Indigenous Well-being in Northeast India: Patterns and Pathways in Health and Nutrition

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Keywords

Highly tribal concentrated districts, Northeast, NFHS-5, triple burden of disease, India

Abstract

The northeastern region of India is home to diverse tribal communities that face significant health and nutrition challenges. This study aimed to assess disparities in reproductive, maternal, newborn, and child health (RMNCH) indicators between highly tribal concentrated (HTC) districts and other districts while evaluating healthcare utilization patterns among tribal populations. The study analyzed NFHS-5 (2019-21) data from northeastern India, categorizing districts by tribal concentration (HTC: >80%, MTC: 30-80%, LTC: <30%). Descriptive statistics were employed to assess health disparities and geographic vulnerability across districts. The study revealed significant disparities in RMNCH indicators between HTC and LTC districts. HTC districts consistently underperformed in institutional deliveries, iron-folic acid (IFA) supplementation, and nutritional practices compared to LTC districts and the national average for Scheduled Tribes (ST). Geographic vulnerability (GV) was identified as a critical determinant, with high GV areas exhibiting lower healthcare access and utilization. State-level analyses highlighted heterogeneity in health outcomes across northeastern states. The findings underscore the need for targeted interventions to address the unique health and nutrition challenges faced by tribal populations in HTC districts, particularly those with high geographic vulnerability. Strengthening healthcare delivery systems, improving the coverage of existing schemes, and implementing state-specific strategies are essential to improving RMNCH outcomes.

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Introduction

The northeastern (NE) region of India, comprising eight states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura), is home to a diverse array of tribal communities, with over 220 ethnic groups (Tribes India, 2022). According to the Census of India (2011) around, 8.6% of India's population was tribal, of which 104 million or 90% lived in rural areas (Census, 2011). The NE region of India is characterized by its geographical vulnerability, with over 4,500 km of international borders and a hilly terrain (Ghosh, 2020), which adds to the challenges in healthcare delivery for the tribal populations and making them the most socio-economically disadvantaged communities (Cáceres et al., 2023; Chaudhary et al., 2023; Kumar & Kumar, 2022a). The tribal populations in the northeastern region face a "triple burden of disease", affected by communicable diseases, non-communicable diseases, and malnutrition (Kumar et al., 2020; Ladusingh et al., 2018). A study claimed that tribal populations in the region had higher prevalence of undernutrition, anemia, and stunting compared to their non-tribal counterparts (Das et al., 2024; Jaleel et al., 2023).

Recent studies have highlighted that NE region faces significant health challenges, particularly in terms of nutritional deficiencies and related health outcomes (Kumar et al., 2024; Mavalankar, 2016; Tomaszewska & Kwiatkowska, 2019). Various studies reported the disparities in maternal and child health (MCH) indicators between tribal and non-tribal populations in the Northeast (Cáceres et al., 2023; Manna et al., 2022; Shah & Bélanger, 2011). The National Family Health Survey (NFHS-5, 2019-21) revealed that tribal communities in the region lag behind the national average in several key MCH indicators, including institutional deliveries, antenatal care (ANC) visits, and postnatal care (PNC) (Annual Report | International Institute for Population Sciences (IIPS), n.d.). For instance, the institutional delivery rate among tribal women in Nagaland and Manipur was 39% and 57%, respectively, compared to the national average of 89% for tribal populations (Annual Report | International Institute for Population Sciences (IIPS), n.d.). Another study conducted among the Sonowal Kachari tribe in Assam highlighted a significant prevalence of thinness among children aged 6 to 18 years, emphasizing the need for targeted nutritional interventions (Singh & Mondal, 2013). Similarly, a study focusing on the Kora-Mudi children in West Bengal reported alarming rates of undernutrition, underscoring the widespread issue across various tribal groups (Bisai & Mallick, 2011). Moreover, the nutritional challenges faced by tribal populations are exacerbated by socio-

economic factors such as poverty (Jaiswal & J, 2021), low literacy rates, limited access to healthcare services (Cáceres et al., 2023; Kuru et al., 2023), dietary pattern (Khakhalary & Narzari, 2023), and diverse ethnic backgrounds and cultural practices (Jaiswal & J, 2021). A comprehensive review of adult tribal malnutrition across India further corroborates these findings, indicating that tribal communities are among the most disadvantaged in terms of health and nutrition (Das & Bose, 2015; Kumar & Kumar, 2022b). Moreover, A study by Sarkar et. al., (2018) found that tribal women in Meghalaya often opted for home deliveries due to financial constraints, fear of out-of-pocket expenditure, and the unavailability of transportation to reach healthcare facilities (Sarkar et al., 2018). A study found that tribal populations in Manipur often preferred traditional healers over modern healthcare services due to their strong belief in indigenous medicine and the perceived poor quality of care at government facilities (Guite & Acharya, 2006).

Global indigenous health research has highlighted the importance of culturally appropriate and community-driven approaches in addressing the unique health needs of tribal and indigenous populations (Harding & Oetzel, 2019; Rasmus et al., 2020). Studies have emphasized the need to incorporate traditional healing practices, strengthen community engagement, and empower local leadership to improve healthcare access and utilization among these communities (Harding & Oetzel, 2019; Rasmus et al., 2020).

In the context of the NE regions of India, to address the health and nutrition challenges faced by tribal communities in the Northeast, policymakers and healthcare providers have implemented various schemes and interventions. For instance, the Government of Arunachal Pradesh launched the 'Mission Pratiraksha (Mission Pratiraksha: Boosting Immunization Coverage in Remote Areas of Arunachal Pradesh | NFS, n.d.)' and 'Dulari Kanya (Dulari Kanya | District Papum Pare | India, n.d.)' schemes to improve maternal and child health outcomes. Similarly, the 'Mironbising Gi Khudol (Family Welfare Department, Manipur : STATE INNOVATION, n.d.)' scheme in Manipur aims to provide comprehensive maternal and child healthcare services in remote areas. However, the effectiveness of these interventions in reaching the most vulnerable tribal populations remains a subject of ongoing research and evaluation.

The health and nutrition status of tribal communities in the NE region remains a pressing concern, with significant disparities in MCH indicators, the triple burden of disease, and barriers to healthcare access. The present study aimed to assess the disparities in supply-

dependent and demand-dependent reproductive, maternal, newborn, and child health (RMNCH) indicators between tribal populations residing in highly tribal concentrated (HTC) districts and their counterparts in other districts, and to evaluate the utilization patterns of public healthcare facilities for antenatal care (ANC), delivery services, and general healthcare seeking behavior among tribal populations, while identifying the determinants and barriers influencing the adoption of recommended healthcare practices.

Data and Methodology

Data source

The present study analyzed data from the fifth round of the National Family Health Survey (NFHS-5, 2019-21), a large-scale, nationally representative cross-sectional survey conducted by the International Institute for Population Sciences (IIPS) under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India. The survey covers a range of RMNCH indicators and provides district-level estimates. The survey also collects information on social caste of the heads of households. Based on this, the present study identified if the surveyed households belonged to scheduled tribe, which is interchangeably use as tribal household. Additionally, data from the 2011 Census of India was used to divide districts in the northeast states into different categories of tribal population concentration.

The objective of this study was to provide an overview on the current status of the tribal population in the northeastern region. Therefore, analyses were conducted based on the sample of STs from NFHS-5 data. Further, based on the overall proportion of tribal households (as per 2011 census estimates), all districts in northeastern region were divided into three categories: 1) low tribal concentration (LTC) (<30%), 2) medium tribal concentration (MTC) (30% to 80%) and 3) HTC (>80%). For the newly designated districts formed after the 2011 census was conducted, NFHS-5 estimates were considered to determine the level of tribal concentrations.

Description of variables

The present study categorized various RMNCH (Reproductive, Maternal, Newborn, and Child Health) indicators into two distinct groups: supply-dependent indicators and demand-dependent indicators. This classification was based on the premise that supply-dependent indicators are primarily influenced by system-level efforts and healthcare supply mechanisms, while demand-dependent indicators are shaped by the behavioral responses and healthcare-seeking practices of beneficiaries.

Supply-dependent indicators include variables such as receiving iron folic acid (IFA) tablets or syrup during pregnancy, institutional delivery, outreach by frontline workers (FLWs) to non-users of family planning (FP) services, the Method Information Index (MII), counseling on breastfeeding, and receiving nutrition supplements from Anganwadi Centers (AWCs). These indicators reflect the availability and accessibility of healthcare services and the effectiveness of system-level interventions.

Demand-dependent indicators focus on individual behaviors and include variables such as consuming 100+ IFA tablets among those who received them, antenatal care (ANC) in the first trimester, at least four ANC visits, postnatal check-ups within two days of delivery, the use of modern reversible family planning methods, the intention to use family planning among non-users, timely initiation of breastfeeding, and exclusive breastfeeding. These indicators highlight the role of individual decision-making and healthcare utilization. Table 1 provides detailed definitions of these indicators, offering a comprehensive understanding of the variables analysed in this study.

Table 1. Description of the variables/indicators

Indicators	Definition
Supply dependent	
Received iron folic acid (IFA) tablets/syrup	Mothers given or bought IFA tablets/syrup during pregnancy
Institutional delivery	Whether delivery was conducted in a health facility
FLW outreach to non-users	Women aged 15–49 years who never used any FP services at the time of the survey reported that they were ever told by a health worker about any family planning methods that they can use to avoid pregnancy
Method Information Index (MII)	Women aged 15–49 who received full information on all three domains: 1. Alternative methods of family planning 2. Possible side effects or problems they might have with the method. 3. Informed what to do if they experience any side effects or problems
Counselled on breastfeeding	Women with a live birth in the last 5 years who spoke with a health care provider about breastfeeding during their last pregnancy
Received nutrition supplements from AWC	Women with a live birth in the last 5 years who received any supplementary nutrition from the Anganwadi Centre during last pregnancy
Demand Dependent	
100+ IFA consumption among those who received	Mothers who consumed iron folic acid for 100 days or more during pregnancy for the last child born during the past 5 years
Antenatal care (ANC) in 1st Trimester	Mothers who had an antenatal check-up in the first trimester during pregnancy for the last child born during the past 5 years

4+ ANC	Mothers who had at least 4 antenatal care visits during pregnancy for the last child born during the past 5 years
Postnatal check-up with 2 days of delivery	Mothers who received postnatal care from a doctor/nurse/LHV/ANM/ midwife/other health personnel within 2 days of delivery for the last birth in the past 5 years
Reversible FP use	Women of age 15-49 years who are currently using any modern reversible contraception methods such as pills, IUD, injectable, male condom, female condom, standard days method (SDM), diaphragm, foam/jelly, lactational amenorrhea method (LAM).
Intention to use-FP among non-users	Women aged 15-49 who are not using a contraceptive method, but intent to use in the next 12 months.
Timely initiation of breastfeeding	Children under age 3 years breastfed within one hour of birth
Intention to use-FP among non-users	Women aged 15-49 who are not using a contraceptive method, but intent to use in the next 12 months.
Exclusive breastfeeding	Children under age 6 months exclusively breastfed

Geographic Vulnerability: It was assumed that tribal populations living in vulnerable or hard-to-reach geographies may have some association with their RMNCH practices. Therefore, districts were classified into different categories of geographic vulnerabilities (GV) based on the following parameters (Wadhawan, 2021):

1. Border districts: districts with international borders
2. Riverine: districts with major rivers flowing within the territory
3. Flood-affected area
4. Cyclone/drought prone area
5. High altitude: elevation above 3000 mts. in most parts of the district

Based on these parameters, a composite index, i.e. additive score, was estimated for each district to identify the level of GV at the district-level. The estimates' score ranged from 0 to 3. Out of 104 districts, 23 districts had a GV score 0, 52 districts scored 1, 23 districts scored 2 and the remaining 6 districts scored 3.

Statistical methodology

The analytical approach focused on both univariate and bivariate analyses to comprehensively understand the patterns and relationships within the data.

For univariate analysis, we examined the distribution of individual variables across multiple domains. This included analyzing demographic characteristics of tribal populations, supply-dependent RMNCH indicators (such as institutional deliveries and IFA supplementation), and demand-dependent RMNCH indicators (including healthcare-seeking behaviors and community practices). Geographic vulnerability scores were also analyzed individually to understand the distribution of geographic challenges across districts. For continuous variables,

we calculated measures of central tendency (mean and median) and measures of dispersion (standard deviation and range) to understand the spread and central values of the data. For categorical variables, we computed frequency distributions and proportions to understand the distribution patterns across different categories.

The bivariate analysis component focused on examining relationships between multiple variables of interest. We performed cross-tabulations to understand the associations between health indicators and district-wise tribal concentration levels (HTC, MTC, and LTC). This analysis helped identify patterns in healthcare utilization across districts with different tribal population concentrations. Additionally, we examined the relationship between healthcare utilization patterns and geographic vulnerability scores to understand how geographic challenges influence healthcare access. State-wise variations in health outcomes were also analyzed through cross-tabulations to identify regional patterns and disparities. Comparative analyses were specifically conducted to assess disparities between HTC and LTC districts across various health indicators, providing insights into the impact of tribal concentration on health outcomes.

Results

Characteristics of districts in the northeastern region

Analysis of 104 districts of the NE region revealed distinct tribal population concentrations: 41.3% (n=43) were highly tribal concentrated (HTC) districts with >80% tribal population, 26.0% (n=27) had moderate concentration (30-80%), and 32.7% (n=34) showed low concentration (<30%). Spatial distribution indicated predominant tribal concentrations (>80%) in Arunachal Pradesh, Nagaland, Manipur, Mizoram, and Meghalaya, while Assam and select districts of Tripura and Sikkim exhibited lower tribal densities (<30%). Notably, several districts in Arunachal Pradesh, Manipur, Nagaland, and Sikkim demonstrated concurrent high tribal proportions (66%-96%) and geographical vulnerability (GV) scores >2, suggesting potential healthcare accessibility challenges in these regions. This demographic and geographic heterogeneity has significant implications for healthcare planning and service delivery across the northeastern states. The district-wise proportions of tribal population are shown in Figure 1.

Figure 1. District-wise proportion of Tribal population in NE states
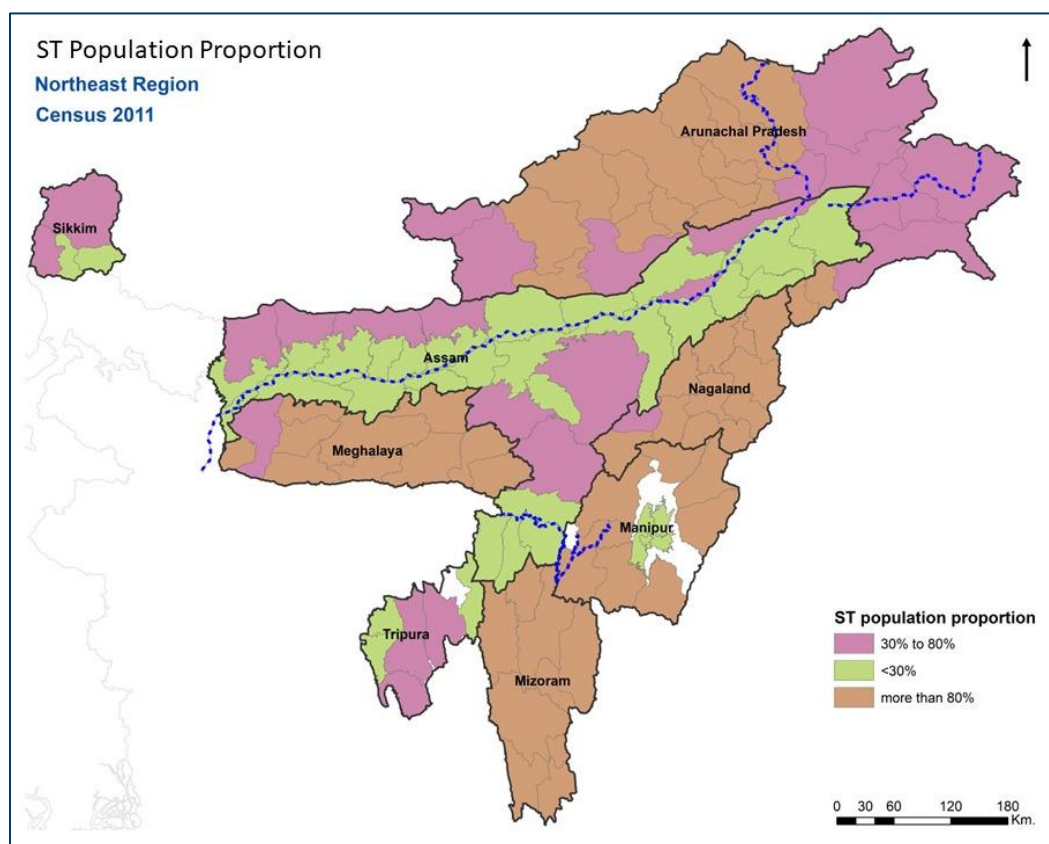
Socio-demographic characteristics

The tribal populations in the northeastern region predominantly reside in rural areas, with over 80% living in rural settings in states such as Tripura, Assam, Arunachal Pradesh, Manipur, and Meghalaya (Table 2). This rural concentration highlights the geographical isolation and limited access to healthcare services faced by these communities. Economic disparities are stark, with 75–80% of tribal populations in Tripura and Assam belonging to the poor or poorest wealth quintiles, followed by Meghalaya, Manipur, Nagaland, and Arunachal Pradesh, where 55–69% fall into these

categories. Such economic vulnerabilities exacerbate challenges in accessing healthcare and other essential services. Religious affiliations also vary significantly across the region, with Christianity being the predominant religion in Nagaland (99%), Manipur (98%), Mizoram (95%), and Meghalaya (89%), while Hinduism is the majority religion in Assam and Tripura (>75%). In Sikkim, a majority of the tribal population (63%) practices Buddhism, reflecting the region's cultural and religious diversity.

Fertility and literacy levels further illustrate the socio-demographic disparities. Meghalaya and Manipur

report the highest Total Fertility Rates (TFR) at over 3, indicating higher reproductive rates, while Sikkim and Assam have the lowest TFRs at 1 and 1.5, respectively, suggesting better adoption of family planning practices. Educational attainment remains a concern, with Arunachal Pradesh exhibiting the highest illiteracy rate among tribal populations (23%), followed by Tripura (20%) and

Assam (17%). These socio-demographic characteristics collectively underscore the need for targeted interventions to address the unique challenges faced by tribal populations, particularly in rural and economically disadvantaged areas, while considering the cultural and religious diversity that shapes their healthcare-seeking behaviors (Table 2).

Table 2. Socio-demographic characteristics of tribal population in north-eastern states, 2019-21

	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
Household's characteristics								
Place of residence								
Urban	11.8	8.5	18.3	17.6	56.3	27.7	33.9	5.1
Rural	88.2	91.5	81.7	82.4	43.7	72.3	66.1	94.9
Wealth quintile								
(Lowest/low)	55.4	74.1	64.7	68.8	18.7	58.2	24.1	79.7
Religion								
Hindu	8.7	88.3	0.3	4.7	0.2	0.6	24	75.7
Muslim	0	0.5	0	0.3	0.1	0.1	0.5	0
Christian	50.1	10.7	98.3	88.5	94.7	99.2	12.1	15.9
Buddhist	16	0.5	0	0	4.9	0	63.3	8.3
Others	25.2	0.1	1.3	6.6	0.1	0	0.1	0.1
Maternal characteristics								
Mean age at first birth	21.3	21.2	22.7	21.3	22.6	22.7	21.9	20.3
TFR	1.8	1.5	3	3.1	1.9	1.8	1	1.8
Education								
No schooling	22.7	17.3	10.1	12.5	4.2	8.2	7.7	19.8
Up to 8 years	25.6	28	33.1	40.2	30.8	33.5	34.7	44.2
9 years or more	51.7	54.6	56.8	47.3	65	58.3	57.6	36

Source: NFHS 5 survey data

Health vulnerability among tribal population in northeastern region

The study utilized a range of RMNCH indicators to comprehensively assess health vulnerabilities among tribal

populations in the northeastern region. These indicators were categorized into three domains: maternal healthcare, family planning (FP), and nutritional practices. Maternal healthcare indicators

included women receiving or purchasing iron folic acid (IFA), institutional deliveries, 100+ IFA consumption, antenatal care (ANC) in the first trimester, four or more ANC visits, and postnatal care (PNC) within two days of delivery. FP indicators encompassed frontline worker (FLW) outreach to non-users, the Method Information Index (MII), current use of reversible FP methods, and intention to use FP among non-users. Nutritional practices were assessed through counseling on breastfeeding, receiving nutritional supplements from Anganwadi Centers (AWC), timely initiation of breastfeeding, and exclusive breastfeeding.

Findings reveal significant disparities in supply-dependent RMNCH indicators between highly tribal concentrated (HTC) and low tribal concentrated (LTC)

districts. For instance, institutional deliveries were markedly lower in HTC districts (59%) compared to LTC districts (92%), as were women receiving IFA during pregnancy (HTC: 82% vs LTC: 94%) and nutritional supplements from AWCs (HTC: 31% vs LTC: 50%). Similarly, FP indicators such as MII were lower in HTC districts, though FLW outreach to non-users was an exception, showing relatively higher estimates. When compared to the national average for Scheduled Tribes (ST), HTC districts consistently underperformed across most supply-dependent indicators, underscoring systemic challenges in service delivery. These findings highlight the critical need for targeted interventions to address health inequities in HTC districts, particularly in improving maternal healthcare and nutritional practices (Table 3a).

Table 3 (a). Supply-dependent indicators among tribal population in northeastern region of India, 2019-21

Supply dependent indicators	Districts with tribal population concentration			
	<30%	30% to 80%	>= 80%	National average (Tribal Population)
Received IFA tablets/syrup	94	87.1	82.5	88.3
Institutional delivery	92.4	86.2	58.5	88.6
FLW outreach to non-users of FP method	55.2	52.4	50.8	26.5
Method Information index	56.7	55.5	50	54
Counselled on breastfeeding	70.1	70.6	53.6	81.6
Received nutrition supplements from AWC	50.1	41.1	30.7	60.8

Analysis of demand-dependent indicators revealed substantial disparities between highly tribal concentrated (HTC) and low tribal concentrated (LTC) districts across multiple healthcare utilization metrics. The findings demonstrated consistently lower performance in HTC districts compared to LTC districts across all key indicators. Specifically, the consumption of 100+ iron folic acid (IFA) tablets showed a significant differential (HTC: 38% vs LTC: 49%), while antenatal care coverage, measured by four or more ANC visits, exhibited a 12-percentage point gap (HTC: 48% vs LTC: 60%). Postnatal care utilization within two days of delivery demonstrated an even wider disparity of 20 percentage points (HTC: 55% vs LTC: 75%).

Furthermore, substantial variations were observed in family planning practices and infant feeding behaviors. The adoption of reversible family planning methods was notably lower in HTC districts (19%) compared to LTC districts (31%), representing a 12-percentage point difference. Similarly, exclusive breastfeeding practices showed a marked disparity of 27 percentage points (HTC: 48% vs LTC: 75%), indicating significant challenges in achieving optimal infant feeding practices in HTC districts. These findings suggest that behavioral and socio-cultural factors may significantly influence healthcare utilization patterns in tribal-concentrated areas (Table 3b)

Table 1 (b). Demand-dependent indicators among tribal population in northeastern region of India, 2019-21

Demand dependent indicators	Districts with tribal population concentration			
	<30%	**30% to 80%**	**>= 80%**	**National average (Tribal Population)**
100+ IFA consumption	48.7	37.1	38.2	45.1
ANC in 1st Trimester	65.9	61.4	56.2	31
4+ ANC	59.9	51.9	47.7	57.6
PNC within 2 days	75.9	67.7	55.2	74.7
Reversible FP use	30.8	34.2	18.9	12.8
Intention to use-FP among non-users	18.6	23.6	12.6	25.3
Timely initiation of breastfeeding (0-6 months children)	54	44.8	71.4	46.1
Exclusive breastfeeding (0-6 months children)	75.3	62.3	47.9	71.4

Impact of Geographic Vulnerability on RMNCH Practices in Tribal Populations

Geographic vulnerability (GV) emerged as a significant determinant of RMNCH (Reproductive, Maternal, Newborn, and Child Health) practices across all district categories, with particularly pronounced effects in highly tribal concentrated (HTC) districts. Analysis revealed that tribal populations residing in areas with high geographic vulnerability scores (GVS) consistently demonstrated lower healthcare access and utilization compared to their counterparts in low tribal concentrated (LTC) districts with minimal geographic barriers.

Supply-dependent indicators exhibited substantial variations across GVS gradients, particularly in HTC districts. Notable disparities were observed in the distribution of iron folic acid (IFA) tablets during pregnancy (high GV: 69% vs. low GV: 83%), frontline worker (FLW) outreach to family planning non-users (high GV: 38% vs. low GV: 54%), and access to nutritional supplements from Anganwadi Centers (high GV: 9% vs. low GV: 31%). These disparities underscore the significant impact of geographical barriers on healthcare delivery systems.

The influence of geographic vulnerability on demand-dependent indicators was evident across both HTC and LTC districts. In LTC districts, first-trimester antenatal care (ANC) coverage showed a stark contrast between high and low vulnerability areas (31% vs. 81%, respectively). Similarly, postnatal check-ups within two days of delivery demonstrated a 20%-point deficit in geographically vulnerable districts. HTC districts with high geographic vulnerability demonstrated particularly concerning trends in maternal healthcare and nutrition indicators, including suboptimal rates of 100+ IFA consumption, four or more ANC visits, timely initiation of breastfeeding, and exclusive breastfeeding practices (Table 4).

State-level health scenario of tribal communities

Analysis of state-level health indicators reveals significant disparities between highly tribal concentrated (HTC) and low tribal concentrated (LTC) districts across northeastern states. Maternal healthcare indicators demonstrated notable variations, with substantial gaps in institutional delivery rates between HTC and LTC districts in Manipur (57% vs 96%), Meghalaya (55% vs 89%), Nagaland (39% vs 72%), and Arunachal Pradesh (76% vs 86%). Demand-dependent indicators showed particularly pronounced disparities in Manipur (100+ IFA consumption: 37% vs 74%; 4+ ANC: 56% vs 96%; PNC within 2 days: 54% vs 86%) and Nagaland (first trimester ANC: 44% vs 72%; 4+ ANC: 13% vs 46%; PNC within 2 days: 42% vs 68%).

Family planning (FP) indicators exhibited varying patterns across states. Meghalaya demonstrated substantial gaps between HTC and LTC districts in both supply and demand-dependent indicators (FLW outreach: 28% vs 32%; reversible FP use: 13% vs 35%; intention to use: 12% vs 28%). Conversely, Nagaland and Sikkim showed better performance in HTC districts for Method Information Index (MII) and reversible FP use. Nutrition practices revealed mixed patterns, with HTC districts generally performing better in timely breastfeeding initiation, except in Assam, Tripura, and Arunachal Pradesh. However, significant gaps persisted in breastfeeding counseling between HTC and LTC districts in Meghalaya (57% vs 75%), Arunachal Pradesh (51% vs 58%), Manipur (39% vs 49%), and Nagaland (22% vs 43%). Notably, Arunachal Pradesh and Nagaland reported particularly low rates (12-16%) of nutrition supplement receipt from Anganwadi Centers. These findings suggest systematic disparities in both supply and demand-side indicators across HTC districts, with Sikkim being the notable exception (Table 5).

Table 4. Effect of geographical vulnerabilities on RMNCH indicators among tribals populations in NE region, 2019-2021

Tribal proportion		<30%				30% - 80%				>80			
Geographic Vulnerability		0	1	2	3	0	1	2	3	0	1	2	3
Supply dependent	Received IFA tables/syrup	97.0	90.5	96.2	92.6	85.1	85.5	91.1	81.0	83.1	83.2	67.6	69.5
	Institutional delivery	91.5	93.4	93.0	69.2	81.2	85.9	90.9	85.3	58.3	60.1	36.8	74.2
	FLW outreach to non-users	39.6	50.6	63.1	40.2	42.3	50.2	66.9	54.1	53.7	49.8	34.0	38.3
	Method Information index	40.8	58.8	57.2	100.0	61.7	51.3	57.3	82.6	48.8	49.9	56.9	58.3
	Counselled on breastfeeding	92.7	67.8	70.4	27.8	66.4	70.9	73.5	52.4	53.4	55.1	34.6	37.3
	Received nutrition supplements from AWC	42.8	55.9	47.8	33.1	27.9	46.2	44.3	14.0	30.7	31.7	17.2	8.7
Demand dependent	100+ IFA consumption (women who received IFA)	43.3	45.4	57.7	47.5	32.6	37.9	56.7	34.9	47.0	46.9	28.6	15.0
	ANC in 1st Trimester	81.3	58.7	70.6	31.2	59.2	57.1	69.5	60.1	56.9	56.1	51.7	52.6
	At least 4 ANC visits	70.5	53.4	65.5	10.8	55.6	48.9	53.6	40.3	50.1	47.7	27.7	31.1
	PNC within 2 days	81.7	75.7	76.0	60.5	65.6	63.2	75.8	71.9	58.6	53.9	41.2	58.4
	Reversible FP use	31.3	35.4	27.7	30.6	27.4	34.3	39.1	23.2	18.8	17.6	32.5	21.4
	Intention to use among non-user	7.6	20.6	19.5	5.3	19.9	20.9	31.1	17.6	13.0	12.0	19.3	19.7
	Exclusive breastfeeding	100.0	75.9	73.8	73.4	56.5	60.2	70.7	50.4	47.9	47.7	52.3	43.6
	Timely initiation of breastfeeding	48.5	50.9	57.3	49.4	54.8	40.1	44.1	64.7	69.1	74.4	54.1	27.5

Table 5. State-wise estimates for supply- and demand-dependent indicators among tribal population in northeastern states of India, 2019-21

State	District's Tribal population	Maternal health indicators						Family planning				Nutrition			
		Supply dependent		Demand dependent				Supply dependent		Demand dependent		Supply dependent		Demand dependent	
		Received IFA tables/syrup	Institutional delivery	100+ IFA Consumption (women who received IFA)	ANC in 1st Trimester	At least 4 ANC visits	PNC within 2 days of delivery	FLW outreach to non-users	Method Information index	Reversible FP use	Intention to use among non-user	Counselled on breastfeeding	Received nutrition supplement from AWC	Timely initiation of breastfeeding	Exclusive breastfeeding
Arunachal Pradesh	30% to 80%	80.0	86.1	29.2	53.8	39.7	58.0	19.4	60.4	27.2	23.4	57.8	15.5	51.6	70.2
	>= 80%	75.4	75.8	23.7	48.7	32.9	58.7	18.1	52.0	26.6	21.5	51.2	10.6	49.7	55.9
	<30%	95.8	92.9	55.5	67.1	61.4	76.8	22.4	59.2	29.2	19.4	72.6	49.9	56.3	72.7
Assam	30% to 80%	90.2	87.2	48.7	64.9	58.6	69.1	21.0	63.9	35.1	25.3	71.4	46.8	49.8	63.8
	<30%	92.8	96.2	73.8	72.3	95.6	85.9	0.4	-	12.3	19.4	49.5	5.3	54.3	45.2
Manipur	>= 80%	82.2	56.7	36.9	68.5	56.5	54.2	6.4	25.8	15.1	23.5	39.4	15.9	59.4	68.0
	30% to 80%	86.6	89.0	55.9	62.4	47.6	74.9	32.4	54.7	34.6	28.2	75.0	32.3	46.0	82.9
Meghalaya	>= 80%	85.6	54.9	50.1	52.9	53.0	53.9	28.2	56.2	13.4	11.9	57.5	35.3	81.7	40.5
	>= 80%	88.7	87.4	70.7	73.9	59.5	71.4	14.6	45.9	17.4	6.4	79.6	47.4	60.5	68.1
Mizoram	30% to 80%	70.6	72.0	14.9	71.7	45.6	67.7	8.0	20.4	15.3	12.7	43.1	12.2	52.5	23.3
Nagaland	>= 80%	66.9	39.1	13.1	44.1	13.5	42.0	10.8	51.8	32.4	18.3	22.4	15.9	58.9	44.0
	<30%	91.3	96.1	47.2	53.2	50.1	71.6	19.7	34.1	30.2	9.7	68.8	33.9	16.7	0.0
Sikkim	30% to 80%	94.6	98.7	52.9	72.4	64.7	64.8	20.2	54.2	55.3	27.1	83.3	48.7	46.6	21.5
	<30%	86.7	88.9	30.5	62.0	50.0	71.3	7.3	49.3	39.8	22.4	61.6	60.9	50.5	95.8
Tripura	30% to 80%	84.3	84.3	25.7	51.6	41.2	64.2	11.7	28.3	37.3	22.4	75.8	46.4	25.8	53.1

Family Planning Use and Reasons for Non-Use Among Tribals in Meghalaya

The data shows that contraceptive use is significantly lower in districts with ≥80% tribal populations (24.3%) compared to those with 30–80% tribal populations (47.8%), while the use of traditional methods remains similar (5.3% vs. 5.1%). Fertility-related reasons are the most common for not using FP methods, but they are less frequent in high tribal concentration districts (41.2%) compared to moderate concentration districts (60.3%). Conversely, health-related reasons (20.4% vs. 11.9%), lack of access (12.4% vs. 3.4%), and "other" reasons (11.4% vs. 3.2%) are more prominent in districts with ≥80% tribal populations, indicating greater systemic and logistical barriers (Table 6).

Table 6. FP use and reason for non-use among tribals in Meghalaya

Contraceptive use	District with tribal population	
	30% - 80%	≥ 80%
Currently using any FP method	47.8	24.3
Using Traditional Methods	5.1	5.3
Reason for not using FP methods		
Fertility related reason	60.3	41.2
Any opposition	21.7	9.4
Unaware about method/source	0.7	1.4
Lack of access	3.4	12.4
Health related	11.9	20.4
Other	3.2	11.4
Don't' know	4.7	7.0

Reasons for Non-Use of Facilities for Delivery and Treatment

The figure highlights that financial constraints are a major barrier to healthcare facility use among tribals in Meghalaya, followed by geographic inaccessibility in remote areas. Cultural preferences, including reliance on traditional practices, also contribute to non-utilization. Additionally, a smaller proportion of respondents reported being unaware of available healthcare services, reflecting gaps in health education and outreach efforts (Figure 2).

Figure 2. Reasons for non-use of facility for delivery and treatment among tribals in Meghalaya, 2019-2021
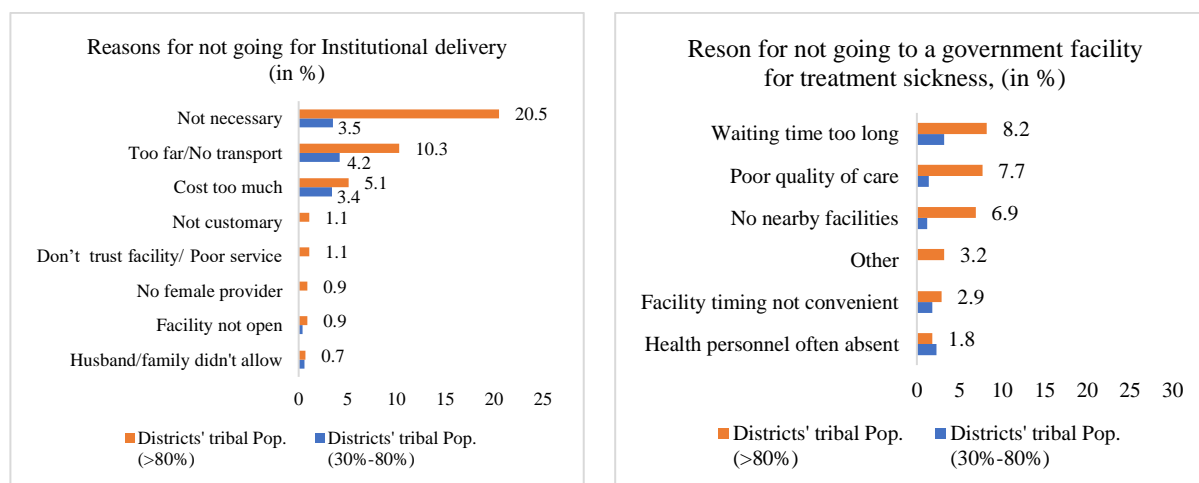
FP Use and Reasons for Non-Use Among Tribals in Manipur

The data shows that contraceptive use is relatively similar between districts with 30–80% tribal populations (62.5%) and those with ≥80% tribal populations (61.2%). However, the use of traditional methods is notably high in both groups, at 41.8%. Fertility-related reasons are the most common explanation for not using FP methods, with a higher proportion in districts with ≥80% tribal populations (73.0%) compared to 30–80% districts (59.5%). Opposition to FP use is slightly higher in districts with ≥80% tribal populations (9.9% vs. 7.9%). Health-related reasons are more prominent in districts with 30–80% tribal populations (22.6% vs. 7.2%), while lack of access remains low in both groups (6.7% vs. 5.4%) (Table 7).

Table 7. FP use and reason for non-use among tribals in Manipur

Contraceptive use	District with tribal population	
	30% - 80%	≥ 80%
Currently using any FP method	62.5	61.2
Using Traditional Methods	41.8	41.8
Reason for not using FP methods		
Fertility related reason	**59.5**	**73.0**
Any opposition	7.9	9.9
Unaware about method/source	0.0	0.5
Lack of access	6.7	5.4
Health related	**22.6**	**7.2**
Other	12.0	9.8
Don't' know	0.0	1.1

Reasons for Non-Use of Facilities for Delivery and Treatment Among Tribals in Manipur

The figure highlights key barriers to institutional delivery and treatment among tribals. For institutional delivery, the most common reasons in districts with ≥80% tribal populations include lack of transport (17.2%) and high costs (16.3%), while in districts with 30–80% tribal populations, "not necessary" (14.5%) is a significant reason. For treatment, waiting times are a major barrier in districts with 30–80% tribal populations (32.9%), while poor quality of care (8.6%) and inconvenient facility timing (20.5%) are notable in districts with ≥80% tribal populations. These findings emphasize the need to address logistical, financial, and systemic barriers to improve healthcare access (Figure 3).

Figure 3. Reasons for non-use of facility for delivery and treatment among tribals in Manipur, 2019-21
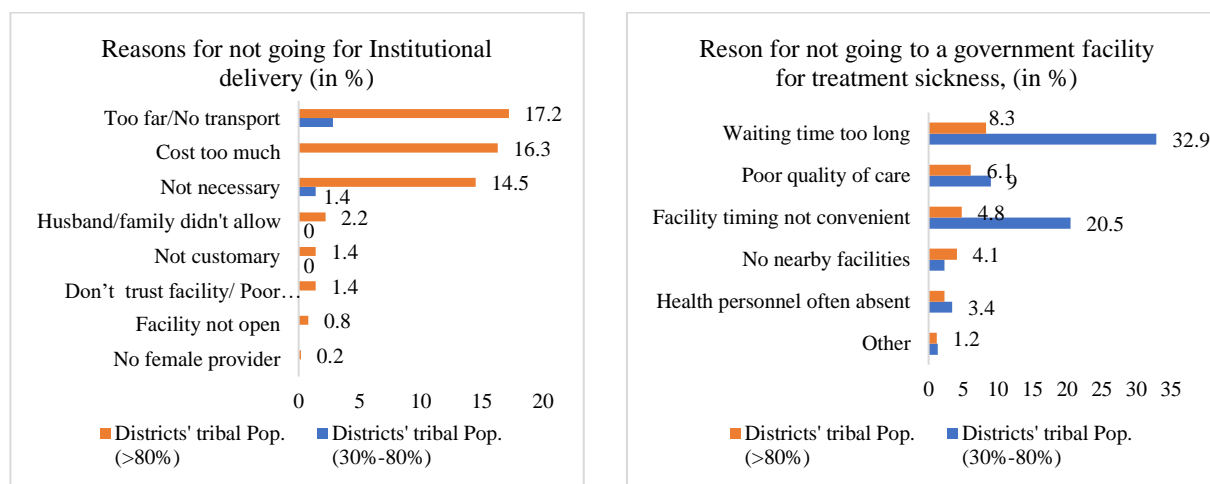
Based on the analysis of Tables 6 & 7 and Figures 2 & 3, we observe distinct patterns in healthcare utilization between Meghalaya and Manipur's tribal populations. While Meghalaya shows significant disparities between HTC and LTC districts in FP use (24.3% vs 47.8%), Manipur demonstrates more uniform utilization (61.2% vs 62.5%). The barriers to healthcare access also differ: Meghalaya's challenges primarily stem from financial and geographic constraints, while Manipur's issues center around transport availability and facility-related factors like waiting times and quality of care.

FP Use and Reasons for Non-Use Among Tribals in Arunachal Pradesh

The data reveals similar contraceptive use patterns between districts with 30-80% and ≥80% tribal populations (57.5% vs 57.0%), with slightly lower traditional method use in high tribal concentration districts (8.7% vs 10.9%). Fertility-related reasons dominate non-use in both groups (64.1% vs 66.7%), while lack of access is notably higher in districts with ≥80% tribal populations (13.6% vs 5.8%). Health-related reasons remain consistently low across both the groups (4.6% vs 4.7%).

Table 8. FP use and reason for non-use among tribals in Arunachal Pradesh

| Contraceptive use	District with tribal population	
	30% - 80%	**≥ 80%**
Currently using any FP method	57.5	57.0
Using Traditional Methods	10.9	8.7
Reason for not using FP methods		
Fertility related reason	**66.7**	**64.1**
Any opposition	**11.9**	**10.0**
Unaware about method/source	2.2	1.9
Lack of access	5.8	**13.6**
Health related	4.7	4.6
Other	9.1	8.6

Reasons for Non-Use of Facilities in Arunachal Pradesh

The figure 4 shows that distance to health facilities and lack of transport are major barriers for both delivery and treatment services, particularly in districts with ≥80% tribal populations. Poor facility infrastructure and quality of care are also significant concerns, with waiting time being a notable barrier in districts with 30-80% tribal populations. Financial constraints appear to be less prominent compared to logistical and infrastructure-related challenges.

Figure 4. Reasons for non-use of facility for delivery and treatment among tribals in Arunachal Pradesh
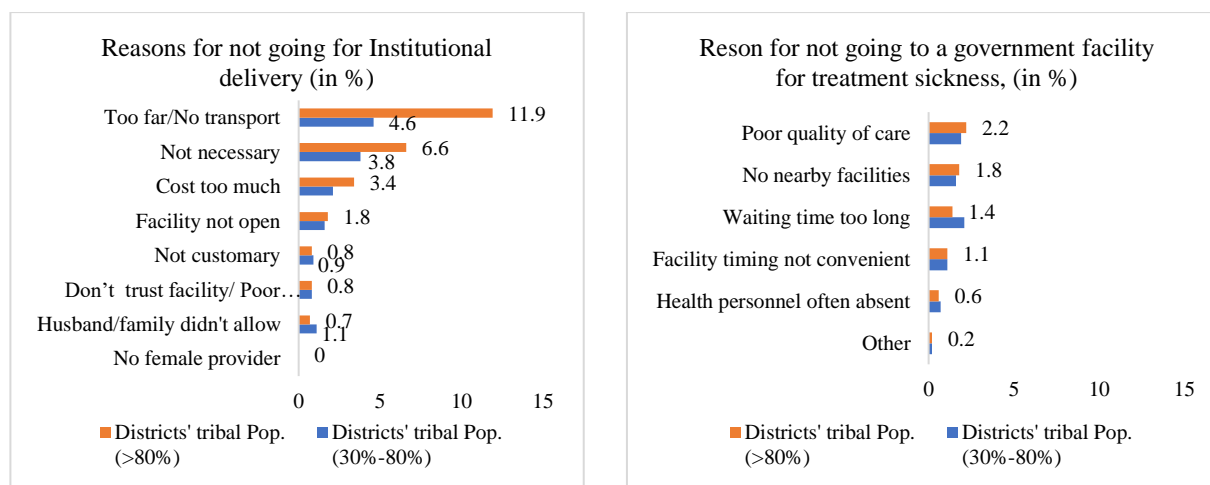
Discussion

This study provides comprehensive insights into the health vulnerabilities of tribal populations in northeastern India, revealing significant disparities in RMNCH indicators between HTC and LTC districts. The findings align with previous studies that have documented persistent health inequities among tribal communities in India (Cáceres et al., 2023; Seshadri et al., 2020).

The analysis reveals that institutional delivery rates in HTC districts significantly lag behind LTC districts, particularly in Manipur (57% vs 96%), Meghalaya (55% vs 89%), and Nagaland (39% vs 72%). These disparities echo findings from other studies highlighting the challenges of healthcare access in geographically isolated tribal areas (Rao et al., 2018). The lower utilization of institutional delivery services in HTC districts can be attributed to both supply-side barriers, such as inadequate healthcare infrastructure, and demand-side factors, including cultural preferences and financial constraints (S. Kumar & Dansereau, 2014).

Family planning practices demonstrate interesting variations across states. While Meghalaya shows substantial gaps between HTC and LTC districts in contraceptive use (24.3% vs 47.8%), Manipur and Arunachal Pradesh exhibit more uniform utilization patterns. The high reliance on traditional methods in Manipur (41.8%) aligns with previous research highlighting the influence of cultural practices and traditional beliefs on contraceptive choices among tribal populations (Palo et al., 2020; Sreedevi et al., 2023).

The study's findings on maternal healthcare indicators reveal persistent gaps in antenatal care utilization, particularly in HTC districts. This finding aligns with national-level studies that have documented lower ANC coverage among tribal populations (Algur et al., 2023). The observed disparities in iron-folic acid consumption and nutritional supplementation suggest the need for targeted interventions, as recommended by similar studies in other tribal regions (Chakma et al., 2013).

Geographic vulnerability emerges as a critical determinant of healthcare access, particularly affecting supply-dependent indicators. This finding supports previous research emphasizing the role of geographical barriers in healthcare utilization among tribal communities (Cáceres et al., 2023; D. Kumar et al., 2022). The study reveals that districts with high geographic vulnerability scores face greater challenges in healthcare delivery.

The analysis of nutrition practices reveals concerning trends, particularly in breastfeeding counseling and supplementation programs. The significant variations between HTC and LTC districts in exclusive breastfeeding rates align with study highlighting the influence of socio-cultural factors and healthcare access on infant feeding practices (D. Sarkar et al., 2020). The lower rates of nutritional supplement receipt from Anganwadi Centers in states like Arunachal Pradesh and Nagaland (12-16%) indicate systemic challenges in program implementation.

State-specific analyses reveal distinct patterns of healthcare utilization barriers. While some states struggle with basic healthcare delivery, others face challenges in improving service quality. The findings underscore the need for context-specific interventions that address both supply and demand-side barriers while considering the unique characteristics of each region. This aligns with recommendations from previous studies emphasizing the importance of culturally sensitive and geographically appropriate healthcare delivery models for tribal populations (Barman & Roy Chowdhury, 2023; Linga Reddy Gaddam, 2024; Mavalankar, 2016; Nanda & Dhar, 2017).

Conclusion

The study provides compelling evidence of persistent health disparities affecting tribal populations in northeastern India, particularly in HTC districts. The findings demonstrate that geographic vulnerability, coupled with socio-cultural factors, significantly influences healthcare access and utilization patterns among tribal communities.

The analysis reveals that while some states have made progress in certain areas, significant challenges remain in ensuring equitable access to quality healthcare

services. The disparities in both supply and demand-dependent indicators suggest the need for a comprehensive approach that addresses infrastructure development, service delivery strengthening, and community engagement.

To improve the tribal populations' health outcomes, interventions must focus on reducing geographic barriers, enhancing healthcare infrastructure, strengthening outreach services, and promoting culturally sensitive healthcare delivery. Additionally, efforts should be made to address the specific needs of each state and district, considering their unique demographic and geographic characteristics. This targeted approach, combined with sustained commitment to tribal health improvement, will be crucial in reducing health inequities and ensuring better health outcomes for scheduled tribe populations in northeastern India.

Declarations

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Ethical declarations

The present study utilizes a secondary dataset available in the public domain for legitimate research purposes with no identifiable information on the survey participants. Hence, there is no requirement for any additional ethical approval.

Consent for publication

Not applicable. No details, images or videos related to individual participants were obtained. In addition, data are available in the public domain.

Competing interests

The authors declare no competing interests.

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