

RESEARCH ARTICLE

Unequal health outcomes: Wealth-based inequalities in major non-communicable diseases among reproductive-age women in North India

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Abstract

India's non-communicable disease burden has increased rapidly, but chronic conditions remain unevenly distributed across socioeconomic groups. This study examines wealth-related disparities in four major outcomes: anaemia, diabetes, thyroid disorder, and high blood pressure among women aged 15–49 years in six North Indian states: Uttar Pradesh, Uttarakhand, Himachal Pradesh, Haryana, Punjab, and Rajasthan. Using nationally representative data from the National Family Health Survey (NFHS)-4 (2015–2016) and NFHS-5 (2019–2021), women are grouped into low, middle, and high wealth categories based on the NFHS wealth index. Multivariable logistic regression models are used to estimate the relationship between socioeconomic position and disease outcomes. Wealth-related inequality is clearly condition-specific and varies across states. Anaemia remains concentrated among women in the Poor wealth category and predominantly rural women, pointing to persistent nutritional and health-service deficits. By contrast, diabetes and high blood pressure are more common among older and relatively better-off women, with some urban concentration. Thyroid disorder shows a more mixed wealth gradient. Overall, the evidence points to a continuing double burden in which deprivation-related and cardiometabolic risks coexist among women in North India. The study highlights the need for state-specific and equity-sensitive strategies that combine nutrition interventions with early detection and long-term management of chronic conditions.

Keywords: Wealth inequality; Non-communicable diseases; Reproductive-age women; Women's health; National Family Health Survey; North India

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1. Introduction

Non-communicable diseases (NCDs) have emerged as a predominant cause of morbidity and mortality globally, and particularly in India. Over recent decades, India has

experienced a significant epidemiological transition, with the share of NCDs in the total disease burden increasing from approximately 30% in 1990 to around 55% by 2016. Currently, diseases such as cardiovascular illnesses, diabetes, chronic respiratory disorders, and cancer account for about 62% of all deaths in the country (Thakur *et al.*, 2020). Alarmingly, nearly 4 out of 10 Indians face the risk of premature death from NCDs before reaching 70 years, underscoring a critical public health challenge (Kulothungan *et al.*, 2024). However, the distribution and determinants of NCDs are not uniform across the population. Significant socioeconomic inequalities persist, influencing exposure to risk factors, healthcare access, and health outcomes. Wealth, a prominent indicator of socioeconomic status, significantly stratifies NCD risk profiles. While affluent populations often experience risk factors related to lifestyle (e.g., sedentary habits, high-calorie diets), they typically benefit from better preventive care and treatment access. Conversely, populations in the Poor wealth category face higher exposure to environmental and occupational hazards and often lack adequate healthcare access, exacerbating their disease burden. Emerging evidence suggests that socioeconomic status remains a key determinant of health disparities in India, with some NCDs historically viewed as “diseases of affluence” increasingly prevalent among poor wealth groups. Recent studies indicate that the prevalence of cardiovascular risk factors rose disproportionately among less wealthy and less educated groups, highlighting an evolving pattern of disease burden across socioeconomic strata (Wetzel *et al.*, 2023). Given these shifting dynamics, a comprehensive assessment of wealth-related inequalities in NCD prevalence is necessary to inform targeted interventions.

While the general increase of NCDs in India is well documented, there is limited research that disaggregates NCD prevalence and outcomes explicitly by wealth strata using recent nationally representative data. This study addresses the critical gap in understanding how wealth disparities shape the distribution and determinants of NCDs in India, with particular emphasis on six major states in North India (Uttar Pradesh, Uttarakhand, Himachal Pradesh, Haryana, Punjab, and Rajasthan). These six states account for nearly one-fourth of India's land area and close to one-third of its population, making them central to any analysis of health outcomes. Importantly, these states encompass contrasting terrains and settlement patterns, from the Himalayan hill states (Uttarakhand, Himachal Pradesh) to the fertile Indo-Gangetic plains (Uttar Pradesh, Haryana, Punjab) and the arid desert region of Rajasthan. This heterogeneity allows us to capture how wealth-based inequalities in NCDs manifest across

different ecological and economic contexts. Addressing wealth-based health inequalities is critical not only from a social justice perspective but also to achieve broader public health objectives. Persistent neglect of disadvantaged groups undermines overall progress in reducing the NCD burden at the population level. Given the substantial socioeconomic diversity within the selected North Indian states, the study offers valuable region-specific insights, aiding state-level policymakers in designing nuanced and targeted public health interventions. Additionally, the study aligns closely with global recommendations, particularly those articulated by the World Health Organization (WHO)'s Commission on Social Determinants of Health (SDH), advocating the reduction of health disparities through improvements in living conditions and equitable resource distribution.

This study makes methodological, theoretical, and analytical contributions to the literature. Methodologically, it uses pooled data from two rounds of the National Family Health Survey (NFHS; 2015–16 and 2019–21) to provide a broader and more robust assessment of wealth-related inequality in women's health outcomes. It also examines four major NCDs simultaneously among reproductive-age women, allowing comparison across conditions rather than focusing on a single disease in isolation. Theoretically, the study brings together the SDH framework with Fundamental Cause Theory, Health Lifestyle Theory, and Intersectionality Theory to interpret wealth-based disparities more comprehensively. Analytically, it offers a North India-focused assessment of wealth gradients in NCDs while highlighting important state-level heterogeneity across the six study states. Thus, this study examines the prevalence and distribution of four major NCDs across low, middle, and high wealth groups in North India and further assesses the relationship between wealth status and the likelihood of these conditions after accounting for key socioeconomic and demographic factors. Through this approach, the study seeks to clarify how wealth is related to women's health outcomes and to identify the factors contributing to observed inequalities, thereby providing a comprehensive picture of the NCD burden across the economic spectrum among women in India.

1.1. Theoretical framework: Social determinants of health and health inequality

Our analysis is guided by the SDH framework, which views health inequalities as socially produced rather than randomly distributed. In this perspective, health outcomes are shaped by the conditions in which people are born, grow, live, work, and age, and by the unequal distribution of power, money, and resources that structures those

conditions (WHO, 2008). The WHO framework usefully distinguishes between structural determinants and intermediary determinants of health inequity. Structural determinants arise from the broader socioeconomic and political context and include social stratifiers such as wealth, education, occupation, gender, and ethnicity. These factors place individuals and groups in unequal social positions and, in turn, shape their exposure to health risks and access to health-protective resources (Solar & Irwin, 2010; WHO, 2008).

This distinction is central to the present study. Wealth is treated not simply as a household attribute, but as an indicator of women's broader social position within unequal institutional and social settings. Its effects are likely to operate through intermediary pathways such as material living conditions, nutrition, housing and sanitation, psychosocial stress, health awareness, care-seeking, and access to screening, diagnosis, and treatment (Solar & Irwin, 2010). In the context of reproductive-age women in North India, these pathways are directly relevant to the four NCDs examined in our study. Anaemia is more likely to reflect deprivation in nutrition and living conditions, whereas diabetes, thyroid disorder, and high blood pressure may also be shaped by lifestyle transition, stress, and unequal access to medical detection and continuity of care. The SDH framework therefore helps link the study's explanatory variables-wealth, education, social status, residence, and state context-to the broader processes through which social inequality becomes embodied in women's health outcomes (Solar & Irwin, 2010; WHO, 2008).

While the SDH framework provides the broader structural backdrop, our study is more specifically situated within Fundamental Cause Theory. This theory argues that socioeconomic status is a fundamental cause of disease. It is considered fundamental because it gives people access to flexible resources. These resources include money, knowledge, power, prestige, and beneficial social connections. People can use these resources to avoid health risks. They can also reduce the effects of illness when it occurs. In addition, these resources help them benefit from new forms of prevention and treatment. Because these resources remain unequally distributed, health inequalities persist even when the proximate mechanisms of disease change over time (Link & Phelan, 1995; Phelan *et al.*, 2004). Later empirical work has shown that socioeconomic inequalities are often larger for more preventable conditions than for less preventable ones, lending support to the argument that socially advantaged groups are better able to convert resources into health protection (Mackenbach *et al.*, 2015; Masters *et al.*, 2015;

Rydland *et al.*, 2020). This perspective is especially relevant to our study because it helps explain why wealth-based inequalities may persist across multiple NCDs, even when the immediate disease pathways differ by condition. The study also draws on Health Lifestyle Theory, which helps explain how socioeconomic inequality is translated into health through everyday behaviours and routine practices. Some studies treat diet, exercise, smoking, alcohol use, and care-seeking as purely individual choices. Health Lifestyle Theory takes a different view. It argues that these behaviours are not shaped by choice alone. They are influenced by the interaction between life chances and life choices. This interaction takes place within structured social contexts (Cockerham, 2005). Health lifestyles reflect class circumstances, gender, age, living conditions, and social networks, which shape both the behavioural options available to individuals and the dispositions guiding their choices. (Christensen & Carpio, 2014; Cockerham, 2005; Cockerham *et al.*, 2020).

This framework is particularly useful for interpreting condition-specific wealth gradients in our study. For example, anaemia may be more closely related to poor diet quality, reproductive burdens, inadequate living conditions, and restricted access to preventive care, whereas diabetes and hypertension may be linked to different constellations of diet transition, physical inactivity, obesity, stress, diagnosis, and treatment. From this perspective, divergent wealth patterns across diseases do not merely reflect isolated behaviours; rather, they reflect socially structured lifestyles that vary across socioeconomic positions (L. Zhang, 2021).

A further conceptual strengthening of the analysis comes from Intersectionality Theory, which highlights that wealth does not operate independently of other axes of social inequality. Intersectionality emerged from Black feminist studies to show that systems of oppression, such as class, gender, race, and other forms of social stratification, are mutually constituted rather than simply additive (Bauer, 2014). In health research, this means that the implications of socioeconomic position may differ depending on how it intersects with other social locations and institutional structures (Veenstra, 2013; Viruell-Fuentes *et al.*, 2012). Applied to this study, an intersectional perspective suggests that wealth-based inequalities in NCDs among reproductive-age women are likely to be shaped by women's simultaneous positions within age, education, caste/social status, religion, marital status, and rural-urban residence (Veenstra & Patterson, 2016). Thus, the same level of household wealth may not translate into the same degree of health protection for all women. Intersectionality therefore helps move the analysis beyond a simple gradient

approach and toward a more nuanced understanding of heterogeneity within wealth groups (Bauer, 2014; Green *et al.*, 2017).

At the same time, it is important to acknowledge the limits of the data in relation to these theoretical frameworks. The SDH framework, Fundamental Cause Theory, and Intersectionality Theory all imply dynamic causal processes operating across time through material, behavioural, psychosocial, and institutional pathways. However, the NFHS data used here are cross-sectional and therefore permit only a pathway-limited analysis. They allow us to identify patterned relationships and wealth-based gradients that are consistent with these theories, but they do not allow strong causal claims regarding temporal ordering, cumulative exposure, or the full set of mechanisms through which wealth shapes different NCD outcomes (Bauer, 2014; Green *et al.*, 2017). The findings should therefore be interpreted as evidence of structured inequality rather than as direct proof of the complete causal model implied by these frameworks.

1.2. Global and national context of wealth-related health inequalities

Globally, low- and middle-income countries now account for a large and growing share of the NCD burden, with nearly 80% of NCD-related deaths occurring in these settings (Daar *et al.*, 2007; Goryakin *et al.*, 2017). Within countries, health outcomes are strongly stratified by socioeconomic status. While high-income countries typically show higher NCD burdens among lower-wealth groups, low- and middle-income countries in earlier stages of the nutrition and lifestyle transition often exhibit higher prevalence of selected NCD risk factors among better-off groups (Ramesh & Kosalram, 2023). India provides a notable example of this changing pattern. Earlier evidence documented a positive wealth gradient for conditions such as obesity, hypertension, and diabetes (Siddiqui & Donato, 2020), but more recent NFHS-based studies suggest that key risk factors have been rising faster among rural, less educated, and lower-wealth populations, thereby narrowing the gradient (Wetzel *et al.*, 2023). This suggests that the wealth gradient for selected NCD risks may be weakening or changing direction, even as inequalities in diagnosis and access to care persist.

Together, nutrition-related conditions such as anaemia remain heavily concentrated among women in the Poor wealth category in India, reflecting continued structural deprivation (Belwal *et al.*, 2021). The country therefore faces a dual burden in which conditions linked with poverty coexist with emerging lifestyle-related diseases. This evolving pattern underscores the need for context-specific

analysis of wealth-related health inequalities. Focusing on six North Indian states, the present study contributes to the literature by examining multiple NCDs together to better understand how wealth gradients in women's health are changing within the Indian context.

1.3. Conceptualising wealth-related inequality in health

To capture wealth-related inequality in NCDs, the health inequality literature offers several measurement approaches. A straightforward and policy-relevant method is to compare disease prevalence across wealth groups, for example, by examining differences between the Poor and Rich wealth categories. More formal summary measures, such as the Concentration Index, provide a compact quantitative assessment of inequality based on the distribution of health outcomes across the wealth ranking (Kakwani *et al.*, 1997). However, in this study, wealth inequality is conceptualised as systematic differences in disease burden across economic strata and is operationalised primarily through group-wise prevalence comparisons that directly indicate whether NCD risks are disproportionately borne by women in the Poor or Rich wealth categories. It is also recognised that wealth is closely intertwined with other socioeconomic factors, including education, caste, occupation, and place of residence, which together shape both health risks and access to diagnosis and care (Safiri *et al.*, 2021; X. Zhang *et al.*, 2023).

1.4. Overview of selected non-communicable diseases

This study focuses on four major NCDs: anaemia, thyroid disorder, diabetes, and high blood pressure. Together, these outcomes capture a broad spectrum of health risks affecting adult women in India (Shah *et al.*, 2024). Anaemia, although sometimes treated separately from chronic diseases, remains highly prevalent among women of reproductive age and is strongly linked to dietary deficit and socioeconomic disadvantage (*Details of Anemia Mukht Bharat* | Ministry of Health and Family Welfare | GOI, n.d.; Jeevan *et al.*, 2025; Kumar *et al.*, 2014). Thyroid disorders are included because of their growing importance among women and the role of differential awareness and diagnosis across socioeconomic groups (Bashir *et al.*, 2025). Diabetes is one of the fastest-rising metabolic conditions in India and is closely linked to long-term complications (India State-Level Disease Burden Initiative Diabetes Collaborators, 2018; Pradeepa & Mohan, 2021). High blood pressure is included as a prevalent and measurable cardiometabolic risk factor whose distribution reflects ongoing lifestyle transitions (Fatima & Mahmood, 2021). Taken together, these four conditions capture multiple dimensions of

women's health, including nutritional deficiency, endocrine imbalance, metabolic disorder, and cardiovascular risk. They are also consistently measured in NFHS data and remain highly relevant from a public health perspective. Analysing these conditions jointly allows us to assess whether wealth-related health inequality follows a uniform pattern or varies by disease. Examining this spectrum is particularly important for women aged 15–49 years, whose health is shaped by reproductive history, hormonal factors, and changing lifestyle risks.

Based on existing literature and the SDH framework, the study hypothesises that wealth-related inequalities significantly influence the distribution of the four outcomes (Figure 1). Women in the Poor wealth category are expected to bear a disproportionate burden because of nutritional deprivation and environmental vulnerability. For diabetes and high blood pressure, we expect a stronger concentration among higher wealth groups, although the wealth gradient may be narrowing as these risks spread more widely across the population. Thyroid disorder is expected to display a more mixed socioeconomic pattern because diagnostic access may shape the observed gradient.

This framework shows how wealth-based inequality shapes women's health by influencing their socioeconomic and household conditions (education, caste, residence, state, age, family responsibilities) (Perkins *et al.*, 2016). These factors affect everyday pathways such as access to healthcare, living conditions, diet, information, and stress, which gradually build health risks (nutritional and metabolic problems, blood pressure dysregulation) (Neff *et al.*, 2009). Over time, this leads to unequal burdens of anaemia, diabetes, thyroid disorders, and hypertension among women aged 15–49 years. The remainder of the paper is organised as follows. Section 2 describes the data, variables, and methods. Section 3 presents descriptive and regression results. Section 4 discusses the findings considering theories and policy. Section 5 concludes the study.

2. Data and methods

2.1. Data sources

This study uses data from NFHS-4 (2015–2016) and NFHS-5 (2019–2021), large nationally representative surveys conducted by the Ministry of Health and Family Welfare with technical support from the Demographic and

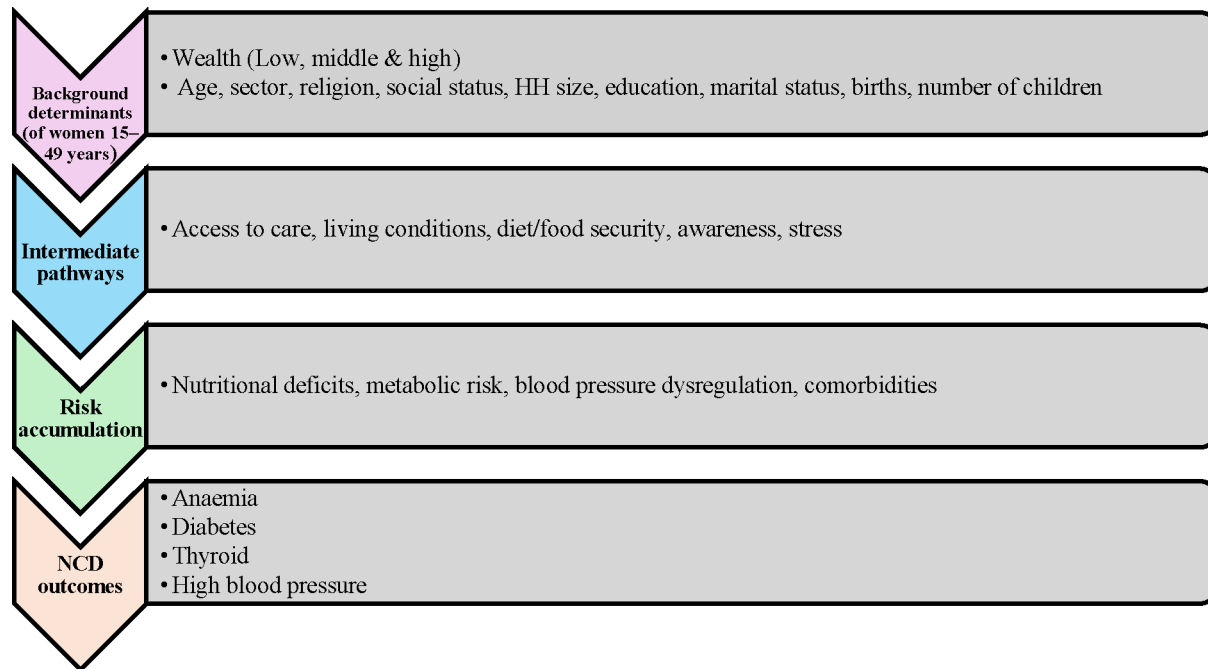


Figure 1. Conceptual framework of the study. Source: Developed by the authors based on WHO (2008) and related literature. Abbreviations: HH: Household; NCD: Non-communicable disease.

Health Surveys Program. NFHS-4 covered approximately 601,509 households and NFHS-5 about 636,699 households across all states and union territories. The surveys provide extensive information on population, health, and nutrition, including biomarker measurements such as blood pressure, blood glucose, and haemoglobin, along with self-reported diagnosed conditions, enabling objective assessment of major NCDs. The present study focuses on non-pregnant women aged 15–49 years from six North Indian states, Uttar Pradesh, Uttarakhand, Himachal Pradesh, Haryana, Punjab, and Rajasthan, with a combined analytical sample of 373,510 women. These states were selected because of their large population share and their diverse socioeconomic contexts, making them suitable for examining wealth-related health disparities.

2.2. Variables and measures

The study examines four major NCDs, each operationalised as a binary outcome (Yes or No). Anaemia is measured using haemoglobin values obtained on site in NFHS through a finger-prick blood test and a portable photometer, and coded as anaemic versus not anaemic. Thyroid disorder is based on self-reported responses to whether the woman has ever been told by a doctor or health professional that she has a thyroid disorder and is coded as diagnosed versus not diagnosed. Diabetes is identified using NFHS blood glucose testing for the eligible subsample, along with information on current use of medication to control diabetes and coded as diabetic versus not diabetic. High blood pressure is derived from NFHS blood pressure measurements, where three readings are taken and averaged, and is coded as hypertensive versus not hypertensive.

2.2.1. Key socioeconomic variable

The primary variable of interest is the wealth index group. The NFHS wealth index is a composite indicator based on household assets and amenities (such as ownership of consumer goods, housing quality, and sanitation facilities), and it places each surveyed household on a relative scale of socioeconomic position within the country. For our analysis, we grouped the population into three broader wealth categories (low, middle, and high) to ensure sufficient sample sizes in each category and to simplify comparisons.

2.2.2. Other socioeconomic and demographic variables

In our study, the rural–urban sector is included to capture geographic and infrastructural disparities and to examine urban–rural differences within wealth groups. Social status reflects India's caste hierarchy, including the Scheduled Caste (SC), Scheduled Tribe (ST), Other Backwards Classes

(OBC), and Others, which is incorporated as an important marker of socioeconomic position and health inequality. Educational attainment (no education, primary, secondary, and higher) is included because it may confound or mediate the relationship between wealth and health through its influence on health awareness, behaviours, and healthcare utilisation. Age is grouped into 15–29 years and 30–49 years to account for variations in NCD risk across the life course. Religion is controlled for to adjust for cultural and lifestyle differences that may indirectly influence health outcomes. Marital status (never married, married, and others) is included to capture differences in social support, stress exposure, and life-course circumstances. The number of children under five is used as an indicator of recent childcare burden, while recent births in the last five years capture fertility momentum and potential nutritional depletion, particularly relevant for anaemia. Household size is incorporated to reflect possible resource dilution as well as the broader household support environment.

2.3. Methods

The analysis combines descriptive and multivariate approaches. First, sample weighted descriptive estimates are presented for the prevalence of anaemia, diabetes, thyroid disorder, and high blood pressure in North India and across the six northern states. These descriptive results are further disaggregated by wealth groups for six North Indian state-levels to identify wealth gradients, while annexure tables summarise the socioeconomic and demographic composition of affected women across wealth groups and states. All descriptive estimates apply NFHS sampling weights to ensure population representativeness.

Second, separate multivariable binary logistic regression models were estimated for each condition to examine the relation between wealth status and disease prevalence. Survey-adjusted regression was used to account for the complex NFHS sampling design, including sampling weights, clustering, and stratification. Wealth index is the main explanatory variable, controlling for age, household size, place of residence, social status, religion, marital status, education, state, number of children under age five, and recent childbirths. All analyses were conducted in Stata 16.1 (StataCorp, United States of America) using “svy” commands and individual sampling weights to account for the complex survey design of NFHS.

3. Results

3.1. Prevalence of four major non-communicable diseases in North Indian states

Table 1 presents the survey-weighted socioeconomic profile of 373,510 women aged 15–49 years from six North Indian states. These states account for more than 30% of India's

population. The sample is predominantly rural (72.97%), Hindu (81.43%), and married (68.32%), and OBC women form the largest social group (46.90%). The age distribution is balanced, although the sample is slightly concentrated in the 15–29 years group (52.94%). Educational attainment remains uneven: 43.30% of women have secondary education, nearly 30% have no education, and only 15.24% have higher education. In wealth terms, 44.32% belong to the richer wealth group, 36.84% to the poor wealth group, and 18.84% to the middle-wealth group. Uttar Pradesh and Rajasthan contribute the largest state shares in the sample. The whole sample captures substantial socioeconomic diversity, but it is weighted more heavily toward rural and socially disadvantaged populations.

Table 1. Weighted distribution of health and socioeconomic characteristics of the sample (unweighted $N = 373,510$)

Characteristic	Weighted %
Health condition	
Anaemia	52.42
Diabetes	1.23
Thyroid disorder	1.59
High blood pressure	8.55
Age	
15–29 years	52.94
30–49 years	47.06
Sector	
Urban	27.03
Rural	72.97
Religion	
Hindu	81.43
Muslim	12.72
Other ^a	5.86
Social status	
Scheduled Caste	25.16
Scheduled Tribe	3.85
Other Backwards Classes	46.90
Others	24.09
Education	
No education	29.73
Primary	11.74
Secondary	43.30
Higher	15.24

(Cont'd...)

Table 1. (Continued)

Characteristic	Weighted %
Household size	
1 to 5	46.40
6 to 10	46.23
≥11	7.37
Marital status	
Never married	28.69
Married	68.32
Others ^b	2.99
Wealth category	
Poor	36.84
Middle	18.84
Rich	44.32
States	
Haryana	7.67
Himachal Pradesh	1.98
Punjab	7.87
Rajasthan	21.28
Uttar Pradesh	58.20
Uttarakhand	2.99
Children ≤ 5 years	
0	60.53
1	22.12
≥2	17.35
Births last five years	
0	74.26
1	16.81
≥2	8.93

Note: ^aSikh, Christian, Buddhist, Jain, and other categories; ^bWidowed, divorced, or separated.

Figure 2 presents the prevalence of the four major NCDs among women in the six North Indian states. Anaemia is by far the most widespread condition, affecting 52.42% of women, and remains a major nutritional and public health concern in the region. High blood pressure is the second most common condition (8.55%), whereas diabetes (1.23%) and thyroid disorder (1.59%) have much lower prevalence. The state-wise pattern shows clear regional variation. Anaemia is highest in Haryana (61.93%) and Punjab (56.32%) and lowest in Uttarakhand (43.98%). High blood pressure is also non-trivial across states, with comparatively higher levels in Haryana and Punjab, while diabetes and thyroid disorder remain low generally, with

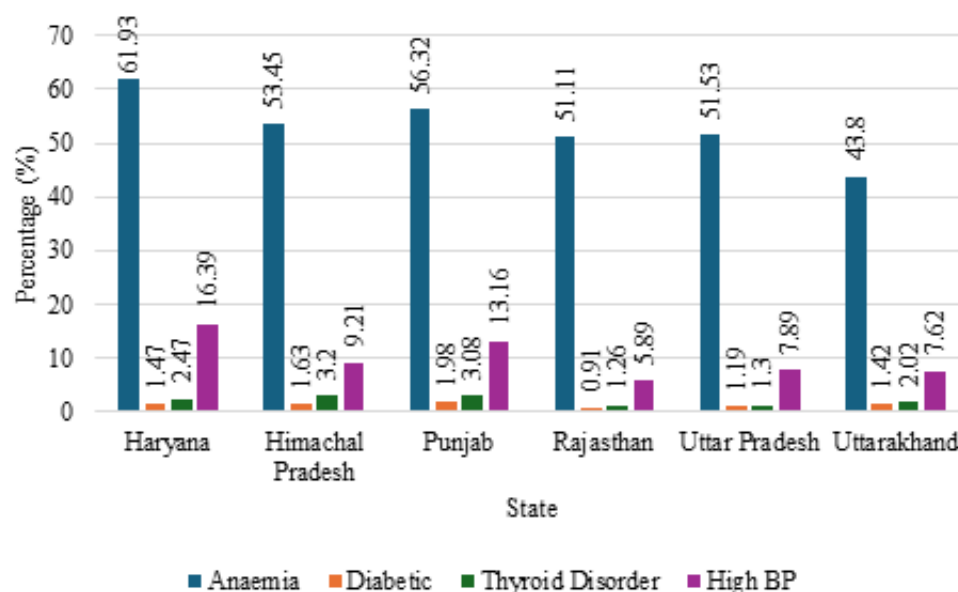


Figure 2. State-wise prevalence of four major non-communicable diseases in six North Indian states.
Abbreviation: BP: Blood pressure.

somewhat higher prevalence in Punjab and Himachal Pradesh. Taken together, these patterns point to a high burden of anaemia alongside a smaller but visible burden of cardiometabolic conditions, with substantial state-level heterogeneity.

3.2. Prevalence of four major non-communicable diseases across wealth groups in North Indian states

To assess wealth-related inequality, Figure 3 plots the prevalence of the four major NCDs across wealth groups. Anaemia remains high in all three groups, with only a modest decline as wealth rises. By contrast, diabetes, thyroid disorder, and high blood pressure display a clearer positive wealth gradient, with higher prevalence among women in the Middle and Rich wealth categories than among women in the Poor wealth category. The contrast suggests that social disadvantage risks and cardiometabolic risks are patterned differently along the economic hierarchy.

The state-level pattern broadly mirrors the regional picture, although the strength of the wealth gradient varies across states (Figure 4). Anaemia remains high across wealth groups in every state; the decline with rising wealth is more visible in Rajasthan and less pronounced in Uttarakhand and Uttar Pradesh. Diabetes, thyroid disorder, and high blood pressure tend to be more prevalent among high-wealth women in most states, although the magnitude of the gradient differs across locations. Largely, the results suggest a dual burden in which persistent nutritional

deficiency coexists with a growing concentration of lifestyle-related NCD risks among high-wealth women, with notable variation across states.

Tables A1–A4 show that the socioeconomic composition of affected women differs across diseases and states. Anaemia is more concentrated among women in the Poor wealth category and rural women in several states, especially Uttar Pradesh, Rajasthan, and Haryana. By contrast, diabetes and high blood pressure are more common among relatively better-off and more urban women, particularly in Uttar Pradesh and Uttarakhand, whereas Himachal Pradesh retains a more rural profile. Thyroid disorder shows a mixed gradient, shifting toward urban women and women in the Middle and Rich wealth categories in states such as Uttar Pradesh, Rajasthan, and Punjab. Across diabetes, thyroid disorder, and high blood pressure, affected women are more often in the 30–49 years age group and are predominantly married. Social composition also varies with wealth: Women in the Poor wealth category with these conditions are more likely to belong to SC and ST groups, while the distribution shifts toward OBC and Other groups as wealth rises. Education increases with wealth, but the disease burden is not confined to highly educated women. Tables A1–A4 underscore substantial state-specific variation and confirm that the wealth gradient is neither uniform nor identical across conditions. Overall, these patterns highlight substantial state-specific heterogeneity in wealth-related health risks

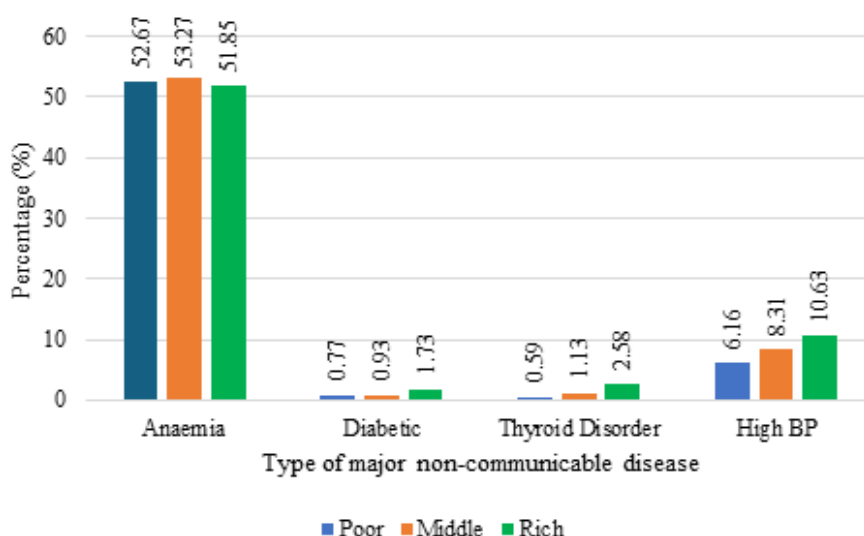


Figure 3. Prevalence of four major non-communicable diseases by wealth category in six North Indian states.
Abbreviation: BP: Blood pressure.

and underscore the need for targeted and equity-sensitive policy responses.

3.3. Determinants of major non-communicable diseases among women in India

Table 2 reports survey-adjusted logistic regression estimates as odds ratios for the four outcomes among non-pregnant women aged 15–49 years in the six study states. The results suggest that age, marital status, education, wealth, social group, location, and state context are all related to women's health risks, but the direction and magnitude of these relations differ across conditions.

Age is one of the most consistent predictors. Women aged 30–49 years have substantially higher odds of diabetes (odds ratio [OR]: 2.62), thyroid disorder (OR: 2.40), and high blood pressure (OR: 1.578) than women aged 15–29 years. Anaemia shows the opposite pattern: women aged 30–49 years have slightly lower odds (OR: 0.95), indicating that anaemia remains more common among younger women. Household size has a more limited linkage. Compared with women living in households of 1–5 members, those in larger households have lower odds of diabetes, thyroid disorder, and high blood pressure.

Place of residence matters mainly for metabolic conditions. Rural women are less likely than urban women to have diabetes (OR: 0.78) or thyroid disorder (OR: 0.65), while the rural-urban difference is not statistically significant for anaemia or high blood pressure. Religious differences are selective rather than uniform. Relative to Hindu women, women in the Other religion category

have higher odds of thyroid disorder (OR: 1.14) and high blood pressure (OR: 1.39), while Muslim women have higher odds of high blood pressure (OR: 1.18). Caste-based differences are also condition-specific. ST women have markedly higher odds of anaemia (OR: 1.43) than SC women but lower odds of thyroid disorder (OR: 0.75) and high blood pressure (OR: 0.81). OBC women have lower odds of anaemia (OR: 0.94) and thyroid disorder (OR: 0.86), whereas women in the Others social status show slightly higher odds of diabetes (OR: 1.11).

Marital status is among the strongest correlates of cardiometabolic conditions. Compared with never-married women, married women have substantially higher odds of diabetes (OR: 2.98), thyroid disorder (OR: 3.22), and high blood pressure (OR: 3.31). Women in the widowed, divorced, or separated category (combined as Others) similarly face markedly higher odds of diabetes (OR: 3.47), thyroid disorder (OR: 3.06), and high blood pressure (OR: 3.48). Anaemia follows a different pattern: married women have slightly lower odds (OR: 0.88) than never-married women. Education is similarly non-uniform in its relationship with anaemia. Higher educational attainment is linked with lower odds of anaemia, with the strongest reduction among women with higher education (OR: 0.83). At the same time, education is positively linked with thyroid disorder and, to a lesser extent, high blood pressure. For diabetes, the relationship is weaker: primary and secondary education are linked to modestly higher odds, whereas higher education is not statistically significant.

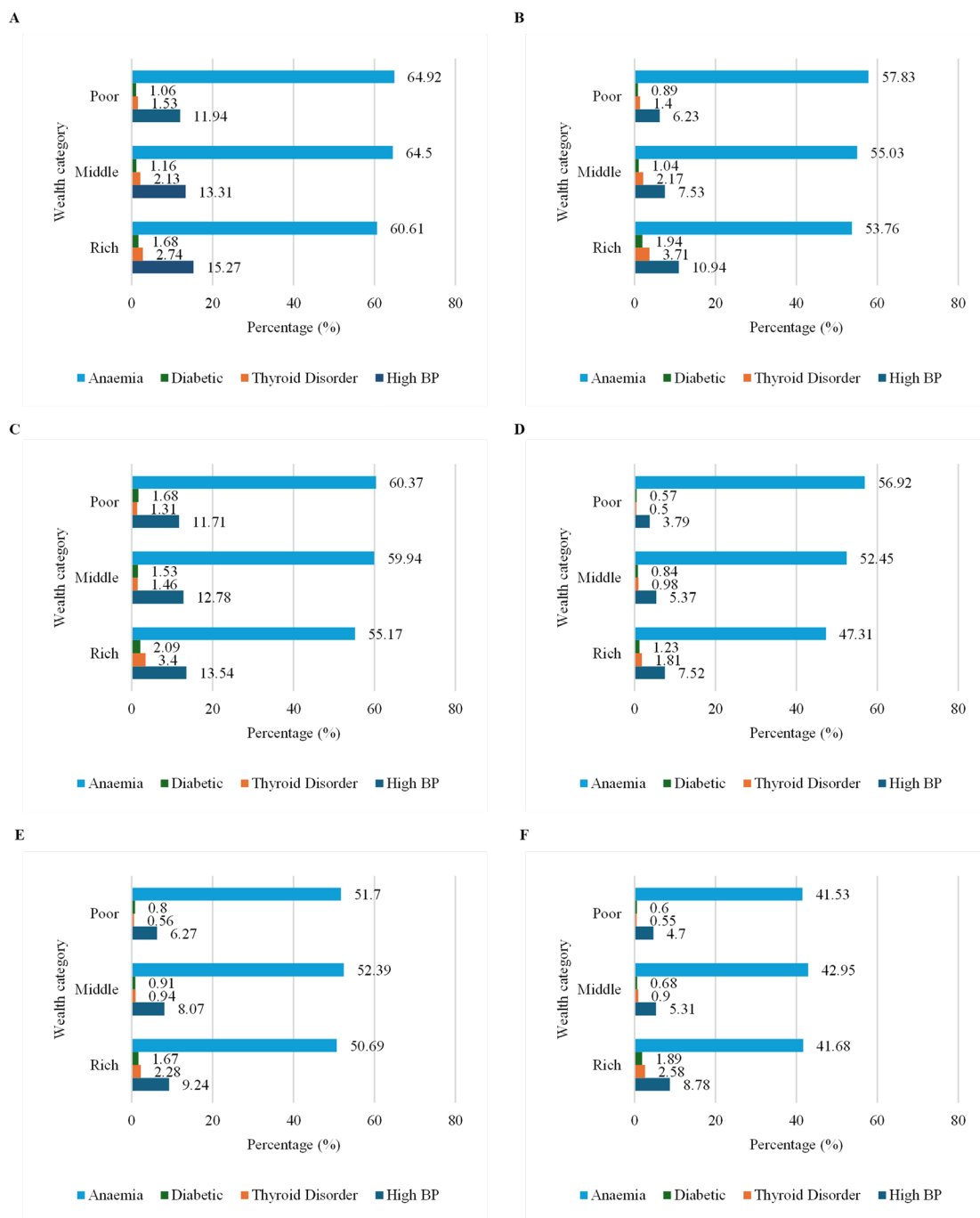


Figure 4. State-wise prevalence of four major non-communicable diseases by wealth category in six North Indian states. (A) Haryana; (B) Himachal Pradesh; (C) Punjab; (D) Rajasthan; (E) Uttar Pradesh; (F) Uttarakhand. Abbreviation: BP: Blood pressure.

Table 2. Survey-adjusted logistic regression results presented as odds ratios for selected non-communicable diseases among women aged 15–49 years

Background characteristics		Anaemia	Diabetes	Thyroid disorder	High blood pressure
Age group	15–29 (Ref.)				
	30–49	0.947*** (0.011)	2.619*** (0.156)	2.395*** (0.125)	1.578*** (0.033)
Household size	1–5 (Ref.)				
	6–10	1.023** (0.010)	0.872*** (0.037)	0.837*** (0.032)	0.927*** (0.016)
	≥11	1.016 (0.021)	0.787*** (0.072)	0.767*** (0.063)	0.860*** (0.035)
Sector	Urban (Ref.)				
	Rural	1.000 (0.015)	0.781*** (0.039)	0.647*** (0.026)	0.982 (0.035)
Religion	(Hindu) Ref.				
	Muslim	0.982 (0.018)	1.019 (0.069)	1.073 (0.072)	1.177*** (0.044)
	Others ^a	0.978 (0.028)	1.078 (0.088)	1.136* (0.074)	1.393*** (0.064)
Social status	Scheduled Caste (Ref.)				
	Scheduled Tribe	1.427*** (0.043)	1.045 (0.127)	0.749** (0.087)	0.810*** (0.049)
	Other Backwards Classes	0.942*** (0.012)	0.989 (0.056)	0.855*** (0.043)	0.992 (0.027)
	Others	0.938*** (0.014)	1.111* (0.061)	1.044 (0.053)	1.030 (0.029)
Marital status	Never married (Ref.)				
	Married	0.884*** (0.012)	2.978*** (0.258)	3.216*** (0.246)	3.311*** (0.105)
	Others ^b	0.982 (0.026)	3.470*** (0.406)	3.063*** (0.340)	3.484*** (0.162)
Education	No education (Ref.)				
	Primary	0.966** (0.014)	1.130** (0.069)	1.389*** (0.086)	1.089*** (0.027)
	Secondary	0.956*** (0.011)	1.096* (0.056)	1.678*** (0.080)	1.090*** (0.025)
	Higher	0.828*** (0.014)	0.946 (0.068)	2.198*** (0.131)	1.116*** (0.037)
Wealth index	Poor (Ref.)				
	Middle	1.045*** (0.013)	1.167** (0.074)	1.594*** (0.098)	1.335*** (0.036)
	Rich	0.986 (0.013)	1.889*** (0.117)	2.364*** (0.140)	1.489*** (0.044)
State	Haryana (Ref.)				
	Himachal Pradesh	0.707*** (0.027)	1.143 (0.108)	1.318*** (0.099)	0.485*** (0.031)
	Punjab	0.809*** (0.026)	1.206** (0.103)	1.031 (0.072)	0.595*** (0.037)
	Rajasthan	0.595*** (0.013)	0.820** (0.064)	0.758*** (0.049)	0.366*** (0.021)
	Uttar Pradesh	0.629*** (0.012)	1.237*** (0.081)	0.876** (0.050)	0.549*** (0.029)
	Uttarakhand	0.471*** (0.013)	1.093 (0.103)	0.918 (0.075)	0.446*** (0.028)
Children ≤ 5 years	0 (Ref.)				
	1	0.992 (0.013)	1.026 (0.059)	1.048 (0.053)	1.039 (0.025)
	≥2	1.019 (0.017)	1.239*** (0.097)	1.018 (0.077)	1.036 (0.034)

(Cont'd...)

Table 2. (Continued)

Background characteristics		Anaemia	Diabetes	Thyroid disorder	High blood pressure
	0 (Ref.)				
Births last five years	1	1.209*** (0.018)	0.465*** (0.034)	0.736*** (0.044)	0.873*** (0.022)
	≥2	1.410*** (0.028)	0.413*** (0.050)	0.616*** (0.064)	0.873*** (0.032)
Number of observations		373,510	373,510	373,510	373,510
Wald F-statistic		F (25, 14806) = 90.05	F (25, 14806) = 55.69	F (25, 14806) = 119.41	F (25, 14806) = 232.5

Notes: Significance level: * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$. Robust standard errors are shown in parentheses. Ref. indicates the reference category.

*Sikh, Christian, Buddhist, Jain, and other categories; ^bWidowed, divorced, and separated. Survey-adjusted odds ratios were estimated using svy: logit, accounting for sampling weights, clustering, and stratification.

Wealth shows one of the clearest gradients in the regression results. Relative to women in the Poor wealth category, women in the Middle wealth category have higher odds of all four conditions, although the increase is small for anaemia. The gradient is much steeper for diabetes, thyroid disorder, and high blood pressure. Among women in the Rich wealth category, the odds are 1.89 for diabetes, 2.36 for thyroid disorder, and 1.49 for high blood pressure. By contrast, anaemia does not differ significantly between women in the Poor and Rich wealth categories. This pattern reinforces the descriptive evidence: anaemia remains closely tied to deprivation, whereas diabetes, thyroid disorder, and high blood pressure show a stronger positive wealth gradient.

State effects confirm the importance of regional context. Compared with Haryana, all other states have significantly lower odds of anaemia, with the sharpest reductions in Uttarakhand and Rajasthan. Diabetes odds are higher in Punjab and Uttar Pradesh and lower in Rajasthan. Thyroid disorder is more likely in Himachal Pradesh but less likely in Rajasthan and Uttar Pradesh. High blood pressure is lower than in Haryana in every other study state. These contrasts suggest that the wealth gradient operates within broader state-specific environments shaped by nutrition, healthcare access, and public health systems.

Fertility-related variables add another layer of heterogeneity. The number of children aged five years or younger is mainly linked with diabetes, for which odds rise when women have two or more young children, while the relationship with anaemia is weak. Recent childbirth shows a clearer pattern: women with one or more births in the previous five years have higher odds of anaemia but lower odds of diabetes, thyroid disorder, and high blood pressure. Taken together, the regression results show that age, marital status, wealth, education, and place of residence are central correlates of women's NCD outcomes, but their effects are clearly disease specific. The Wald F-statistics are statistically significant in all four models, confirming

the joint explanatory relevance of the included covariates. Average marginal effects are reported in Table A5.

4. Discussion

This study shows that wealth-related inequality shapes the burden of major health conditions among women aged 15–49 years in North India, but the pattern is clearly condition-specific rather than uniform. Within the broader SDH framework, these differences reflect unequal living conditions, nutrition, education, healthcare access, and social position (WHO, 2008). More specifically, Fundamental Cause Theory helps explain why wealth remains important across multiple outcomes even when the immediate disease pathways differ. Because wealth provides flexible resources such as money, knowledge, social advantage, and access to healthcare, it continues to influence exposure, prevention, diagnosis, and management across conditions (Link & Phelan, 1995; Phelan *et al.*, 2004).

In our study, anaemia most clearly reflects persistent structural disadvantage. Although it remains widespread across all wealth groups, it is more strongly linked with lower education, social disadvantage, and recent childbirth. This pattern is consistent with Fundamental Cause Theory because anaemia is substantially preventable through improved nutrition, maternal care, and timely health intervention. Its continued concentration among disadvantaged women suggests unequal access to the resources needed to avoid risk or reduce its consequences (Mackenbach *et al.*, 2015; Rydland *et al.*, 2020). In this sense, anaemia is not only a nutritional condition; it is also an outcome of unequal social and material circumstances.

Health Lifestyle Theory adds an important layer to this interpretation. Anaemia among women in poorer wealth groups is unlikely to result from individual choices alone. Instead, it is more plausibly shaped by socially structured routines and constraints. These include poorer diet quality,

limited dietary diversity, restricted care-seeking, and nutritional depletion associated with recent or repeated births. (Christensen & Carpio, 2014; Cockerham, 2005; Giridharan *et al.*, 2025). The finding of a strong relationship between anaemia and recent childbirth supports this view. Reproductive burden is not merely biological; it is embedded in household and social arrangements that shape women's access to food, rest, and healthcare. Our findings on the protective role of education for anaemia are also consistent with this argument, as education may improve awareness, health practices, and women's ability to navigate health systems (Safiri *et al.*, 2021).

A different wealth gradient emerges for diabetes, thyroid disorder, and high blood pressure. These conditions are more prevalent among women in middle and higher wealth groups, and diabetes and thyroid disorders also show an urban relationship. This does not contradict Fundamental Cause Theory. Instead, it suggests that wealth operates through a different set of pathways for these conditions. In this setting, women in higher wealth categories may face greater exposure to sedentary routines, energy-dense diets, obesity-related risks, and other features of nutrition transition, while also being more likely to obtain testing and diagnosis (Popkin & Ng, 2022; Subramanian *et al.*, 2011; Wetzel *et al.*, 2023). Thus, the positive wealth gradient reflects both differential risk exposure and differential access to detection.

Here, Health Lifestyle Theory is especially useful because it moves the interpretation beyond individual choice. Diet, physical activity, body weight, stress, and healthcare use are socially patterned practices rather than purely personal decisions (Cockerham, 2005; Cockerham *et al.*, 2020). Higher wealth group women may be more exposed to dietary transition and reduced routine physical activity, both of which can elevate long-term metabolic risk. At the same time, thyroid disorder is partly diagnosis-dependent, so the observed wealth gradient may also capture inequality in medical surveillance and formal diagnosis rather than only inequality in underlying prevalence (Dinsa *et al.*, 2012; X. Zhang *et al.*, 2023).

Intersectionality Theory further strengthens the interpretation by showing that wealth does not operate independently of other social locations. Its implications are shaped by intersections with caste or social status, education, residence, age, and marital status (Bauer, 2014; Veenstra, 2013; Viruell-Fuentes *et al.*, 2012). In our findings, the especially high odds of anaemia among ST women are important in this regard. They suggest that economic disadvantage and social marginalisation may combine to intensify vulnerability. More broadly, the same level of household wealth is not translated into the same

degree of health protection for all women. An intersectional perspective therefore helps move the analysis beyond a simple gradient and toward a more nuanced understanding of heterogeneity within wealth groups (Green *et al.*, 2017; Veenstra & Patterson, 2016).

At the state level, the findings further show that the wealth gradient is context-specific rather than fixed. Differences across Haryana, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand, and Himachal Pradesh suggest that food systems, healthcare infrastructure, public health delivery, and broader development conditions shape disease patterns alongside individual and household characteristics (Neff *et al.*, 2009). This is where the SDH framework remains especially useful as a broad backdrop. It reminds us that wealth works through wider institutional and environmental settings rather than in isolation (WHO, 2008). The evidence points to a stratified epidemiological shift, marked by the coexistence of affluence-associated and cardiometabolic conditions among different strata of the female population.

The findings carry important policy implications. The marked heterogeneity across the six states suggests that policy responses should be differentiated rather than uniform. In Haryana and Punjab, where anaemia remains especially high, stronger nutrition-sensitive and reproductive health interventions are needed, including iron-folic acid supplementation, maternal nutrition support, anaemia screening, and better follow-up of women with recent births. Punjab also appears to require greater attention to diabetes screening and metabolic risk reduction. In Uttar Pradesh, the evidence points to a dual burden: anaemia remains concentrated among women in the Poor wealth category and rural women, while diabetes and high blood pressure are more visible among women in the Middle and Rich wealth categories and urban women. This calls for a two-track strategy that combines nutrition and maternal health support for disadvantaged women with expanded NCD screening, early detection, and continuity of care in urban and transitioning populations.

In Uttarakhand, high blood pressure is comparatively more noticeable. Primary care strengthening should place greater emphasis on routine blood pressure monitoring. It should also focus on early diagnosis. Long-term treatment adherence must be prioritised. In Himachal Pradesh, thyroid disorders appear relatively more visible. The affected population retains a more rural profile. The state may benefit from improved diagnostic access. Awareness efforts should be strengthened. Continuity of endocrine care is needed in geographically dispersed areas. Rajasthan, where anaemia remains strongly linked to women in the Poor wealth category and rural women, requires

continued priority to food security, women's nutrition, and reproductive health outreach. Overall, the findings suggest that state policy should follow distinct epidemiological profiles. Nutrition-focused interventions are needed in settings where deprivation-related conditions dominate. Stronger chronic disease screening is required where cardiometabolic risks are more pronounced. Long-term management of these conditions should also be prioritised.

The study also has limitations. Relevant factors such as diet, physical activity, healthcare access, and awareness of diagnosis are not fully observed, so omitted variable bias remains possible. Some outcomes are partly self-reported, which may introduce measurement error. Because the analysis is cross-sectional, the estimates should be interpreted as relationships rather than causal effects. Robustness checks based on alternative model specifications and subsample analyses produced similar substantive patterns.

5. Conclusion

This study shows that wealth-related inequality in major health conditions among reproductive-age women in North India is not uniform across diseases. Using NFHS-4 and NFHS-5 data for six states, the analysis finds that anaemia remains more closely linked to structural disadvantage, while diabetes, thyroid disorder, and high blood pressure are more concentrated among older women and women in the Middle and Rich wealth categories. These findings point to a differentiated epidemiological pattern in which deprivation-related and cardiometabolic conditions coexist across socioeconomic groups. The study also highlights that wealth-related health inequality is shaped by broader socioeconomic conditions, including education, social status, residence, and state context. From a policy perspective, this implies that women's health in North India cannot be addressed through a single undifferentiated NCD strategy: nutrition-sensitive and reproductive health interventions remain crucial for disadvantaged women, while chronic disease screening, early detection, and continuity of care need strengthening for conditions such as diabetes, thyroid disorder, and high blood pressure. Future research should examine temporal change, underdiagnosis, and clustering across conditions to better understand how social inequality is translated into women's health outcomes.

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Conflict of interest

The authors declare they have no competing interests.

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Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

The NFHS-4 and NFHS-5 datasets for India can be obtained from the following web link: <https://dhsprogram.com/data/available-datasets.cfm>

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Appendix

Table A1. Prevalence of anaemia across states by wealth category

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Age	15-29 years	42.1	44.3	41.0	52.2	51.8	50.0	48.9	49.5	45.4	54.8	56.2	54.8	52.1	54.1	50.8	55.4	59.7	56.0
	30-49 years	57.9	55.7	59.0	47.8	48.2	50.0	51.1	50.5	54.6	45.2	43.8	45.2	47.9	45.9	49.2	44.6	40.3	44.0
Sector	Urban	2.7	2.6	15.9	14.6	20.0	41.1	17.3	18.2	41.6	4.2	13.5	43.7	7.1	14.6	53.3	5.8	20.4	56.4
	Rural	97.3	97.4	84.1	85.4	80.0	58.9	82.7	81.8	58.4	95.8	86.5	56.3	92.9	85.4	46.7	94.2	79.6	43.6
Religion	Hindu	95.6	97.0	95.9	75.6	89.1	92.8	29.3	30.0	38.1	94.2	91.4	87.1	87.1	84.4	81.4	87.0	79.8	77.0
	Muslim	2.3	1.4	1.3	22.6	7.9	3.5	2.3	1.3	1.2	5.1	7.5	10.0	11.3	14.1	15.6	12.8	20.0	22.3
	Other ^a	2.1	1.6	2.8	1.8	3	3.7	68.4	68.7	60.7	0.7	1.1	2.9	1.6	1.5	3	0.2	0.2	0.7
Social status	Scheduled Caste	39.8	30.5	20.2	50.8	50.1	24.9	80.3	74.2	39.7	24.2	24.6	15.4	32.6	22.6	18.3	33.0	19.9	14.5
	Scheduled Tribe	8.6	5.7	4.2	1.2	0.9	0.5	0.4	0.4	0.4	32.9	9.3	4.6	7.2	6.0	4.4	2.0	1.0	0.7
	Other Backwards Classes	10.0	14.5	20.5	35.9	34.4	38.2	11.7	14.1	18.1	36.5	52.2	51.5	23.7	29.6	30.5	54.1	57.4	50.2
	Other	41.6	49.3	55.1	12.1	14.6	36.4	7.6	11.3	41.8	6.4	13.9	28.5	36.5	41.8	46.8	10.9	21.7	34.6
	1 to 5	67.5	67.8	64.5	53.7	56.7	52.5	67.7	61.2	59.4	47.7	47.6	44.9	56.0	55.2	56.1	43.0	38.7	40.2
	6 to 10	30.5	31.1	32.0	43.3	40.5	41.6	30.0	37.7	37.3	47.8	45.8	45.9	40.8	42.1	39.7	51.0	50.9	47.4
Household size	≥11	2	1.1	3.5	3	2.8	5.9	2.3	1.1	3.3	4.5	6.6	9.2	3.2	2.7	4.2	6	10.4	12.4
	No education	23.2	10.8	4.0	47.8	33.7	14.1	50.0	36.7	11.6	55.0	37.3	18.8	33.6	26.1	12.3	45.0	29.3	15.3
Education	Primary	19.7	14.1	7.1	16.3	17.4	9.6	14.3	18.0	8.7	14.1	15.1	11.3	17.3	14.2	9.1	13.7	12.1	8.4
	Secondary	53.6	66.0	61.7	33.5	45.0	55.8	34.4	43.3	59.0	28.2	40.8	47.9	44.8	50.5	47.7	36.3	46.6	47.6
	Higher	3.5	9.1	27.2	2.4	3.9	20.5	1.3	2.0	20.7	2.7	6.8	22.0	4.3	9.2	30.9	5.0	12.0	28.7
Marital status	Never Married	23.0	25.1	22.6	25.8	24.9	22.6	24.9	27.2	26.9	24.3	27.0	27.3	28.2	28.3	28.0	30.0	32.9	32.5
	Married	72.0	70.9	74.6	68.8	70.5	74.2	70.0	68.3	69.3	72.0	70.0	70.0	66.8	68.0	69.0	66.9	64.8	65.0
	Others ^b	5	4	2.8	5.4	4.6	3.2	5.1	4.5	3.8	3.7	3	2.7	5	3.7	3	3.1	2.3	2.5
	0	71.6	72.4	68.5	59.2	63.7	62.5	65.4	68.4	69.0	57.5	62.2	60.4	63.4	63.3	63.8	55.0	56.7	58.2
Children ≤ 5 years	1	17.6	17.2	21.3	20.6	18.6	21.5	18.6	18.5	20.9	21.5	19.7	23.2	20.2	20.0	22.6	23.2	22.5	23.4
	≥2	10.8	10.4	10.2	20.2	17.7	16	16	13.1	10.1	21	18.1	16.4	16.4	16.7	13.6	21.8	20.8	18.4

(Contd...)

Table A1. (Continued)

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Births last five years	0	78.1	79.8	78.1	68.6	72.6	74.5	72.9	76.1	78.8	69.4	74.2	75.4	73.4	73.7	75.8	68.0	71.8	74.4
	1	15.8	14.9	17.8	16.8	16.4	17.7	15.0	15.3	16.7	17.7	16.2	18.3	15.7	16.8	17.4	17.9	17.1	17.6
	≥2	6.1	5.3	4.1	14.6	11	7.8	12.1	8.6	4.5	12.9	9.6	6.3	10.9	9.5	6.8	14.1	11.1	8

Notes: Repeated 0% values indicate sparse "Yes" cases after weighting and should be interpreted as low-support estimates rather than absence of risk. Values of 100% reflect column-percentage normalization and strong sample concentration, rather than true universality, and should be interpreted cautiously, particularly in strata with limited effective sample size. ^aSikh, Christian, Buddhist, Jain, and other categories; ^bWidowed, divorced, and separated.

Table A2. Prevalence of diabetes across states by wealth category

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Age	15–29 years	12.2	28.1	11.2	35.1	15.1	18.5	5.5	15.9	7.1	29.6	26.1	14.9	14.7	18.3	11.5	29	24.6	13.9
	30–49 years	87.8	71.9	88.8	64.9	84.9	81.5	94.5	84.1	92.9	70.4	73.9	85.1	85.3	81.7	88.5	71	75.4	86.1
Sector	Urban	13.3	0	23.6	8.9	13.7	44	12.1	5.7	44.1	6.7	12.9	50.7	6.9	18.8	62.2	6.6	19.9	68.6
	Rural	86.7	100	76.4	91.1	86.3	56	87.9	94.3	55.9	93.3	87.1	49.3	93.1	81.2	37.8	93.4	80.1	31.4
Religion	Hindu	98.5	99.6	93.6	77.4	89.6	93.5	27.3	24.1	40.4	89.2	89.5	86.8	86.6	80.1	78.5	87.5	80.5	79.8
	Muslim	0	0	2.1	19.6	7.1	2.4	0	0	0.6	8.6	7.1	9.1	13.4	19.9	16.6	12.5	19.2	19.4
	Other ^a	1.5	0.4	4.3	3	3.3	4.1	72.7	75.9	59	2.2	3.4	4.1	0	0	4.9	0	0.3	0.8
Social status	Scheduled Caste	39.1	26.7	14.6	37	36.4	20.3	71.9	76.4	38.6	30.4	28.9	13.4	30.8	15.7	16.6	29.4	14	13.1
	Scheduled Tribe	1.8	5.1	3.7	3.5	1	1.2	0	0	0.1	20.4	10.6	5.1	5.8	10.5	2.2	2.4	1.7	0.3
	Other Backwards Classes	15	10.2	26.8	43.3	34.1	35	20.6	9.6	16.1	38.3	45.2	44.9	27.6	37.7	32.1	54.9	61.2	46
	Other	44.1	58	54.9	16.2	28.5	43.5	7.5	14	45.2	10.9	15.3	36.6	35.8	36.1	49.1	13.3	23.1	40.6
	Household size	76.5	69.7	72.5	64.6	62.8	56.8	69.8	69.8	70.2	64.8	47.2	58.7	57.4	59.8	61.4	48.8	51.3	50.9
Household size	6 to 10	23.5	30.3	23.3	31.9	35.1	39.1	27.2	25.9	27.2	30.7	45.7	36.2	37.8	32.5	33.4	45.7	41.6	40.4
	≥ 11	0	0	4.2	3.5	2.1	4.1	3	4.3	2.6	4.5	7.1	5.1	4.8	7.7	5.2	5.5	7.1	8.7

(Cont'd...)

Table A2. (Continued)

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Education	No education	36	20.1	6	50.4	44.2	17.3	84.1	38.2	20.2	69	54.2	33.2	60	45.6	18.1	55.8	39.5	23
	Primary	29.8	27	12.5	25.1	20.3	14.8	9.4	20.1	13.5	11.7	12.1	13.4	17.2	10.5	9	13.6	19.4	11.4
	Secondary	34.2	43.1	62.2	22.2	32.1	54.1	6.5	41.6	53.8	18	27.2	38.7	19	38.4	46.9	27.6	34.2	42.6
	Higher	0	9.8	19.3	2.3	3.4	13.8	0	0.1	12.5	1.3	6.5	14.7	3.8	5.5	26	3	6.9	23
Marital status	Never Married	7.2	9.9	6.3	7.4	7.1	4.4	1.7	9.1	3.7	4.6	7.8	6.9	11.6	10.6	5	12.6	9.7	6.1
	Married	78.2	82	84.7	84.9	82.9	88.4	82.9	80.8	88.8	89.5	91.2	89.3	82.6	80.9	85.8	82	87.5	87.7
	Others ^b	14.6	8.1	9	7.7	10	7.2	15.4	10.1	7.5	5.9	1	3.8	5.8	8.5	9.2	5.4	2.8	6.2
	0	85.9	80.2	74.8	70.5	69.2	71.4	65.4	77.1	78.7	71.1	63	74.3	77.1	73.4	73.9	63.6	70.6	72.4
Children ≤ 5 years	1	11	10.3	17.2	12.4	16.2	16.3	31.9	16.4	16.7	11.9	22.4	14.1	6.9	13.5	14.3	19.7	19.9	17.5
	≥ 2	3.1	9.5	8	17.1	14.6	12.3	2.7	6.5	4.6	17	14.6	11.6	16	13.1	11.8	16.7	9.5	10.1
	0	96.9	80.8	94.3	74.4	85.9	86.4	84.9	86.7	92.4	77.9	84.5	92.3	84.8	90.8	89.9	77.2	84.8	89.9
Births last five years	1	0	16.3	3.6	8.5	7	9.9	14.1	10.2	6.8	13.1	10.5	5.6	7.3	6.5	8.5	14.4	12.2	7.6
	≥ 2	3.1	2.9	2.1	17.1	7.1	3.7	1	3.1	0.8	9	5	2.1	7.9	2.7	1.6	8.4	3	2.5

Notes: Repeated 0% values indicate sparse "Yes" cases after weighting and should be interpreted as low-support estimates rather than absence of risk. Values of 100% reflect column-percentage normalization and strong sample concentration, rather than true universality, and should be interpreted cautiously, particularly in strata with limited effective sample size. ^aSikh, Christian, Buddhist, Jain, and other categories; ^bWidowed, divorced, and separated.

Table A3. Prevalence of thyroid disorder across states by wealth category

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Age	15–29 years	17.3	20.8	15.7	43.9	31.7	21.7	13.9	28.6	18.4	24.1	26.1	23.7	35.6	26.9	18	28.6	21.4	22.4
	30–49 years	82.7	79.2	84.3	56.1	68.3	78.3	86.1	71.4	81.6	75.9	73.9	76.3	64.4	73.1	82	71.4	78.6	77.6
Sector	Urban	9.7	0.9	27	19.3	18.9	47	11.4	29.1	51.6	13.3	24.8	65.2	5.2	18.2	62.3	6.2	25.8	71.2
	Rural	90.3	99.1	73	80.7	81.1	53	88.6	70.9	48.4	86.7	75.2	34.8	94.8	81.8	37.7	93.8	74.2	28.8
Religion	Hindu	94.9	97.7	92.1	65	87.6	92.3	9.7	18.8	41.3	92.1	91.2	88.7	93.4	86.2	83.4	86.8	75.3	82.6
	Muslim	4.3	1.5	3.2	33.7	10.4	2.3	0	1.1	0.5	5.8	7.3	8.3	6.6	9.4	12.5	12.9	24.7	16.3
	Other ^a	0.8	0.8	4.7	1.3	2	5.4	90.3	80.1	58.2	2.1	1.5	3	0	4.4	4.1	0.3	0	1.1

(Cont'd...)

Table A3. (Continued)

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Social status	Scheduled Caste	57.8	34.2	21	50.8	47.9	19.3	92.3	72.4	30.9	29.4	22.7	11.9	52.5	20.5	16.7	32	14.4	16
	Scheduled Tribe	3.8	8.6	4.9	1.6	1	0.6	0	0	0.5	12	6.9	4.2	3.3	9.6	1.2	1.3	1.1	0.2
	Other																		
	Backwards Classes	2.1	15.4	15.4	42.2	33.7	33.1	1.7	11.6	19	47.3	49.7	45.9	16.4	41.1	26.4	52.2	53.3	38.8
	Other	36.3	41.8	58.7	5.4	17.4	47	6.0	16	49.6	11.3	20.7	38	27.8	28.8	55.7	14.5	31.2	45
Household size	1 to 5	82.4	78.2	78.9	55.4	62.4	64.8	65.3	74.3	60.8	56.1	59.5	59	54.4	68.9	64.9	48.7	53.8	53.4
	6 to 10	15.9	21.7	17.9	44.6	34.8	32.1	34.7	22.2	35.2	41.6	36.4	35.6	42.4	20.8	30.5	46.7	39.5	38.1
	≥ 11	1.7	0.1	3.2	0	2.8	3.1	0	3.5	4	2.3	4.1	5.4	3.2	10.3	4.6	4.6	6.7	8.5
Education	No education	18.2	10.8	4.2	60.3	36	13.6	64.2	44	9.8	54.8	42.3	17.9	29.8	37.5	8.9	53.7	29.7	12.6
	Primary	13.1	11.2	6.5	13.4	19.9	13.4	10.8	22	7.5	19.7	26.9	12.7	21	13.7	12.3	12	19.2	7.6
	Secondary	62.9	74.1	62.5	24.2	42.2	53.5	25	31.3	57.7	20.6	24	45.5	45.3	42	45.5	28.3	41.4	42.2
	Higher	5.8	3.9	26.8	2.1	1.9	19.5	0	2.7	25	4.9	6.8	23.9	3.9	6.8	33.3	6	9.7	37.6
Marital status	Never Married	12.2	4.7	4.7	19.1	9.4	5.9	6.6	5.4	6.8	6.6	6.1	9	19.1	18.5	4.5	12.7	8.9	7.9
	Married	85.9	86.8	92.5	72	86	88.9	75.6	91.8	88.5	82.5	90.3	87.6	75.2	74.4	91.2	82.1	87.5	88.6
	Others ^b	1.9	8.5	2.8	8.9	4.6	5.2	17.8	2.8	4.7	10.9	3.6	3.4	5.7	7.1	4.3	5.2	3.6	3.5
Children ≤ 5 years	0	72.9	73	74	67.5	72.2	74	82.8	76.8	69.5	77.3	70.9	69.3	80.4	81.8	75.8	62.6	66.5	64
	1	23.7	20.1	21	14.1	16.6	17	10	15.1	22.3	13	17.5	22.3	7.4	5.4	17	23.1	24.2	22.2
	≥ 2	3.4	6.9	5	18.4	11.2	9	7.2	8.1	8.2	9.7	11.6	8.4	12.2	12.8	7.2	14.3	9.3	13.8
Births last five years	0	75.1	84.8	78.4	75.7	82.6	84.5	87.7	86.5	80.5	82.4	83.8	84.6	83.7	90.3	85.9	77	79.6	78.3
	1	24.9	12.9	19.6	9.9	13.3	11.6	12.3	11.7	16.6	10.4	11.2	13.4	16.3	5.1	11.4	14.4	17.7	16.4
	≥ 2	0	2.3	2	14.4	4.1	3.9	0	1.8	2.9	7.2	5	2	0	4.6	2.7	8.6	2.7	5.3

Notes: Repeated 0% values indicate sparse "Yes" cases after weighting and should be interpreted as low-support estimates rather than absence of risk. Values of 100% reflect column-percentage normalization and strong sample concentration, rather than true universality, and should be interpreted cautiously, particularly in strata with limited effective sample size. ^aSikh, Christian, Buddhist, Jain, and other categories; ^bWidowed, divorced, and separated.

Table A4. Prevalence of high blood pressure across states by wealth category

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Age	15-29 years	27.2	20.9	21.1	39.5	36.1	37.1	27.4	25.1	19.6	35.2	32	26.8	32	31.7	23.7	35.1	36.3	31
	30-49 years	72.8	79.1	78.9	60.5	63.9	62.9	72.6	74.9	80.4	64.8	68	73.2	68	68.3	76.3	64.9	63.7	69
Sector	Urban	2	1.3	17	21.9	29.7	45.9	17.2	18.6	36.3	5.4	14.8	49.6	8.5	20.1	53.2	5.4	21.2	55.3
	Rural	98	98.7	83	78.1	70.3	54.1	82.8	81.4	63.7	94.6	85.2	50.4	91.5	79.9	46.8	94.6	78.8	44.7
Religion	Hindu	95.9	96.7	93.9	78.5	90.8	93.6	24.7	25.2	31.8	92.3	89.9	83.7	74.8	80.7	80.9	84.9	79.4	77.5
	Muslim	2.7	1.6	1.6	20	7.1	3.6	0.9	2.8	1	5.5	5.8	10.2	23.3	18.3	15.7	14.9	20.5	21.5
	Other ^a	1.4	1.7	4.5	1.5	2.1	2.8	74.4	72	67.2	2.2	4.3	6.1	1.9	1	3.4	0.2	0.1	1
Social status	Scheduled Caste	40.6	27.9	22.2	50.7	47	22.1	82.7	77.4	38.3	31.2	25.6	14.1	29.1	27	16.7	30.3	18.3	11.9
	Scheduled Tribe	6.2	4.5	2.2	1.1	0.2	0.3	0.9	0.5	0.4	18	6.4	3.4	6.9	6.4	3.9	2.1	1.6	0.8
	Other Backwards Classes	9.7	9.7	18.5	33.9	38	40.9	7.8	11.9	16.1	41.4	54.6	52.7	34.4	33.6	31.8	54.1	56.4	48.4
	Other	43.5	57.9	57.1	14.3	14.8	36.7	8.6	10.2	45.2	9.4	13.4	29.8	29.6	33	47.6	13.5	23.7	38.9
	1 to 5	76.3	71.9	69	61.1	62.7	55.2	78.1	64.5	63	54.9	53.5	50.2	55.2	56.7	60.8	47.1	44.6	45.4
	6 to 10	21.3	26.9	28	36.7	35.4	39.7	20.4	33.4	34.2	40.3	40.2	42.9	43.1	41.7	33.5	47.3	46.4	44.1
Household size	≥ 11	2.4	1.2	3	2.2	1.9	5.1	1.5	2.1	2.8	4.8	6.3	6.9	1.7	1.6	5.7	5.6	9	10.5
	No education	31.7	15	8	54.9	44.1	18	61	52.8	16.9	66.7	48	24.9	51.2	45.7	21	53.2	36.7	19.4
	Primary	20.4	20	11.7	16.2	18.4	11.5	15.7	19.4	12.6	14.4	18.1	15.6	20.4	13.7	10.4	14.9	13	9.1
	Secondary	46.7	61.7	61.9	26.6	36.2	54.3	22.4	26.6	56.3	16.7	28.4	39.9	26.7	35.6	42.1	26.8	38.7	43.5
Education	Higher	1.2	3.3	18.4	2.3	1.3	16.2	0.9	1.2	14.2	2.2	5.5	19.6	1.7	5	26.5	5.1	11.6	28.0
	Never Married	4.3	6.7	6.2	14	10.4	11.2	6.8	7.1	6.9	6.2	6.6	6.5	9.2	7.6	9.4	9.6	11.4	10.7
	Married	88.5	86.7	88.5	78.7	83.4	84.4	85	85.4	87	87.9	88.6	89.4	83.2	84.9	85.1	86.5	85.1	85.8
	Others ^b	7.2	6.6	5.3	7.3	6.2	4.4	8.2	7.5	6.1	5.9	4.8	4.1	7.6	7.5	5.5	3.9	3.5	3.5
Marital status	0	72.2	72	68.6	64.2	63.7	63.5	68.5	73.3	74.2	60	63.1	63.8	66.6	63.6	69.1	53.8	58	59.7
	1	19.5	14.7	21.5	20.5	21.8	19.9	19.7	15.9	18.9	20.3	20.9	23.3	18.3	20.3	20.8	25.4	23.5	24.3
	≥ 2	8.3	13.3	9.9	15.3	14.5	16.6	11.8	10.8	6.9	19.7	16	12.9	15.1	16.1	10.1	20.8	18.5	16
(Cont'd...)																			

Table A4. (Continued)

Background characteristic	Category	Himachal Pradesh			Haryana			Punjab			Rajasthan			Uttarakhand			Uttar Pradesh		
		Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
Births last five years	0	76.2	81.5	79.2	73.7	71.9	75.8	78.7	80.6	84.4	69.1	74.8	78.8	73.9	72.8	82.1	65.8	71	75
	1	18.8	11.8	16.7	15.7	18.8	17	12.6	14	13.1	18.6	15.7	16.6	15.1	16.3	14.5	20.6	19	18.3
	≥ 2	5	6.7	4.1	10.6	9.3	7.2	8.7	5.4	2.5	12.3	9.5	4.6	11	10.9	3.4	13.6	10	6.7

Notes: Repeated 0% values indicate sparse "Yes" cases after weighting and should be interpreted as low-support estimates rather than absence of risk. Values of 100% reflect column-percentage normalization and strong sample concentration, rather than true universality, and should be interpreted cautiously, particularly in strata with limited effective sample size. ^aSikh, Christian, Buddhist, Jain, and other categories; ^bWidowed, divorced, and separated.

Table A5. Marginal effects for the probability of major non-communicable diseases among women aged 15–49 years

Background Characteristics		Anaemia	Diabetes	Thyroid	High blood pressure
Age groups	15–29 (Ref.)				
	30–49	–0.0134*** (0.0030)	0.0097*** (0.0005)	0.0118*** (0.0007)	0.0329*** (0.0015)
Household size	1–5 (Ref.)				
	6–10	0.0055** (0.0023)	–0.0016*** (0.0005)	–0.0027*** (0.0006)	–0.0056*** (0.0013)
	≥11	0.0038 (0.0051)	–0.0027*** (0.0010)	–0.0039*** (0.0011)	–0.0109*** (0.0028)
Sector	Urban (Ref.)				
	Rural	0.0001 (0.0038)	–0.0031*** (0.0007)	–0.0069*** (0.0007)	–0.0013 (0.0026)
Religion	(Hindu) Ref.				
	Muslim	–0.0044 (0.0045)	0.0002 (0.0008)	0.0011 (0.0011)	0.0124*** (0.0030)
	Others ^a	–0.0055 (0.0070)	0.0009 (0.0010)	0.0020* (0.0011)	0.0271*** (0.0042)
Social status	Scheduled Caste (Ref.)				
	Scheduled Tribe	0.0860*** (0.0071)	0.0005 (0.0015)	–0.0040*** (0.0015)	–0.0144*** (0.0039)
	Other Backwards Classes	–0.0146*** (0.0031)	–0.0001 (0.0007)	–0.0023*** (0.0008)	–0.0006 (0.0020)
	Others	–0.0158*** (0.0036)	0.0013* (0.0007)	0.0007 (0.0008)	0.0022 (0.0022)
Marital status	Never married (Ref.)				
	Married	–0.0303*** (0.0034)	0.0092*** (0.0005)	0.0126*** (0.0006)	0.0674*** (0.0015)
	Others ^b	–0.0045 (0.0065)	0.0114*** (0.0013)	0.0118*** (0.0015)	0.0720*** (0.0035)
Education	No education (Ref.)				
	Primary	–0.0085** (0.0035)	0.0015* (0.0008)	0.0040*** (0.0008)	0.0063*** (0.0018)
	Secondary	–0.0112*** (0.0029)	0.0011* (0.0006)	0.0069*** (0.0006)	0.0063*** (0.0016)
	Higher	–0.0468*** (0.0041)	–0.0006 (0.0008)	0.0121*** (0.0010)	0.0081*** (0.0025)
Wealth index	Poor (Ref.)				
	Middle	0.0108*** (0.0031)	0.0014** (0.0006)	0.0049*** (0.0007)	0.0198*** (0.0019)
	Rich	–0.0034 (0.0033)	0.0073*** (0.0007)	0.0112*** (0.0007)	0.0286*** (0.0021)
State	Haryana (Ref.)				
	Himachal Pradesh	–0.0835*** (0.0094)	0.0015 (0.0011)	0.0053*** (0.0015)	–0.0658*** (0.0061)
	Punjab	–0.0503*** (0.0076)	0.0022** (0.0010)	0.0005 (0.0012)	–0.0507*** (0.0063)
	Rajasthan	–0.1262*** (0.0051)	–0.0020** (0.0008)	–0.0041*** (0.0010)	–0.0831*** (0.0059)
	Uttar Pradesh	–0.1123*** (0.0045)	0.0026*** (0.0008)	–0.0021** (0.0009)	–0.0569*** (0.0059)
	Uttarakhand	–0.1841*** (0.0065)	0.0010 (0.0011)	–0.0014 (0.0013)	–0.0715*** (0.0061)
Children ≤ 5 years	0 (Ref.)				
	1	–0.0019 (0.0032)	0.0003 (0.0007)	0.0007 (0.0008)	0.0028 (0.0018)
	≥2	0.0048 (0.0041)	0.0028** (0.0011)	0.0003 (0.0012)	0.0027 (0.0024)
Births last five years	0 (Ref.)				
	1	0.0469*** (0.0037)	–0.0075*** (0.0006)	–0.0044*** (0.0008)	–0.0099*** (0.0018)
	≥2	0.0842*** (0.0048)	–0.0083*** (0.0008)	–0.0064*** (0.0011)	–0.0099*** (0.0026)

Notes: Significance level: * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$. Ref. indicates the reference category. ^aSikh, Christian, Buddhist, Jain, and other categories;

^bWidowed, divorced, and separated.