivery.[36 37] The JSY was initiated in 2005 and was a large-scale national program that offered conditional cash transfer and support services to poor pregnant women to use institutional delivery care facilities, especially in the states with lower coverage.[36] The JSSK, initiated in 2011, provided free and cashless delivery along with some other benefits to pregnant women to eliminate out-of-pocket expenses in order to increase the institutional deliveries.[38] The PNC coverage was estimated at 61% HOI at 73.5 for India in NFHS-5 with a wide variation at the state-level. The increased PNC coverage also resulted in 34.6% increase in HOI for PNC coverage between NFHS-4 and NFHS-5. According to the Indian PNC guidelines,[39] the health workers are paid INR 250 (USD 3.5) for PNC visits, and are expected to undertake 6-7 PNC visits at home from 1st to 42nd day of delivery for counselling the mother on various issues and enabling referral if needed. Considering all the three maternal health services together, the CoC coverage remained at 62.5% in NFHS-5 with only 19.5% change between the two surveys even in the more developed states. Only 45% CoC coverage in NFHS-5 for India translates into 5 out of every 11 woman and newborn not having received all the three MNCH services, which is the basic premise of the ENAP and INAP to address neonatal and maternal mortality.[19 21]

With regards to the policy objective of allocating new opportunities to the vulnerable population who are at a disadvantage due to their circumstances, socio-economic inequities in maternal health services in India have been reported previously, [16 40-46] but the use of HOI to measure inequity has not been attempted. For all the maternal health services, the women

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3 291 belonging to the lowest WI quintile had low HOI compared to those in the highest WI quintile, and
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5 292 the difference was starker for ANC services and in the less developed states. Though the within-
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7 293 district inequalities in intervention coverages are reducing in most states, the pace of reduction has
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9 294 not been the same for every woman. The state of Delhi with the national capital had the one of the
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11 295 least HOI ratio for the women belonging to the lowest WI quintile. The extent of HOI ratio for the
12
13 296 lowest to the highest WI quintile and that to average HOI between the maternal health services
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15 297 within states highlights the specificity needed in targeting women with the respective interventions
16
17 298 to achieve 2025 coverage targets. One of the challenges in achieving equity in maternal health
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19 299 services in India is the dependence on NFHS for retrospective situational analysis rather than for
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21 300 monitoring and evaluation, because the routine health information management system (HMIS)
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23 301 does not allow for tracking of CoC for maternal health services per woman.[47] Real time tracking of
24
25 302 women for utilisation of these services at the district-level is needed to reduce inequity in the
26
27 303 coverage of these services. India has a Mother and Child Tracking System (MCTS) in place since 2009
28
29 304 to follow a mother-child dyad through the CoC, but it is known to be fraught with several issues.[48-
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31 305 50] Clearly, it is important that strategies to improve the MCTS, within digital health, are looked into
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33 306 urgently if India were to reach every woman and newborn to achieve the SDG targets of reduced
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35 307 maternal and neonatal mortality at the district-level.[51-53] High quality timely data for evidence-
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37 308 informed decision making to reduce inequity at the district level can also be obtained through
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39 309 continuous surveys.[54] Furthermore, incentivisation of services is currently only for institutional
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41 310 delivery and for PNC services. With poor coverage of ANC services resulting in poor coverage of CoC,
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43 311 it may be worth considering incentivising the CoC rather than individual maternal health services to
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45 312 address inequity.

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52 313 The major strength of this analysis is the utilisation of HOI to indicate not only inequity in the
53
54 314 coverage rate of the services but also how fairly the available services are distributed among women
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56 315 by geography and wealth index quintiles. This, we believe, allows for understanding the women
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58 316 who need to be targeted to reduce the inequity in the maternal health care in India. The inclusion of
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CoC is another strength as it brings the woman to the centre stage as against the individual maternal health care services. The results from this analysis are generalisable as the sample for the NFHS are nationally representative of ever-married women who reported a livebirth in the last 5 years from the time of data collection. Hence, owing to the large sample size and broad geographic coverage strengthens the external validity of these findings ensuring applicability across different population in India.

Some limitations of the analysis presented should be taken into account. The data on service utilisation is documented in the NFHS are self-reported by women, which may be subject to recall bias. We believe this bias to be of less concern as women self-report accurately indicators related to concrete and observable actions performed on them as opposed to information or advice they were offered.[55 56] We only considered the inequity in coverage and not in the quality of contact with the health system during service utilisation in this analysis as such data are not available in the NFHS. There is a growing literature documenting increased coverage but poor quality of contact for these services,[4] including from India from pregnancy to delivery,[4 50 57-67] and also of poor quality of health care being a major driver of excess mortality across conditions, including neonatal mortality.[68-71] Health system redesign has been suggested for equity in maternal and new born health, by moving all childbirth care services to hospitals in all countries, combined with improvements in the quality of care provided in these facilities, transportation from home to hospital, and continuity of care through hub-and-spoke arrangements.[72] While commenting on the scope of health system re-design is beyond the scope of the analysis undertaken for this paper, more discussion is needed and more options need to be rigorously tried and tested to develop sustainable district health systems which are fit for purpose and respond to continuity of care needs of women and their babies.[73]

CONCLUSION

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342 In conclusion, the findings of this assessment of coverage of maternal health services for livebirths
343 over a decade are encouraging as significant reductions in geographic inequity are documented.
344 However, the findings also emphasise the need for improved targeting of women to reduce the
345 remaining inequity gap to achieve the ENAP targets, in particular for the coverage of 4+ANC visits. It
346 will be important for the national program to monitor the CoC coverage in real time in addition to
347 the three maternal health services individually to monitor and track inequity at the district level for
348 every pregnant woman to ensure that inequity by wealth index is also addressed in India.

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Ethics approval

No ethics approval was required for this analysis as we utilised the de-identified data available in public domain.

Authors' contributions

RD and GAK conceptualized the study; GAK and MM had full access to data in the study and performed data analysis; RD and GAK take full responsibility for the integrity of data and accuracy of the data analysis, and had final responsibility for the decision to submit for publication; RD drafted the manuscript; all authors contributed to the interpretation and approved of the final version of the manuscript. RD is the guarantor.

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Declaration of interests

The authors have no conflict of interest.

Data availability statement sharing

All data generated or analysed during this study are included in this published article and its supplementary information files.

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595 **FIGURE LEGENDS**

596 **Figure 1.** Human Opportunity Index for 4+ antenatal care visits in NFHS-4 in 2015-16 and NFHS-5 in
597 2019-2021 for each state of India.

598 **Figure 2.** Human Opportunity Index for institutional delivery with skilled birth attendant in NFHS-4
599 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

600 **Figure 3.** Human Opportunity Index for post-natal care within 48 hours of delivery in NFHS-4 in
601 2015-16 and NFHS-5 in 2019-2021 for each state of India.

602 **Figure 4.** Human Opportunity Index for continuum of care in NFHS-4 in 2015-16 and NFHS-5 in 2019-
603 2021 for each state of India.

Figure 1. Human Opportunity Index for 4+ antenatal care visits in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.

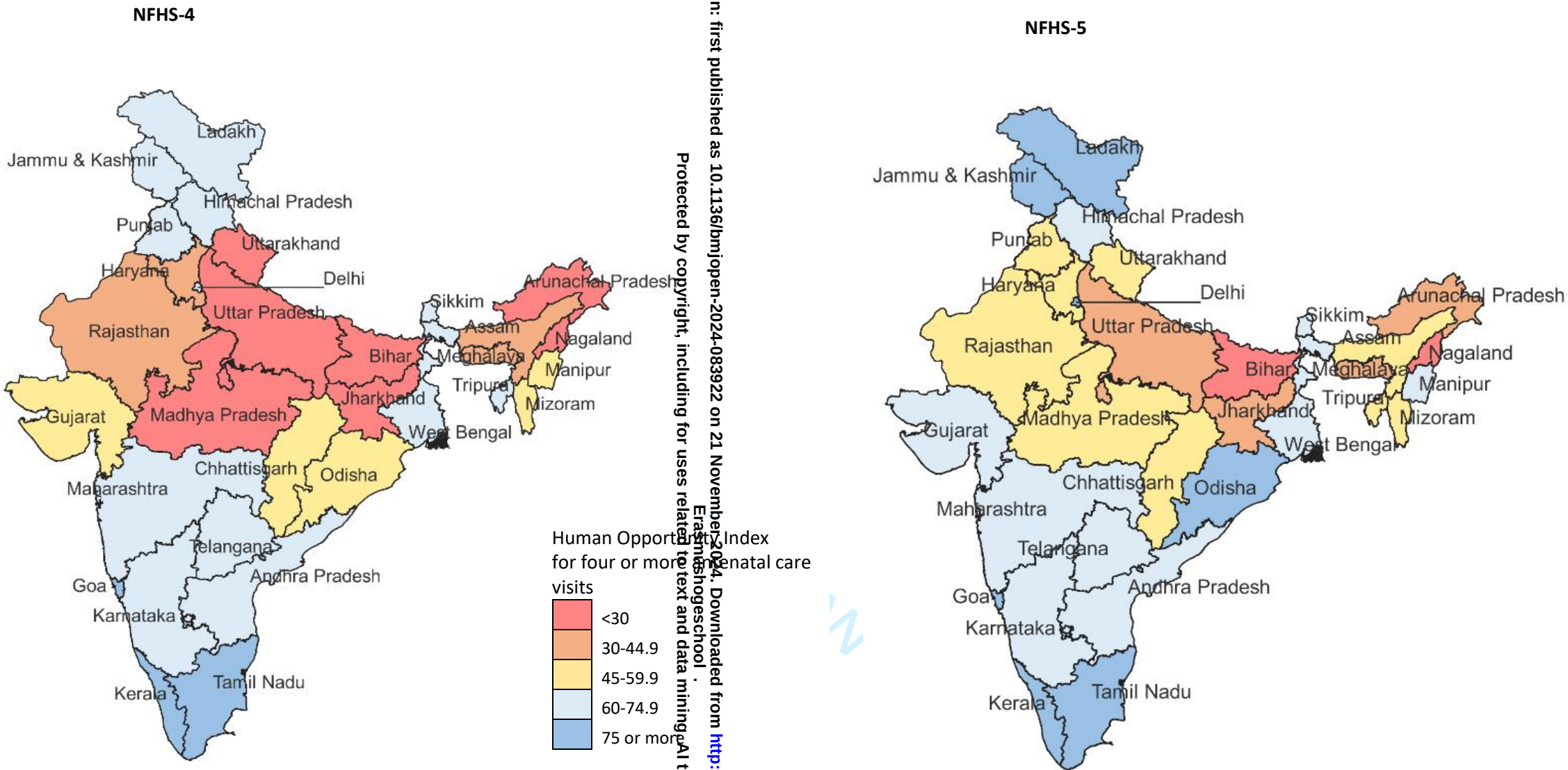
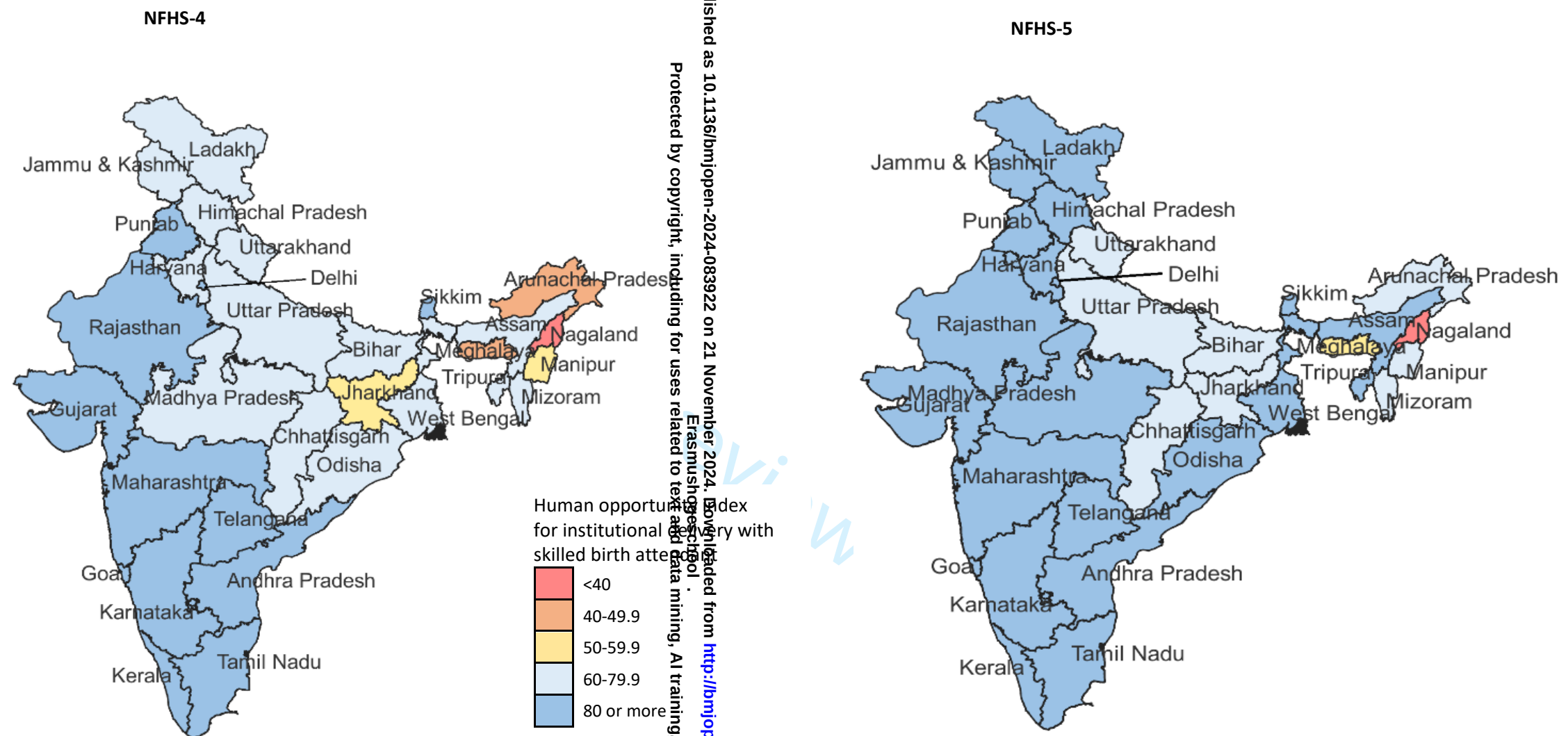
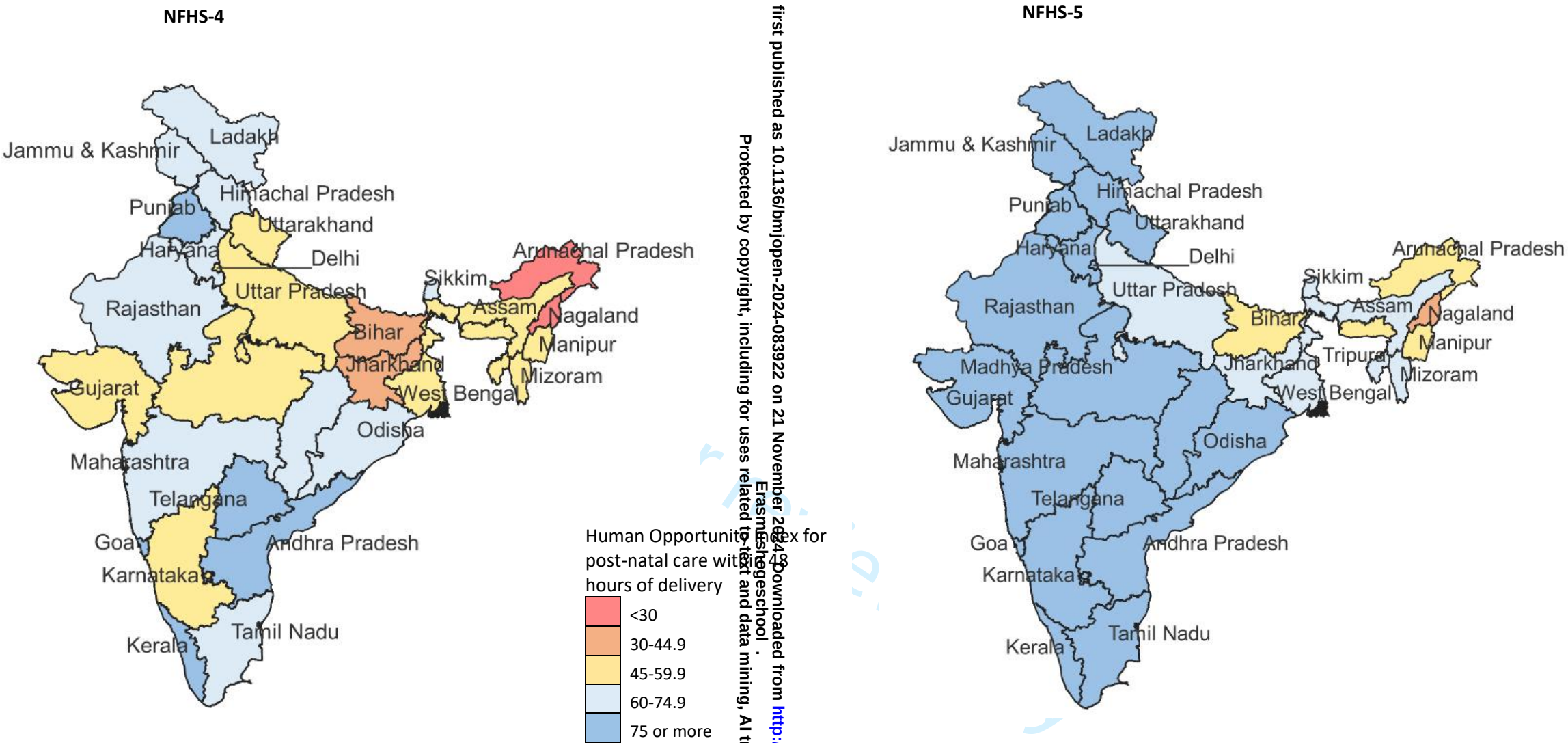


Figure 2. Human Opportunity Index for institutional delivery with skilled birth attendant in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.



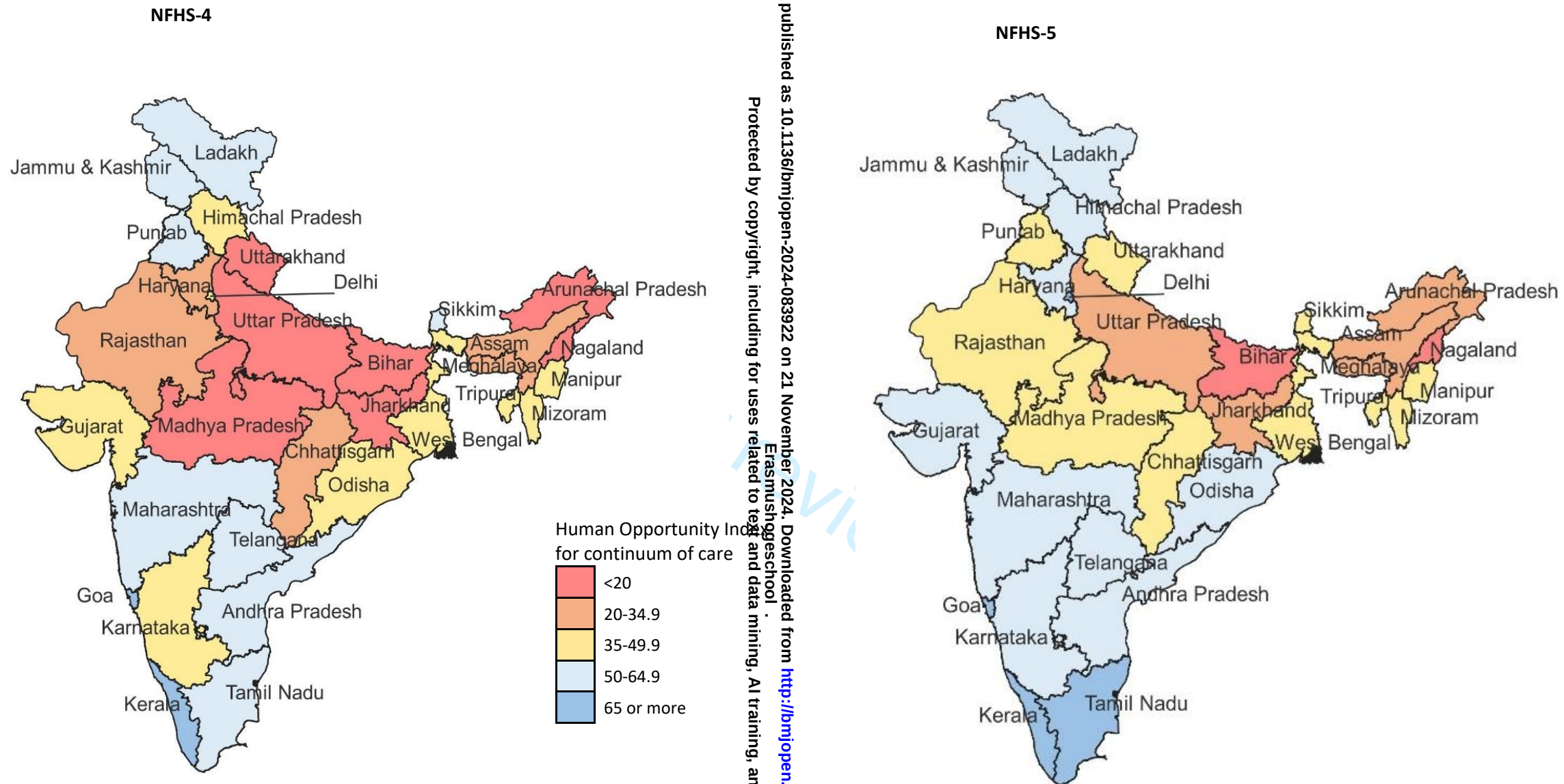
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Figure 3. Human Opportunity Index for post-natal care within 48 hours of delivery in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.



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Figure 4. Human Opportunity Index for continuum of care in NFHS-4 in 2015-16 and NFHS-5 in 2019-2021 for each state of India.



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**Population level trends over a decade in geographical inequality for
opportunity in access to maternal care services: findings from the National Family Health Surveys in India**

Supplementary file

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Supplementary Table 1. Number of districts by state in the National Family Health Survey (NFHS) rounds 4 and 5.

	Number of districts	
	NFHS-4	NFHS-5
India	628	695
Less developed	363	395
Arunachal Pradesh	16	20
Assam	27	33
Bihar	38	38
Chhattisgarh	18	27
Jharkhand	24	24
Madhya Pradesh	50	51
Manipur	9	9
Meghalaya	7	11
Mizoram	8	8
Nagaland	11	11
Odisha	30	30
Rajasthan	33	33
Sikkim	4	4
Tripura	4	8
Uttar Pradesh	71	75
Uttarakhand	13	13
More developed	265	300
Andhra Pradesh	13	13
Delhi	9	11
Goa	2	2
Gujarat	26	33
Haryana	21	22
Himachal Pradesh	12	12
Jammu & Kashmir [§]	22	22
Karnataka	30	30
Kerala	14	14
Maharashtra	35	36
Punjab	20	22
Tamil Nadu	32	32
Telangana	10	31
West Bengal	19	20

Supplementary Table 2. Coverage of four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), and post-natal care within 48 hours of delivery, and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) 4 and NFHS 5 for India and its states. CI denotes confidence interval.

State	Sample size		Four of more ANC visits			Institutional delivery with SBA*			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4 (N)	NFHS-5 (N)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)
India	188,506 [†]	174,796	46.4 (46.2-46.7)	57.0 (56.8-57.3)	22.8 (22.1-23.5)	75.5 (75.3-75.7)	85.0 (84.9-85.2)	12.2 (12.2-12.9)	61.4 (61.2 - 61.6)	78.9 (78.7-79.1)	28.5 (28.0-29.0)	32.9 (32.7-33.1)	45.6 (45.4-45.9)	38.6 (37.6-39.6)
Less developed	132,809	113,519	36.0 (35.7-36.3)	48.0 (47.7-48.3)	33.3 (32.3-34.3)	70.6 (70.3-70.8)	80.9 (80.7-81.2)	14.4 (14.1-15.1)	57.0 (56.7-57.2)	75.1 (74.8-75.3)	31.8 (31.1-32.4)	24.8 (24.6- 25.1)	36.5 (36.3-36.8)	47.2 (45.7-48.6)
Arunachal Pradesh	3,858	4,570	24.6 (23.3- 26.0)	37.2 (35.8-38.6)	51.2 (45.1-57.4)	52.7 (51.1-54.2)	80.6 (79.4-81.7)	52.2 (48.5-56.1)	27.5 (26.1-28.9)	55.4 (53.9-56.8)	101.5 (95.7-107.2)	11.8 (10.8- 12.8)	25.3 (24.1-26.6)	114.7 (104.4-124.4)
Assam	8,534	9,247	45.4 (44.3- 46.4)	50.9 (49.8-51.9)	12.1 (9.5-14.7)	72.5 (71.5-73.4)	84.8 (84.1-85.5)	17.0 (15.6-18.4)	56.9 (55.8-57.9)	67.8 (66.8-68.7)	19.1 (17.1-21.2)	29.9 (20.9-30.9)	35.5 (34.5-36.5)	18.7 (15.1-22.4)
Bihar	16,822	13,874	14.6 (14.1 -15.2)	25.5 (24.7-26.2)	74.7 (70.0-79.3)	66.0 (65.3-66.7)	75.1 (74.4-75.8)	13.8 (11.5-16.0)	47.8 (47.1-48.6)	65.4 (64.6-66.2)	36.8 (35.0-38.7)	9.0 (8.6- 9.4)	17.8 (17.2-18.4)	97.8 (91.5-104.1)
Chhattisgarh	6,805	6,526	56.9 (55.7 - 58.0)	61.2 (60.0-62.4)	7.6 (5.3-9.9)	71.8 (70.7-72.8)	82.1 (81.2-83.0)	14.2 (11.7-16.7)	67.2 (66.0-68.3)	87.2 (86.3-87.9)	29.8 (28.0-31.5)	37.6 (36.4-38.7)	47.3 (46.1-48.5)	25.8 (22.4-29.2)
Jharkhand	8,947	7,465	29.9 (29.0 - 30.9)	38.6 (37.5-39.7)	29.1 (25.4-32.8)	63.8 (62.8-64.8)	74.5 (73.5-75.5)	16.3 (15.0-17.5)	46.8 (45.8-47.8)	74.0 (73.0-75.0)	58.1 (55.6-60.6)	17.0 (16.2-17.8)	27.0 (26.0-28.0)	58.8 (53.3-64.4)
Madhya Pradesh	17,406	11,700	34.9 (34.1-35.6)	57.0 (56.1-57.9)	63.3 (60.9-65.7)	75.9 (75.2-76.5)	86.6 (86.0-87.2)	14.1 (12.1-16.0)	55.9 (55.1-56.6)	85.1 (84.4-85.7)	52.2 (50.8-53.7)	23.1 (22.4 -23.7)	46.1 (45.2-47.0)	99.6 (96.2-102.9)
Manipur	4,429	2,511	65.1 (63.7-66.5)	68.7 (66.8-70.4)	5.5 (2.9-8.2)	67.9 (66.5-69.3)	70.9 (69.1-72.6)	6.6 (5.1-8.0)	62.8 (61.4-64.2)	64.9 (62.9-66.7)	3.3 (0.5-6.2)	49.2 (47.7 -50.7)	50.9 (48.9-52.8)	3.5 (-0.3-7.2)
Meghalaya	3,119	4,602	50.1 (48.4-51.9)	50.3 (48.8-51.7)	0.4 (-3.5-4.3)	56.0 (54.3-57.8)	58.6 (57.2-60.0)	5.0 (3.1-6.9)	58.0 (56.3-59.8)	58.3 (56.8-59.7)	0.5 (-2.8-3.8)	32.1 (30.4 -33.7)	23.9 (22.7-25.1)	-25.5 (-31.1 to -20.0)
Mizoram	3,681	1,896	56.4 (54.8-58.0)	52.4 (50.2-54.7)	-7.1 (-10.6 to - 3.6)	78.1 (76.7-79.4)	79.3 (77.4-81.0)	-1.6 (-6.6)	62.8 (61.2-64.3)	68.1 (65.9-70.1)	8.4 (5.4-11.5)	41.5 (39.9 -43.1)	42.1 (39.9-44.4)	1.4 (-3.3-6.2)
Nagaland	3,136	2,205	13.5 (12.3-14.7)	15.6 (14.1-17.2)	15.6 (5.2-25.9)	33.8 (32.2-35.5)	42.5 (40.5-44.6)	26.0 (20.3-31.4)	22.6 (21.2-24.1)	43.2 (41.2-45.3)	91.2 (83.3-99.0)	7.6 (6.7- 8.6)	9.4 (8.3-10.7)	23.7 (9.3-38.1)
Odisha	9,015	7,141	64.7 (63.7-65.7)	80.0 (79.1-80.9)	23.6 (22.0-25.3)	83.3 (82.5-84.0)	90.1 (89.4-90.7)	8.1 (7.1-9.2)	77.4 (76.5-78.3)	92.1 (91.5-92.7)	19.0 (17.8-20.2)	47.8 (46.8 -48.8)	69.4 (68.4-70.5)	45.2 (42.8-47.6)
Rajasthan	11,950	10,831	38.3 (37.5-39.2)	56.5 (55.6-57.5)	47.5 (44.9-50.1)	85.0 (84.4-85.6)	95.0 (94.5-95.4)	11.8 (10.0-13.6)	65.2 (64.3-66.0)	85.2 (84.5-85.9)	30.7 (28.3-32.1)	29.1 (28.2 -29.9)	49.4 (48.5-50.4)	69.8 (66.5-73.0)
Sikkim	899	569	74.9 (71.9-77.6)	65.4 (61.4-69.2)	-12.7 (-17.0 to - 8.3)	95.2 (93.6-96.4)	96.3 (94.4-97.5)	1.2 (-5.2-8)	75.0 (72.0-77.7)	73.5 (69.7-76.9)	-2.1 (-6.3-2.3)	56.0 (52.7-59.2)	52.0 (47.9-56.1)	-7.1 (-13.7 to -0.6)
Tripura	1,169	1,860	63.5 (60.7-66.2)	54.0 (51.7-56.2)	-15.0 (-19.7 to - 10.3)	80.3 (77.9-82.5)	86.8 (85.2-88.3)	8.1 (5.1-11.1)	61.2 (58.4-64.0)	68.6 (66.4-70.7)	12.1 (7.2-17.0)	45.9 (43.0 -48.7)	39.7 (37.5-42.0)	-13.5 (-20.2 to -6.8)
Uttar Pradesh	28,741	25,556	27.4 (26.9-27.9)	41.5 (40.9-42.1)	51.5 (49.3-53.7)	68.1 (67.5-68.6)	81.1 (80.6-81.5)	19.3 (18.2-20.0)	59.1 (58.6 - 59.7)	76.9 (76.4-77.4)	30.1 (29.1-31.2)	20.0 (19.5 -20.4)	31.1 (30.5-31.7)	55.5 (52.8-58.2)
Uttarakhand	4,298	2,966	29.7 (28.3-31.1)	60.6 (58.8-62.3)	104.0 (98.7- 109.4)	67.9 (66.5-69.2)	80.1 (78.6-81.5)	18.8 (17.7-20.3)	56.9 (55.4-58.4)	84.2 (82.8-85.4)	48.0 (45.2-50.8)	20.5 (19.3 -21.7)	47.7 (45.9-49.5)	132.7 (125.5-139.9)
More developed	55,697	61,277	71.3 (70.9-71.7)	73.7 (73.4-74.1)	3.4 (2.6-4.1)	87.2 (86.9-87.5)	92.6 (92.4-92.8)	6.2 (5.8-6.6)	71.9 (71.5-72.3)	86.0 (85.7-86.3)	19.6 (19.0-20.3)	52.3 (51.9- 52.7)	62.5 (62.2-62.9)	19.5 (18.4-20.6)
Andhra Pradesh	4,055	2,092	75.7 (73.9 - 77.4)	69.3 (67.2-71.2)	-8.5 (-11.0 to - 5.9)	89.5 (88.2-90.7)	95.7 (94.8-96.5)	6.9 (5.5-8.4)	79.3 (77.6 – 80.9)	90.8 (89.5-91.9)	14.5 (12.3-16.7)	57.8 (55.7– 59.8)	62.2 (60.1-64.3)	7.6 (3.8-11.5)
Delhi	1,258	2,379	71.4	79.9	11.9	88.0	91.7	4.2	63.3	87.2	37.8	46.6	69.6	49.4

State	Sample size		Four of more ANC visits			Institutional delivery with SBA*			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4 (N)	NFHS-5 (N)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)	NFHS-4 % of N (95% CI)	NFHS-5 % of N (95% CI)	Percent change from NFHS-4 to NFHS-5 (95% CI)
			(68.8 - 73.8)	(78.2-81.4)	(8.3-15.6)	(86.1-89.7)	(90.5-92.7)	(2.1-6.3)	(60.6 - 66.0)	(85.8-88.5)	(33.3-42.1)	(43.9 - 49.4)	(67.7-71.4)	(43.2-55.5)
Goa	347	322	87.6 (83.7 - 90.7)	93.2 (89.8-95.4)	6.4 (2.2-10.5)	96.8 (94.4-98.2)	98.8 (96.7-99.5)	2.1 (0.1-4.0)	91.4 (87.9 - 93.9)	96.3 (93.5-97.9)	5.4 (2.0-8.7)	80.7 (76.2 - 84.5)	90.1 (86.3-92.9)	11.6 (6.3-17.0)
Gujarat	5,827	7,575	66.4 (65.2 - 67.6)	77.7 (76.7-78.6)	17.0 (15.1-19.0)	83.9 (82.9-84.8)	90.3 (89.6-90.9)	7.6 (4.4-8.8)	62.9 (61.7 - 64.2)	89.4 (88.6-90.0)	42.1 (40.1-44.2)	42.3 (41.0- 43.5)	66.3 (65.3-67.4)	56.7 (53.5-60.0)
Haryana	5,719	5,162	45.4 (44.1 - 46.7)	60.8 (59.4-62.1)	33.9 (30.7-37.1)	82.1 (81.1-83.1)	93.4 (92.6-94.0)	13.3 (11.5-15.0)	68.3 (67.0 - 69.5)	91.3 (90.5-92.0)	33.7 (31.8-35.5)	34.3 (33.1 - 35.6)	55.6 (54.3-57.0)	62.1 (58.0-66.2)
Himachal Pradesh	2,292	2,145	66.2 (64.3 - 68.1)	71.8 (69.8-73.6)	8.5 (5.3-11.7)	75.9 (74.1-77.6)	84.3 (82.7-85.8)	11.1 (8.5-13.6)	73.6 (71.8 - 75.4)	88.9 (87.5-90.2)	20.8 (18.2-23.4)	49.5 (47.4 - 51.5)	59.3 (57.2-.61.3)	19.8 (15.2-24.4)
Jammu & Kashmir [§]	6,280	5,367	79.5 (78.5 - 80.5)	80.7 (79.6-81.7)	1.5 (0.1-2.9)	83.2 (82.2-84.1)	91.0 (90.2-91.7)	9.4 (8.2-10.6)	73.0 (71.9 - 74.1)	80.3 (79.2-81.3)	10.0 (8.4-11.6)	61.8 (60.6 - 63.0)	65.1 (63.8-66.4)	5.3 (3.2-7.5)
Karnataka	5,876	6,389	73.5 (72.3 - 74.6)	70.8 (69.6-71.9)	-3.7 (-5.4 to -2.0)	90.7 (90.0-91.5)	92.5 (91.8-93.1)	2.0 (1.1-2.9)	60.5 (59.2 - 61.7)	86.4 (85.5-87.2)	42.8 (40.6-45.0)	44.6 (43.3 - 45.9)	59.1 (57.9-60.3)	32.5 (29.4-35.6)
Kerala	2,128	2,360	90.3 (89.0 - 91.5)	82.2 (80.6-83.7)	-9.0 (-10.6 to -7.4)	99.9 (99.6-100.0)	99.8 (99.5-99.9)	-0.1 (-1.3-0.1)	86.3 (84.7 - 87.7)	92.8 (91.7-93.8)	7.5 (5.7-9.3)	78.4 (76.6 - 80.1)	77.9 (76.2-79.5)	-0.6 (-3.1-1.8)
Maharashtra	7,143	7,415	72.3 (71.3 - 73.3)	71.3 (70.3-72.3)	-1.4 (-3.0- 0.2)	86.7 (85.9-87.5)	91.0 (90.3-91.6)	5.0 (4.0-5.9)	76.9 (75.9 - 77.9)	84.1 (83.3-84.9)	9.4 (8.0-10.7)	54.4 (53.2 - 55.5)	60.2 (59.1-61.3)	10.7 (8.3-13.0)
Punjab	4,132	4,520	68.2 (66.7 - 69.6)	58.3 (56.8-59.7)	-14.5 (-16.8 to -12.2)	92.0 (91.2-92.8)	94.1 (93.4-94.7)	2.3 (1.5-3.2)	88.4 (87.4 - 89.3)	87.1 (86.1-88.0)	-1.5 (-2.7 to -0.3)	59.1 (57.6 - 60.6)	50.2 (48.7-51.6)	-15.1 (-17.8 to -12.3)
Tamil Nadu	6,181	5,228	80.7 (79.7 - 81.7)	91.6 (90.8-92.3)	13.5 (12.2-14.8)	98.8 (98.5-99.1)	99.5 (99.3-99.7)	0.7 (0.1-1.0)	72.4 (71.3 - 73.5)	92.2 (91.4-92.9)	27.3 (25.7-29.0)	60.8 (59.6 - 62.0)	84.9 (84.0-85.9)	39.6 (37.5-41.8)
Telangana	NA	5,429	73.1 (71.0 - 75.1)	69.7 (68.5-70.9)	-4.7 (-7.6 to -1.7)	87.2 (85.6-88.7)	91.4 (90.6-92.1)	4.8 (3.8-5.6)	81.7 (79.8 - 83.4)	86.6 (85.7-87.5)	6.0 (3.7-8.2)	57.6 (55.3- 59.9)	56.9 (55.6-58.2)	-1.2 (-5.3-2.9)
West Bengal	4,459	4,894	74.2 (72.9 - 75.5)	75.7 (74.4-76.9)	2.0 (0.1-3.9)	77.0 (75.8-78.2)	91.2 (90.4-91.9)	18.4 (17.8-19.1)	63.1 (61.7 - 64.5)	68.2 (66.9-69.5)	8.1 (5.6-10.5)	47.4 (46.0 - 48.9)	52.0 (50.6-53.4)	9.7 (6.3-13.1)

*Includes doctor, auxiliary nurse midwife, nurse, midwife, and lady health visitor

[†]Data missing on 101 women for institutional delivery with SBA, PNC within 48 hours of delivery, and continuum of care in NFHS-5

[§]Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh

Supplementary Table 3. Human Opportunity Index for geographic inequality for four of more antenatal care (ANC) visits, institutional delivery with skilled birth attendant (SBA), post-natal care within 48 hours of delivery and continuum of care for the most recent livebirth in the last 5 years in the National Family Health Survey (NFHS) rounds 4 and 5 for India and its states. CI denotes confidence interval.

	Human Opportunity Index											
	Four of more ANC visits			Institutional delivery with SBA			Post-natal care within 48 hours of delivery			Continuum of care		
	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)	NFHS-4	NFHS-5	Percent change from NFHS 4 to NFHS-5 (95% CI)
India	35.8	48.4	35.2 (34.5 to 35.9)	68.9	80.4	16.7 (16.8 to 17.0)	54.6	73.5	34.6 (34.2 to 35.1)	24.4	37.1	52.2 (51.1 to 53.0)
Less developed states	27.9	40.7	45.9 (44.9 to 46.9)	64.5	76.2	18.1 (17.7 to 18.6)	50.6	69.4	37.2 (36.6 to 37.8)	18.5	29.7	60.5 (59.2 to 61.9)
Arunachal Pradesh	20.2	34.3	69.8 (62.7 to 76.9)	47.0	77.5	64.9 (51.1 to 68.5)	22.7	51.9	128.6 (122.1 to 135.2)	8.2	21.9	167.1 (154.4 to 179.8)
Assam	40.7	45.6	12.0 (9.2 to 14.9)	66.5	82.3	23.8 (22.1 to 25.4)	51.1	64.7	26.6 (24.3 to 28.9)	24.9	31.0	24.5 (20.3 to 28.7)
Bihar	12.8	22.9	78.9 (73.9 to 83.9)	61.0	72.1	18.2 (16.6 to 19.6)	43.1	59.6	38.3 (36.2 to 40.3)	7.7	15.3	98.7 (91.8 to 105.6)
Chhattisgarh	52.0	57.2	10.0 (7.5 to 12.5)	68.6	78.5	14.4 (12.2 to 16.2)	63.0	85.3	35.4 (33.5 to 37.3)	33.1	43.3	30.8 (27.0 to 34.6)
Jharkhand	25.0	36.0	44.0 (39.7 to 48.3)	59.5	70.4	18.3 (16.6 to 20.3)	43.2	70.9	64.1 (61.4 to 66.8)	13.8	24.1	74.6 (68.3 to 81.0)
Madhya Pradesh	29.4	52.2	77.6 (74.8 to 80.3)	70.8	84.1	18.8 (17.7 to 19.8)	51.3	82.8	61.4 (59.8 to 63.0)	19.1	41.2	115.7 (111.9 to 119.5)
Manipur	54.9	61.2	11.5 (8.2 to 14.8)	58.0	62.0	6.9 (3.3 to 10.0)	54.4	57.7	6.1 (2.7 to 9.4)	39.2	41.5	5.9 (1.3 to 10.4)
Meghalaya	44.3	45.4	2.5 (-1.9 to 6.9)	49.6	52.5	5.8 (1.9 to 9.8)	52.0	53.4	2.7 (-1.1 to 6.4)	26.4	20.5	-22.3 (-28.8 to -15.9)
Mizoram	52.4	46.6	-11.1 (-14.8 to -7.3)	72.1	72.4	0.4 (-2.0 to 2.9)	59.0	63.9	8.3 (5.0 to 11.6)	37.9	36.6	-3.4 (-8.5 to 1.6)
Nagaland	8.3	11.3	36.1 (22.3 to 50.0)	26.2	37.4	42.7 (35.0 to 49.7)	17.2	37.5	118.0 (108.5 to 127.5)	4.4	6.5	47.7 (28.0 to 67.5)
Odisha	59.2	76.2	28.7 (26.8 to 30.6)	79.2	87.3	10.2 (9.1 to 11.4)	74.4	90.7	21.9 (20.6 to 23.2)	42.6	64.8	52.1 (49.4 to 54.8)
Rajasthan	33.0	51.2	55.2 (52.2 to 58.1)	81.8	93.9	14.8 (13.3 to 15.7)	61.2	82.6	35.0 (33.4 to 36.5)	24.6	44.2	79.7 (76.0 to 83.3)
Sikkim	71.3	60.1	-15.7 (-20.5 to -10.9)	94.4	95.2	0.8 (-0.9 to 2.6)	71.9	70.4	-2.1 (-6.7 to 2.5)	52.1	48.3	-7.3 (-14.4 to -0.2)
Tripura	60.4	50.4	-16.6 (-21.6 to -11.5)	76.4	83.5	9.5 (5.5 to 12.7)	58.2	64.2	10.3 (5.1 to 15.5)	42.9	35.3	-17.7 (-24.8 to -10.6)
Uttar Pradesh	21.9	38.1	74.0 (71.4 to 76.6)	64.0	78.0	21.9 (20.1 to 22.8)	53.5	73.2	36.8 (35.6 to 38.0)	15.6	27.9	78.8 (75.6 to 82.1)
Uttarakhand	25.9	55.7	115.1 (109.0 to 121.1)	65.2	78.5	20.4 (19.2 to 22.8)	54.3	81.5	50.1 (47.1 to 53.1)	17.5	43.3	147.4 (139.3 to 155.5)
More developed states	65.2	68.2	4.6 (3.9 to 5.3)	82.8	90.1	8.8 (7.4 to 9.2)	66.2	82.6	24.8 (24.1 to 25.4)	45.7	56.3	23.2 (22.2 to 24.2)
Andhra Pradesh	74.3	68.3	-8.1 (-10.8 to -5.4)	88.0	95.4	8.4 (7.2 to 10.0)	77.6	90.4	16.5 (14.2 to 18.8)	56.1	59.3	5.7 (1.7 to 9.7)
Goa	86.0	92.4	7.4 (3.0 to 11.9)	96.7	98.5	1.9 (1.0 to 3.9)	90.5	95.6	5.6 (2.1 to 9.2)	79.0	88.8	12.4 (6.7 to 18.1)
Gujarat	59.7	73.1	22.4 (20.2 to 24.7)	80.1	87.5	9.2 (8.0 to 10.6)	59.9	87.1	45.4 (43.2 to 47.6)	36.7	61.2	66.8 (63.1 to 70.4)
Haryana	37.3	56.6	51.7 (47.9 to 55.5)	75.6	90.5	19.7 (18.3 to 21.3)	61.3	88.7	44.7 (42.5 to 46.9)	27.2	51.2	88.2 (83.3 to 93.1)
Himachal Pradesh	61.7	67.1	8.8 (5.2 to 12.3)	72.7	82.5	13.5 (10.9 to 16.2)	69.8	87.3	25.1 (22.2 to 27.9)	45.4	54.3	19.6 (14.6 to 24.6)
Jammu & Kashmir*	71.9	76.3	6.1 (4.4 to 7.8)	77.8	87.9	13.0 (11.1 to 14.4)	67.1	77.2	15.1 (13.2 to 16.9)	53.3	59.5	11.6 (9.1 to 14.2)
Karnataka	69.3	65.1	-6.1 (-7.9 to -4.2)	88.4	90.3	2.1 (1.1 to 3.1)	55.3	83.6	51.2 (48.8 to 53.6)	39.6	52.6	32.8 (29.4 to 36.3)
Kerala	88.9	77.3	-13.0 (-14.8 to -11.3)	99.8	99.7	-0.1 (-0.3 to 0.1)	84.2	91.5	8.7 (6.7 to 10.6)	75.7	72.9	-3.7 (-6.3 to -1.1)
Maharashtra	69.3	66.7	-3.8 (-5.5 to -2.0)	83.9	88.2	5.1 (4.0 to 6.2)	74.2	80.8	8.9 (7.4 to 10.4)	50.0	54.5	9.0 (6.4 to 11.6)
Delhi	68.8	75.3	9.4 (5.5 to 13.3)	86.0	90.2	4.9 (2.6 to 7.2)	59.1	85.1	44.0 (39.3 to 48.7)	42.7	65.3	52.9 (46.2 to 59.7)
Punjab	64.6	54.7	-15.3 (-17.8 to -12.8)	91.1	92.9	2.0 (1.0 to 3.0)	86.9	85.4	-1.7 (-3.0 to -0.4)	55.5	46.9	-15.5 (-18.5 to -12.5)
Tamil Nadu	77.5	89.6	15.6 (14.2 to 17.0)	98.4	99.2	0.8 (0.5 to 1.1)	68.4	90.4	32.2 (30.4 to 33.9)	56.4	82.0	45.4 (43.0 to 47.7)
Telangana	71.8	68.2	-5.0 (-8.0 to -2.0)	85.6	90.4	5.6 (3.7 to 7.6)	79.9	85.4	6.9 (4.5 to 9.3)	55.7	54.9	-1.4 (-5.7 to 2.8)
West Bengal	69.4	72.2	4.0 (1.9 to 6.2)	71.3	89.2	25.1 (23.3 to 27.1)	58.0	63.8	10.7 (7.3 to 12.7)	42.0	47.3	12.6 (8.8 to 16.4)

*Ladakh is combined with Jammu & Kashmir in NFHS-5; NFHS 4 did not provide separate data for Ladakh.

Supplementary Table 4. Ratio of Human opportunity index (HOI) between wealth index quintiles I and V for the maternal services for India and its states, National Family Health Survey-5.

	Ratio of HOI between wealth index quintiles I and V			
	Four of more antenatal care visits	Institutional delivery with skilled birth attendant	Post-natal care within 48 hours of delivery	Continuum of care
India	0.52	0.69	0.73	0.38
Less developed states	0.55	0.69	0.74	0.41
Arunachal Pradesh	0.43	0.58	0.70	0.38
Assam	0.63	0.75	0.79	0.54
Bihar	0.32	0.72	0.71	0.25
Chhattisgarh	0.89	0.72	0.93	0.70
Jharkhand	0.51	0.64	0.81	0.33
Madhya Pradesh	0.72	0.83	0.91	0.63
Manipur	0.40	0.40	0.48	0.33
Meghalaya	0.66	0.47	0.88	0.55
Mizoram	0.16	0.28	0.36	0.12
Nagaland	0.27	0.35	0.47	0.08
Odisha	0.84	0.81	0.94	0.69
Rajasthan	0.77	0.92	0.92	0.73
Sikkim	1.41	0.94	1.17	0.22
Tripura	0.81	0.79	0.68	0.39
Uttar Pradesh	0.60	0.76	0.80	0.43
Uttarakhand	0.51	0.68	0.81	0.43
More developed states	0.83	0.80	0.76	0.63
Andhra Pradesh	0.66	0.75	0.73	0.39
Goa	1.07	1.01	1.01	0.73
Gujarat	0.79	0.83	0.96	0.63
Haryana	0.52	0.67	0.70	0.39
Himachal Pradesh	0.70	0.60	0.77	0.43
Jammu and Kashmir	0.76	0.74	0.78	0.61
Karnataka	0.75	0.90	0.91	0.64
Kerala	0.95	1.00	0.89	0.95
Maharashtra	0.68	0.73	0.78	0.54
Delhi	0.34	0.24	0.36	0.02
Punjab	0.54	0.84	0.80	0.57
Tamil Nadu	1.01	0.96	0.94	0.96
Telangana	0.78	0.83	0.89	0.63
West Bengal	0.85	0.90	0.70	0.53

Ratio of HOI

	Less than 0.50
	0.51-0.89
	0.90-1.09
	1.10-1.49
	1.50 or more