ORIGINAL RESEARCH ARTICLE

Geospatial Patterns of Non-Communicable Diseases among Women (15-49 Years) in Northeast India: Evidence from NFHS-4 and NFHS-5

Jitenkumar Singh Kh[1], Nirendrakumar Singh Haobijam[2*], Jagajeet Prasad Singh[3], Nongzaimayum Tawfeeq Alee[4], Alfred Rozer Nandeibam[5]

[1]ICMR Data Centre, ICMR Headquarter, New Delhi, India
[2,3]Department of Public Health, Indian Institute of Health Management Research, Jaipur, India
[4]Department of Applied Psychology, Gandhi Institute of Technology and Management, Vishakhapatnam, India
[5]Department of Community Medicine, Jawaharlal Nehru Institute of Medical Sciences, Imphal, India

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ABSTRACT

Introduction: Non-communicable diseases (NCDs) are a major cause of morbidity and mortality in both urban and rural populations, leading to substantial loss of potentially productive years of life, particularly among adults aged 35-64 years. Evidence indicates that without effective preventive strategies, NCD-related deaths may reach alarming levels, especially in low-resource countries, underscoring the need for timely public health interventions.

Methodology: This study utilized secondary data on selected NCDs diabetes, thyroid disorders, asthma, and heart diseases from the 4th and 5th rounds of the National Family Health Survey (NFHS). The analysis included 98,702 women from NFHS-4 and 103,433 women from NFHS-5, aged 15-49 years, across eight northeastern states of India. Geospatial analysis was employed to identify district-level hotspot and cold-spot clustering based on disease density.

Results: A comparison between NFHS-4 (2015-16) and NFHS-5 (2019-21) revealed heterogeneous trends across the four NCDs. In NFHS-4, diabetes prevalence was highest in Sikkim, heart disease in Meghalaya, and asthma in Tripura. In NFHS-5, Tripura reported the highest prevalence of diabetes and thyroid disorders, while asthma and heart disease were most prevalent in Mizoram.

Conclusion: The observed rise in NCD prevalence and hotspot clustering among women over five years is concerning. Targeted, district-specific interventions are warranted to address the growing NCD burden in the region.

Keywords: Geospatial Analysis, Hotspot Clustering, Non-Communicable Diseases, Women, Northeast India

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***Correspondence:** Dr. H. Nirendrakumar Singh (Email: hnirendra10@gmail.com)

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INTRODUCTION

Non-Communicable Diseases (NCDs) are chronic conditions that last for years and require ongoing medical care, often leading to limitations in daily activities. Globally, NCDs are the primary contributors to mortality and disability, accounting for approximately 43.8 million deaths in 2021.[1] India's burden of NCDs is escalating.[2] The burden is particularly concerning in Northeast India, a region characterized by diverse geography, socio-cultural heterogeneity, and uneven healthcare access.[3]

Despite national progress in disease surveillance through NFHS, limited research has examined how spatial clustering of NCDs among women aged 15-49 years has evolved between NFHS-4 (2015-16) and NFHS-5 (2019-21), and which socio-demographic factors are associated with these patterns. The prevalence of major NCDs among women (15-49 years) in Northeast India is notable.[4] There is already a 5% to 7.4% prevalence in diabetes in northeast India; while states like Tripura and Mizoram have higher prevalence (7.5%-10%).[5] Mizoram reports the highest asthma prevalence (3.9%), in comparison to the national average of 1-2%.[6] Northeast India with high consumption of cyanogenic foods that liberate thiocyanate on metabolism, which interfere with iodine uptake in thyroid gland, has increased prevalence of thyroid disorder[7] hence various research pointed out the rise in thyroid disorders[8,9].

Research indicates that due to indulgent in high risk factors northeastern states are reporting high number of CVD in hospitals.[10-13] This study explores how factors on the social determinants of health such as Age, Wealth index, Marital status, Urban-Rural residence, contribute to the geospatial distribution of NCDs by focusing on women aged 15-49 years is particularly critical, as gender-specific vulnerabilities which are linked to reproductive health priorities, limited screening, and socio-cultural barriers. By integrating geospatial analysis with demographic determinants, this study aims to generate evidence for targeted, equity-based interventions to address the growing NCD burden among women in Northeast India. The objectives of the study were to describe state-wise NCD prevalence among women aged 15-49 years; to identify changes in hotspot clustering between NFHS-4 and NFHS-5; and to examine associations between NCD prevalence and socio-demographic factors (e.g., age, wealth, marital status, place of residence).

METHODOLOGY

This study utilizes secondary data from the National Family Health Surveys (NFHS) rounds 4 and 5, conducted under the aegis of the Ministry of Health and Family Welfare (MoHFW), Government of India. The surveys were implemented by the International Institute for Population Sciences (IIPS), Mumbai, and provide robust and comprehensive health-related data across India. NFHS follows a multi-stage, stratified sampling design to ensure representativeness at national, state, and district levels. In rural areas, villages serve as Primary Sampling Units (PSUs) selected using Probability Proportional to Size (PPS) sampling, while in urban areas, Census Enumeration Blocks (CEBs) act as PSUs. Within each PSU, households are randomly selected, and sampling weights provided in the dataset were applied during analysis to adjust for differential selection probability and non-response bias.

The analysis focused on four major Non-Communicable Diseases Diabetes, Thyroid Disorder, Heart Disease, and Asthma among women aged 15-49 years across eight states of Northeast India. These conditions were self-reported based on respondents. NFHS is a reliable source for population-level health analysis. Its data ensures high data quality, validity, and reliability through several measures i.e. Rigorous interviewer training, Standardized data collection instruments Field supervision, re-interviews, and consistency check for error detection. Cross-verification protocols within Computer-Assisted Personal Interview (CAPI) systems used in NFHS-5.

The total sample comprised 103,433 women, distributed across the eight states: Arunachal Pradesh (19,765), Assam (34,979), Manipur (8,042), Meghalaya (13,089), Mizoram (7,279), Nagaland (9,694), Sikkim (3,271), and Tripura (7,314).

Spatial clustering analysis was conducted using the Getis-Ord Gi* statistic in R version 4.1.1 which identifies statistically significant hotspot based on disease density at the cluster level. Hotspots represent clusters with higher-than-average disease prevalence, while coldspots indicate lower-than-average areas. Z-scores and p-values were used to determine statistical significance, with a 95% confidence level set as the threshold. Also, a global spatial autocorrelation analysis using Moran's *I* statistic was conducted to measure the overall spatial dependence of NCD prevalence across the Northeast region. A positive and significant Moran's *I* value indicates that districts with similar prevalence rates are spatially clustered rather than randomly distributed, providing a broader regional context to local hotspot detection.

RESULTS

The results collectively underscore distinct spatial and socio-demographic clustering of NCDs across Northeast India, highlighting the complex interplay of geography, socio-economic status, and demographic characteristics in shaping disease prevalence.

There were 98,702 participants in NFHS-4 and 103,433 in NFHS-5 from the northeastern states. The sample characteristics were comparable across both rounds, as shown in Table 1, with no statistically sig-

nificant differences (p >0.05) in age, wealth quintile, and marital status distribution between rounds. However, a significant shift toward rural representation was observed in NFHS-5 (p <0.05).

Table 1 presents state-wise socio-demographic characteristics (age, wealth, marital status, residence) and prevalence of single and multiple NCD comorbidities. Chi-square tests indicated significant associations (p < 0.001) between age group, wealth quintile, and NCD prevalence across several states.

Table 2 summarizes the comparative prevalence (%) of Diabetes mellitus Thyroid Disorder, asthma, and heart disease among women aged 15-49 years across the northeastern states of India based on NFHS-4 (2015-16) and NFHS-5 (2019-21). During NFHS-4 (2015-16), the overall prevalence of diabetes among women in Northeast India was 1.0% [0.8-1.2], with the highest levels observed in Sikkim of 1.4%, Tripura 1.3%, and Arunachal Pradesh ,1.2%, and the lowest in Nagaland ,0.6%. Thyroid disorder was most prevalent in Manipur 4.3%, while Sikkim ,0.7% reported the lowest rates. Heart disease showed relatively higher prevalence in Meghalaya (4.8%), Mizoram (3.2%), and Tripura (3.6%). Asthma prevalence during NFHS-4 ranged from 3.6% in Tripura to 1.0% in Assam.

In NFHS-5 (2019-21), the prevalence patterns had shifted considerably. Diabetes prevalence increased in nearly all states, reaching 2.3% in Tripura, 2.1% in Assam. Thyroid disorder showed a mixed trend Tripura, 3.6% and Manipur 3.0% continued to report higher prevalence. In contrast, heart disease prevalence was highest in Mizoram,2.1% followed by Tripura ,1.8%. Asthma prevalence increased notably in Mizoram (3.9%) and Arunachal Pradesh (0.8%) reported the lowest levels.

Overall, comparison between NFHS-4 and NFHS-5 indicates a rising burden of diabetes and asthma, mixed trends for thyroid disorders, and a decline in self-reported heart disease across the northeastern state.

Fig 1.1a, 1.1b, 1.2a, 1.2b, 1.3a, 1.3b, 1.4a, 1.4b represents Spatial hotspot analysis for Diabetes and Thyroid Disorder, Hearth Disease, Asthma revealed regional variations across the Northeastern states between NFHS-4 (2015-16) and NFHS-5 (2019-21).

For Diabetes, the pattern of clustering was most prominent in Tripura, Assam, and Meghalaya where several districts consistently showed spatial concentration of high prevalence across two surveys. In Tripura, spatial clustering was visible in West Tripura, Sepahijala, and Khowai, indicating localized areas of higher diabetes prevalence In Assam, clustering was evident in districts such as Barpeta, Nalbari, Kamrup, and Goalpara, with additional concentration observed in southern and upper districts in NFHS-5. Meghalaya displayed persistent clustering across the Garo Hills region, including West, South West, North, and East Garo Hills, with additional concentration observed in parts of the Khasi Hills.

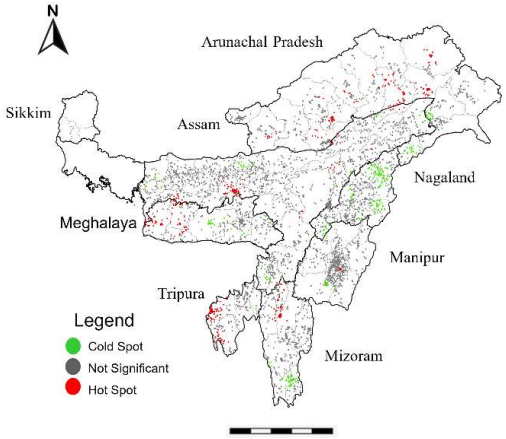
Manipur maintained consistent patterns without major clustering shifts across the two rounds. In contrast, Nagaland and Arunachal Pradesh showed limited hotspot presence. Mizoram exhibited moderate spatial concentration.

Table 1: Distribution of socio-demographic profiles of the respondents

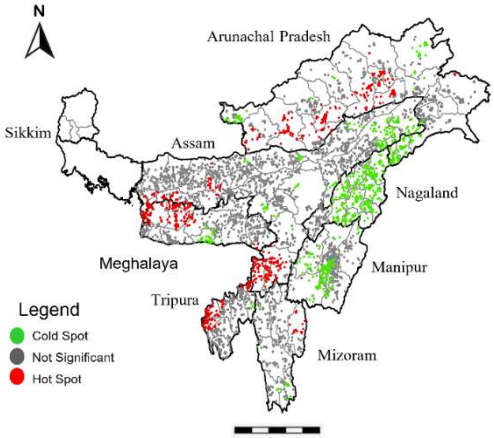
Characteristics	NFHS -IV (n, %)	NFHS -V (n, %)
Age		
15-19 yrs	16070(16.28)	16129 (15.59)
20-29 yrs	33340(33.78)	33995 (32.87)
30-39 yrs	28263(28.63)	29858 (28.87)
40-49 yrs	21029(21.31)	23451 (22.67)
Wealth index		
Richest	18546 (18.79)	18069 (17.47)
Richer	20573 (20.84)	20719 (20.03)
Middle	20856 (21.13)	21411 (20.70)
Poorer	20071 (20.33)	22018 (21.29)
Poorest	18656 (18.90)	21216 (20.51)
Marital status		
Never married	27379 (27.74)	27602 (26.69)
Currently married	65941 (66.81)	70596 (68.25)
Others	5382 (5.45)	5235 (5.06)
Residence		
Urban	26489 (26.84)	19994 (19.37)
Rural	72213 (73.16)	83439 (80.67)

Table 2- Comparative Prevalence (%) of Major Non-Communicable Diseases among Women (15-49 Years) in Northeast India, NFHS-4 (2015-16) and NFHS-5 (2019-21)

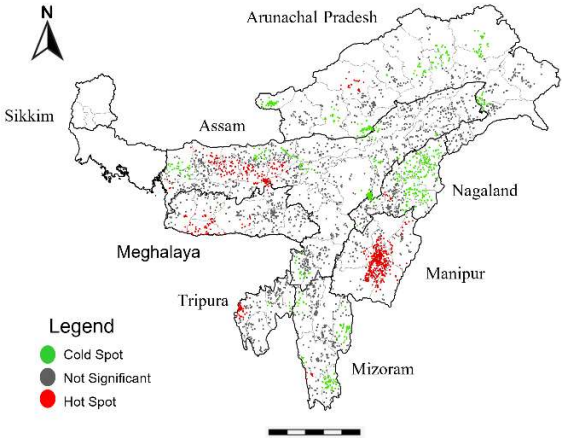
Disease	Diabetes (%) (CI)		Thyroid Disorder (%) (CI)		Heart Disease (%) (CI)		Asthma (%) (CI)	
State	NFHS-4	NFHS-5	NFHS-4	NFHS-5	NFHS-4	NFHS-5	NFHS-4	NFHS-5
Arunachal Pradesh	1.2 (1.0-1.4)	1.9 (1.7-2.1)	0.9 (0.7-1.1)	0.7 (0.5-0.9)	1.4 (1.2-1.6)	0.6 (0.4-0.8)	1.2 (1.0-1.5)	0.8 (0.6-1.0)
Assam	0.9 (0.8-1.0)	2.1 (1.9-2.3)	1.5 (1.3-1.8)	2.6 (2.4-2.8)	1.3 (1.1-1.5)	1.2 (1.0-1.4)	1.0 (0.8-1.1)	1.6 (1.4-1.8)
Manipur	0.9 (0.7-1.0)	1.1 (0.9-1.3)	4.3 (3.8-4.8)	3.0 (2.6-3.4)	2.9 (2.6-3.3)	1.2 (1.0-1.4)	1.5 (1.3-1.8)	1.4 (1.2-1.6)
Meghalaya	1.1 (0.8-1.5)	1.9 (1.5-2.3)	3.0 (2.4-3.6)	2.0 (1.8-2.2)	4.8 (4.0-5.8)	1.0 (0.8-1.2)	3.2 (2.6-3.9)	2.6 (2.2-3.0)
Mizoram	0.9 (0.7-1.0)	1.4 (1.2-1.6)	1.2 (1.0-1.5)	0.9 (0.7-1.1)	3.2 (2.8-3.6)	2.1 (1.7-2.5)	1.6 (1.3-1.9)	3.9 (3.3-4.5)
Nagaland	0.6 (0.5-0.8)	0.8 (0.6-1.0)	0.9 (0.7-1.2)	0.5 (0.3-0.7)	2.5 (2.2-2.9)	1.3 (1.1-1.5)	1.3 (1.0-1.6)	0.7 (0.5-0.9)
Sikkim	1.4 (1.1-1.7)	2.1 (1.5-2.7)	0.7 (0.5-1.1)	1.8 (1.2-2.4)	0.6 (0.4-0.9)	1.5 (1.1-1.9)	1.0 (0.7-1.3)	1.0 (0.6-1.4)
Tripura	1.3 (1.0-1.6)	2.3 (1.9-2.7)	1.4 (1.1-1.7)	3.6 (3.2-4.0)	3.6 (3.1-4.1)	1.8 (1.4-2.2)	3.6 (3.0-4.2)	2.7 (2.1-3.3)
Total (Northeast)	1.0 (0.8-1.2)	1.7 (1.6-1.8)	1.8 (1.6-2.0)	1.8 (1.7-1.9)	2.3 (2.0-2.5)	1.2 (1.0-1.3)	1.5 (1.3-1.7)	1.7 (1.5-1.9)



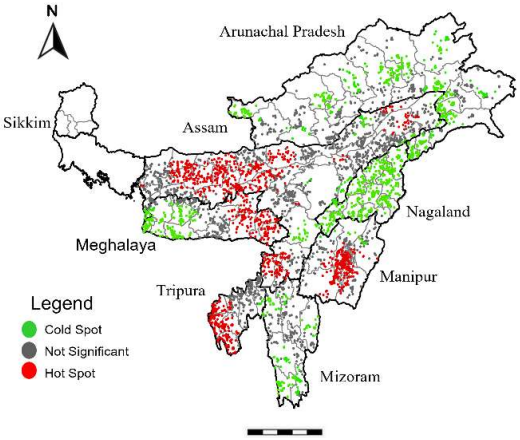
1.1a: Hotspot Clustering of Diabetes, NFHS-4 (2015-16)



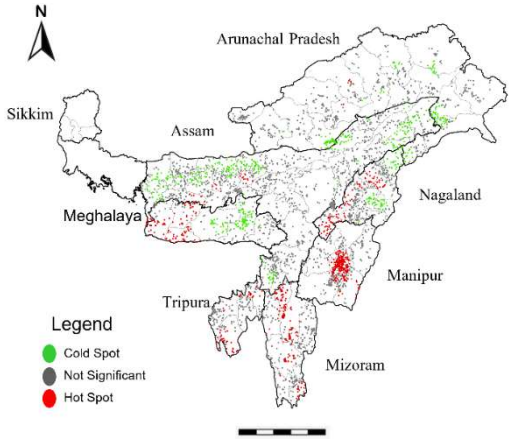
1.1b: Hotspot Clustering of Diabetes, NFHS-5 (2019-21)



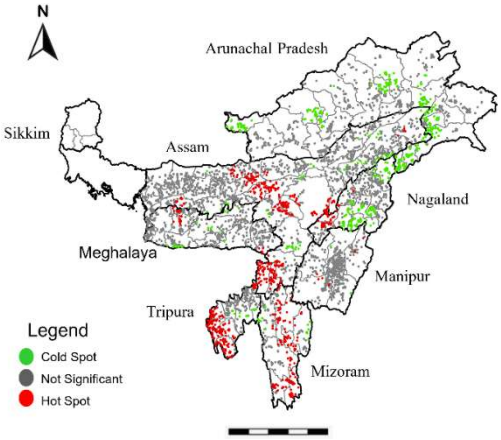
1.2a: Hotspot Clustering of Thyroid Disorder, NFHS-4 (2015-16)



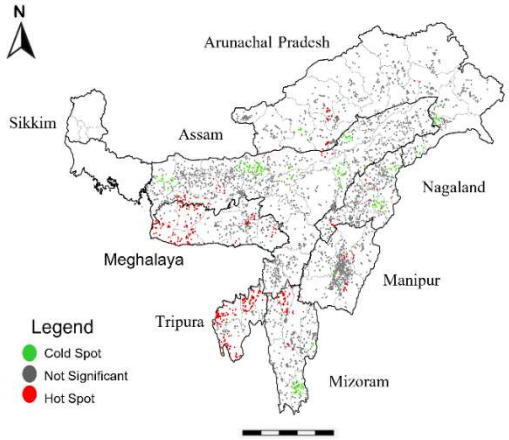
1.2b: Hotspot Clustering of Thyroid Disorder, NFHS-5 (2019-21)



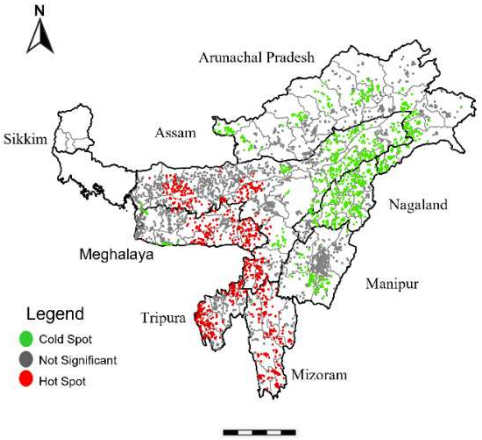
1.3a: Hotspot Clustering of any Heart Disease, NFHS-4 (2015-16)



1.3b: Hotspot Clustering of Any Heart Disease, NFHS-5 (2019-21)



1.4a: Hotspot Clustering of Asthma, NFHS-4 (2015-16)



1.4b: Hotspot Clustering of Asthma, NFHS-5 (2019-21)

Figure 1: Spatial distribution of hotspots for Diabetes, Thyroid Disorder, Asthma, and heart disease among women aged 15-49 years across Northeast India based on NFHS-4 (2015-16) and NFHS-5 (2019-21)

Table 3: Prevalence (%) of Major Non-Communicable Diseases among Women (15-49 Years) by Selected Background Characteristics, NFHS-5 (2019-21)

Characteristics	Diabetes (%)	Thyroid (%)	Asthma (%)	Heart (%)	Total (%)
Age group (years)					
15-19 yrs	0.6 (96)	0.7 (112)	1.1(191)	0.5 (83)	16,129
20-29 yrs	0.9 (291)	1.2 (424)	1.4 (471)	0.8 (260)	33,995
30-39 yrs	1.7 (520)	1.9 (607)	1.8 (547)	1.3 (406)	29,858
40-49 yrs	3.6 (875)	2.2 (571)	2.0 (494)	1.6 (395)	23,451
Wealth Index					
Richest	2.7 (477)	2.9 (560)	1.5 (296)	1.1 (194)	18,069
Richer	2.0 (393)	1.8 (379)	1.4 (318)	1.2 (249)	20,719
Middle	1.5 (331)	1.4 (312)	1.5 (334)	1.1 (250)	21,411
Poorer	1.4 (305)	1.1 (244)	1.6 (368)	1.0 (229)	22,018
Poorest	1.3 (276)	1.0 (219)	1.8 (387)	1.0 (222)	21,216
Marital Status					
Never married	0.7 (185)	0.9 (248)	1.2 (355)	0.6 (176)	27,690
Currently married	2.0 (1,470)	1.8 (1,373)	1.7 (1,216)	1.2 (883)	70,596
Others (widowed/divorced/separated)	2.5 (127)	1.7 (93)	2.5 (132)	1.6 (85)	5,147
Place of Residence					
Urban	2.0 (395)	2.6 (523)	2.2 (439)	1.4 (271)	19,994
Rural	1.7 (1,387)	1.4 (1,191)	1.5 (1,264)	1.0 (873)	83,439

For Thyroid Disorder, hotspot clustering was more widespread and pronounced compared to diabetes. Assam, Meghalaya, and Tripura again demonstrated the strongest clustering tendencies, indicating concentrated areas of higher prevalence. In Assam, spatial clustering extended across both western and central districts. Meghalaya exhibited hotspot concentration in the Jaintia Hills and parts of the Khasi Hills, while Tripura showed clustering across multiple districts, particularly in West and South regions. Mizoram displayed emerging clustering in select districts, whereas Nagaland and Arunachal Pradesh reflected minimal hotspot activity.

Figures 1.3a and 1.3b depict the spatial clustering patterns of *any heart disease* among women aged 15-49 years during NFHS-4 (2015-16) and NFHS-5 (2019-21), respectively. The hotspot analysis reveals a noticeable spatial variation across the Northeast region. During NFHS-4 localized hotspots were evident, primarily concentrated in parts of Manipur, Mizoram, Meghalaya, Assam and few localised hotspots were detected in Assam. By NFHS-5, however, these clusters became more pronounced, with additional emerging hotspots in Assam Mizoram, Tripura indicating a gradual spatial intensification and wider distribution of heart disease risk. Fewer hotspot was detected in Meghalaya and decrease in hotspot in state of Manipur.

Figures 1.4a and 1.4b illustrate the spatial clustering of *asthma* prevalence across Northeast India for NFHS-4 (2015-16) and NFHS-5 (2019-21). The NFHS-4 map shows clustering, with hotspots mainly confined to Tripura, Meghalaya, Mizoram, Assam and a few hotspots in Manipur, Nagaland and Arunachal Pradesh. In contrast, NFHS-5 reveals a clear shift, with new clusters emerging in parts of Meghalaya, Mizoram and a localized hotspots were evident, concentrated in parts of Assam, Tripura which indicates changing spatial dynamics and possible environmental or lifestyle-related influences contributing to increased asthma prevalence in specific pockets.

The table highlights distinct socio-demographic gradients in NCD prevalence among women of reproductive age in Northeast India and prevalence of four major non-communicable diseases (NCDs) diabetes, thyroid disorders, asthma, and heart disease among women aged 15-49 years. Advancing age, higher socioeconomic status, marital status, and urban residence emerge as key correlates of greater disease burden, indicating the growing influence of lifestyle and environmental transitions on women's health in the region. A clear age-related pattern is evident, with the prevalence of diabetes increasing steadily from 0.6% among women aged 15-19 years to 3.6% among those aged 40-49 years. A similar increasing trend is observed for heart disease, rising from 0.5% in the youngest age group to 1.6% in the oldest, while asthma and thyroid disorders also show slightly higher rates among women in their 30s and 40s. With respect to the wealth index, reveal that NCD prevalence tends to be higher among women from wealthier households. The prevalence of diabetes and thyroid disorders was highest among the richest quintile which is 2.7% and 2.9%, respectively and lowest among the poorest (1.3% and 1.0%, respectively). In contrast, the prevalence of asthma and heart disease showed less pronounced variation across wealth categories, although slightly elevated levels were noted among the richer groups. For the marital status, currently married women exhibited the highest prevalence across all four diseases 2.0% for diabetes, 1.8% for thyroid disorders, 1.7% for asthma, and 1.3% for heart disease, compared to their never-married counterparts, among whom the corresponding figures were markedly lower. Women who were widowed, divorced, or separated also reported relatively higher rates. The pattern by place of residence shows an urban-rural divide, with urban

women experiencing a higher prevalence of all diseases. Diabetes and thyroid disorder were 2.0% and 2.6% in urban areas, compared to 1.7% and 1.4% in rural areas, respectively. Similarly, asthma and heart disease were also more prevalent among urban residents (2.2% and 1.4%) than rural women (1.5% and 1.0%). The Chi square test results (P value) indicate significant associations between sociodemographic factors (Age, wealth, marital status, and place of residence) and NCD prevalence of four major diseases (diabetes, thyroid disorder, heart disease and asthma. The effect of age was particularly strong for diabetes (p<0.001), thyroid disorder (p<0.001), asthma (p<0.001), and heart disease (p<0.001)

Overall, the table highlights distinct socio-demographic gradients in NCD prevalence among women of reproductive age in Northeast India. Advancing age, higher socioeconomic status, marital status, and urban residence emerge as key correlates of greater disease burden, indicating the growing influence of lifestyle and environmental transitions on women's health in the region.

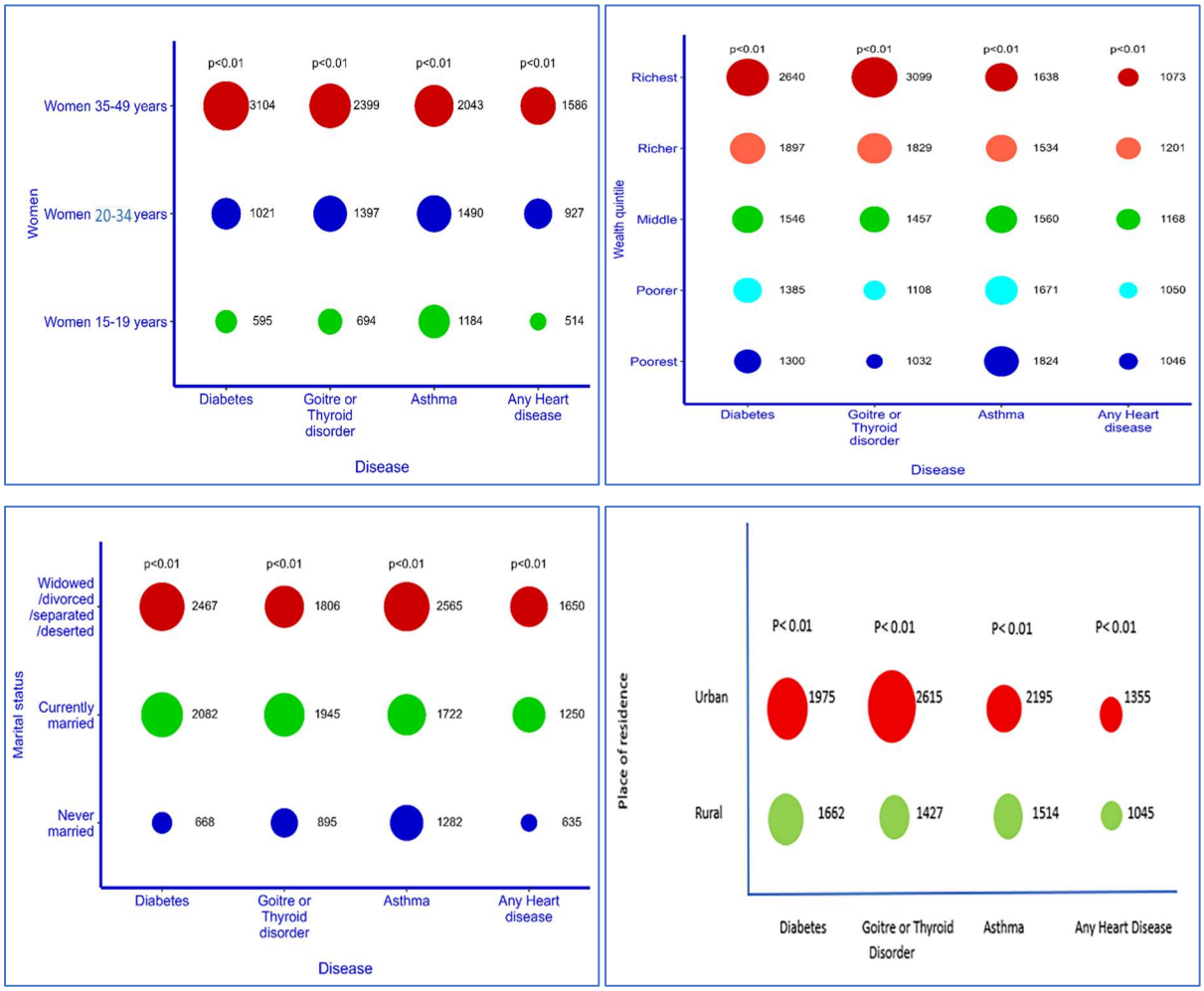


Figure 2: The proportion of women (15-49 years) per 1, 00,000 women respondents of the age group according to their certain socio-demographic characteristics.

Figure 2 illustrates the prevalence of NCDs per 100,000 women across different socio-demographic categories. Across age groups, a consistent increase in NCD prevalence was noted with advancing age. For instance, women aged 35-49 years reported the highest prevalence of diabetes (3,104), thyroid disorder (2,399), asthma (2,043), and heart disease (1,586).

It is evident that the number of women with Diabetes, Goitre or Thyroid disorder, Asthma and any heart disease is higher among elder women when compared to their younger counterparts. It is observed that the number of women having diabetes increases as the age of women increases and the result is statistically significant. The number of women having Diabetes is the highest among the age group of 35-49 years (3104), followed by the age group 24-34 years (1021) and 15-19 years (595). Similarly, the number of women having Goitre or Thyroid Disorder was relatively higher among the age group of 35-49 years (2399) when compared to women aged 24-34 years (1397) and the lowest number was reported among the age group of 15-19 years (1184). Further, a total of 2043 women of 35- 49 years reported having Asthma, followed by (1490) cases in 24-34 years, and (1184) in 15-19 years. The number of women reporting heart disease is also highest among the age group

of 35- 49 years (1586), as compared to 24-34 years (927) and 15- 19 (514) years age categories.

Among the age group of 35-49 years, women having diabetes was observed to be the highest (3104), followed by Goitre or Thyroid disease (2399), asthma (2043) and any heart disease (1586). Further, asthma was reported to be highest among the age group of 24-34 years and the least reported disease in the same age group was any heart disease (927). Seeing the diseases among the age group 15 to 19 years, asthma (1184) occurred highest followed by goitre or thyroid disorder (694), diabetes (595) and any heart disease (514).

In terms of wealth index, diabetes and Thyroid Disorder prevalence were highest among women in the richest quintile and declined progressively in lower quintiles. In contrast, asthma was more common among the poorest women (1,824). Diabetes and Thyroid Disorder were observed to have the highest number among women belonging to the richest quintile and the number decreased as the wealth quintile went down. However, similar pattern was not observed in Asthma or any heart disease. The number of women having Diabetes increased as the wealth quintile increased. The number was reported to be the highest among women belonging to the richest wealth quintile (2640) and the least number was reported among women of poorest wealth quintile (1300). Similarly, for Goitre or thyroid disorder, the highest number was observed among women with richest wealth quintile (3099) and the number decreased as the wealth index went down; the lowest as reported by women was with the poorest wealth quintile (1032).

For asthma, women with the poorest wealth quintile were relatively higher (1824), in comparison to poorer wealth quintile (1671) and the least was reported by women of richer wealth quintile (1534). Further, it was also observed that women of richer wealth quintile reported having the highest number of any heart diseases (1201), followed by women of middle wealth quintile (1168). The least number was reported among women belonging to poorest wealth quintile (1046). Among women of the richest wealth quintile, goitre or Thyroid Disorder was reported the most (3099), followed by diabetes (2640). Further, diabetes was the most commonly reported disease among women of richer wealth quintile (1897) followed closely by goitre or thyroid disease (1829). Comparing the diseases across middle, poorer and poorest, the highest occurrence of asthma was observed among women belonging to middle (1560), poorer (1671) and poorest wealth quintile (1824).

Marital status also showed significant variation. Widowed/divorced/separated/deserted women reported the highest rates of diabetes (2,467), asthma (2,565), and heart disease (1,650). However, goitre/Thyroid Disorder was highest among currently married women (1,945). Never-married women reported comparatively lower rates across all NCDs, with asthma being the most frequently reported condition (1,282).

For Goitre or thyroid disorder, the highest number was observed among women who were currently married (1945), followed by widowed/ divorced/ separated/deserted women (1806) and never married (895). Among widowed/divorced/ separated/deserted women, asthma was found to be relatively higher (2565) when compared to diabetes (2467), goitre or thyroid disorder (1806) and any heart disease (1650). For women who were currently married, diabetes was reported to be the highest (2082), followed by goitre or any thyroid disease (1945) and the least was observed with any heart disease (1250). Further, among women who were never married, asthma was observed to be more common (1282) when compared to diabetes (668), goitre or thyroid disorder (895) and any heart disease (635).

Also, the analysis in case of place of residence reveals a significant disparity. Women in urban areas consistently reported a higher burden of disease across most conditions. Specifically, the prevalence of Diabetes was markedly higher in urban areas (1975 cases) compared to rural areas (1662). A similar urban-rural divide was observed for Goitre or Thyroid Disorder (2615 urban vs. 1427 rural) and Any Heart Disease (2195 urban vs. 1514 rural). While Asthma was also more common among urban women (1,355 vs. 1045 in rural areas. In conclusion, place of residence is a significant factor, with urban women demonstrating a consistently higher prevalence of the reported non-communicable diseases.

The results collectively underscore distinct spatial and socio-demographic clustering of NCDs across Northeast India, highlighting the complex interplay of geography, socio-economic status, and demographic characteristics in shaping disease prevalence.

Discussion

The present study provides a comprehensive spatial overview of the prevalence of major non-communicable diseases (NCDs) among women aged 15-49 years in Northeast India using NFHS-4 (2015-16) and NFHS-5 (2019-21) datasets. Across states such as Meghalaya and Tripura, there is evidence of dynamic shifts in the spatial distribution of diabetes hotspots between the two survey periods. Despite these changes, persistent hotspots in areas like East Garo Hills (Meghalaya) and West Tripura (Tripura) highlight ongoing health challenges that demand sustained, district-level interventions. In contrast, an increase in cold spot clustering in states such as Nagaland and Mizoram may not necessarily indicate a reduction in disease burden but may also indicates under-detection, limited diagnostic facilities, or disparities in healthcare access. It also indicates systemic underreporting or diagnostic gaps due to difficult terrain, cultural differences in health-seeking behav-

iour, or logistical barriers. This spatial heterogeneity underscores the complex interplay that influenced NCD distribution in the region. Certain limitations may also be acknowledge based on self-reported diagnoses, due to recall bias specially in this region. Also, NFHS-5 coincided with the COVID-19 pandemic, which might have influenced reporting accuracy.

From a policy perspective, the findings emphasize the need to strengthen surveillance and healthcare delivery in hotspot districts through integration with India's National Programme for Prevention and Control of Non-Communicable Diseases (NP-NCD). Specific interventions such as mobile screening units, community outreach services, and enhanced engagement of frontline health workers could improve early detection and treatment of NCDs. Similarly, validation and clinical confirmation of Self-reported NCD data. Future studies must include qualitative/longitudinal methods and assess behavioral and lifestyle risks to understand regional NCD patterns.

Strength and Limitations

The study's strength lies in the use of nationally representative NFHS data, which ensures representativeness not only at the state but also at the district level. The graphical and spatial representation of hotspot and cold spot clusters makes the findings easily interpretable for policymakers, enabling clearer visualization of priority districts for targeted NCD interventions.

However, certain limitations must be acknowledged. The analysis is based on self-reported diagnoses, which may lead to underestimation or misclassification of cases due to recall bias or lack of awareness especially in remote or low-literacy areas. Additionally, data collection for NFHS-5 coincided with the COVID-19 pandemic, which might have influenced healthcare-seeking behavior and reporting accuracy.

A key suggestion arising from this study is that self-reported NCD data in national surveys should be validated through document verification or concurrent clinical confirmation to improve reliability. Furthermore, future research should incorporate qualitative and longitudinal approaches to explore barriers to healthcare access in hotspot districts. Including behavioral and lifestyle determinants such as physical inactivity, unhealthy diet, tobacco use, and alcohol consumption will also enrich understanding of regional NCD risk factors.

Conclusion

The increase in prevalence and hotspot clustering for NCDs among women in the region over a five-year period is a cause for concern and findings indicate increasing NCD clustering, suggesting a need for targeted interventions addressing modifiable risk factors. The analysis revealed notable increases in NCD prevalence and prevalence of spatial clustering, particularly for diabetes and thyroid disorders. The findings correspond directly to the study's objectives by (1) mapping state-wise NCD prevalence, (2) identifying temporal changes in hotspot clustering between NFHS rounds, and (3) exploring socio-demographic associations with NCD prevalence. The observed clustering patterns suggest evolving intra-regional disparities in these regions. These findings should be viewed as evidence of evolving NCD clustering that signals the need for targeted, region-specific interventions addressing modifiable risk factors, healthcare access, and diagnostic capacity.

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Availability of Data: The dataset used is available in the public domain via the DHS Program website.

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