

## REPORT

## Exploring the nexus between sociodemographic factors and hypertension, awareness, and treatment utilization among women in India

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## Abstract

Hypertension is one of the leading non-communicable diseases (NCDs) in India. It is influenced by elevated blood sugar levels, higher body mass index (BMI), and various sociodemographic factors. This chronic condition poses a significant global health burden and adversely affects women's health and treatment outcomes. Consistent with these facts, we aimed to investigate the crucial determinants of hypertension as well as patterns of awareness and treatment utilization among women in India. We used data from the fifth round of the National Family Health Survey, including 661,958 women aged 15–49 years. Descriptive statistics, a Chi-squared test, and a multivariable logistic regression model were employed to explore the associations and determinants of hypertension, awareness, and treatment utilization among women. The study found that the overall prevalence of hypertension, awareness, and treatment was 11.04%, 7.31%, and 2.82%, respectively. Moreover, older women (odds ratio [OR]: 5.90;  $p < 0.005$ ), women with lower levels of education (OR: 1.37;  $p < 0.005$ ), those belonging to Scheduled Tribes (OR: 1.23;  $p < 0.005$ ), women with higher BMI (OR: 2.56;  $p < 0.005$ ), women with diabetes (OR: 2.25;  $p < 0.005$ ), and women who smoked (OR: 1.15;  $p < 0.005$ ) had significantly higher odds of hypertension. In contrast, awareness and treatment of hypertension were less likely among women with lower education, those belonging to Scheduled Tribes, those residing in eastern and northeastern districts, and those who smoked. This study underscores the crucial determinants of hypertensive prevalence and of lower awareness and treatment utilization among women in India. Given these identified risk factors and vulnerabilities, targeted interventions such as tobacco control, diabetes management, women's health education, community-based group formation, identification of vulnerable regions, outreach initiatives, and awareness campaigns need to be prioritized by policymakers and public health practitioners to reduce the NCD burden and improve awareness and treatment accessibility in India.

**Keywords:** Hypertension; Awareness; Treatment; Scheduled Tribes; Women; India**\*Corresponding author:**Mriganka Dolui  
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## 1. Introduction

Hypertension is a major non-communicable disease (NCD) and a leading global risk factor to health worldwide, as identified by the World Health Organization (WHO) (Ezzati *et al.*, 2002). Approximately four out of every five people with

hypertension are not receiving adequate treatment; however, if countries can scale up coverage, 76 million deaths could be averted between 2023 and 2050 (WHO, 2023). Hypertension can be effectively controlled with simple, low-cost medication regimens, yet only about one in five people with hypertension has their condition under control. Hypertension substantially contributes to disability-adjusted life years related to cardiovascular diseases, exceeding the contribution of other metabolic risk factors, such as elevated total cholesterol, increased fasting blood sugar levels, and high body mass index (BMI), and is a major cause of cardiovascular mortality (Ezzati *et al.*, 2002). This condition arises when the pressure within blood vessels becomes excessively elevated (Abarca-Gómez *et al.*, 2017). In recent years, the prevalence of hypertension has risen, contributing to a substantial disease burden among women globally and in India (Anchala *et al.*, 2014). The adverse effects of hypertension can be intensified by other factors that significantly increase the risk of cardiovascular disease, such as tobacco use, unhealthy diet, alcohol consumption, physical inactivity, chronic stress, elevated BMI and cholesterol levels, and diabetes (WHO, 2015).

India presents a unique setting for studying the determinants of hypertension, awareness, and treatment utilization among women, owing to its diverse population and complex healthcare landscape. A prior study reported an increasing prevalence of hypertension among adult women, which rose significantly with age and body weight (Bhimarasetty *et al.*, 2022). Another study showed that a higher proportion of younger women fell into the pre-hypertensive category, with only a small proportion diagnosed with hypertension and merely 1% currently on medication (International Classification of Functioning, Disability and Health [ICF] & International Institute for Population Sciences [IIPS], 2021). India has taken initiatives to tackle hypertension at the population level by introducing a screening program for hypertension and diabetes. In 2013, the Indian government implemented a national action plan aimed at preventing and controlling NCDs, setting an ambitious goal to decrease the prevalence of hypertension (Ministry of Health and Family Welfare [MoHFW], 2017). An observational study revealed that blood pressure control among patients in public health facilities increased from 26% at registration in the “India Hypertension Control Initiative” to 60% during the follow-up period (Kaur *et al.*, 2021). Simultaneously, efforts have been made to strengthen primary and secondary healthcare facilities and monitoring systems (MoHFW, 2017). The fifth round of the National Family Health Survey (NFHS-5; 2019–2021) reported a significant increase in mean diastolic blood pressure among males

aged 16–17 years and females aged 11–12 and 17–18 years in India (ICF & IIPS, 2021). This finding highlights the importance of including regular blood pressure evaluations in standard health check-ups of adolescents, enabling the earliest possible introduction of secondary prevention measures (Saha *et al.*, 2008).

In India, hypertension is one of the leading NCDs that adversely affect women’s health (Gupta, 2004). Recent estimates suggest that nearly 21% of adult women (aged 15–49 years) in the country suffer from hypertension (ICF & IIPS, 2021). The literature further substantiates a high prevalence of hypertension among adolescents, with links to BMI and a family history of NCDs (Daniel *et al.*, 2022). Similarly, among young adults, one in every nine individuals has high blood pressure, underscoring the pivotal role of age as a determinant in hypertension (Geevar *et al.*, 2022). In this context, there is a recommendation to screen for psychological distress among high-risk hypertensive patients, particularly focusing on those who struggle to attain adequate blood pressure control or have apprehensions about potential complications associated with hypertension. It has been observed that 25% of hypertensive cases exhibit signs of psychological distress, including symptoms associated with depression, anxiety, or stress (Loke & Ching, 2022). Individual habits also play an important role in the development of hypertension; smoking, smokeless tobacco use, and alcohol consumption are significant risk factors among women (Mishra *et al.*, 2022). Findings from previous studies also highlight the importance of maternal socioeconomic and lifestyle factors responsible for the occurrence of hypertension among women in India (Boro & Banerjee, 2022; Mishra *et al.*, 2022). Despite substantial policy initiatives and intervention strategies for hypertension management (MoHFW, 2017), the prevalence of hypertension remains high among women in India, although lower than that in men (Rao Guthi *et al.*, 2024), and is accompanied by lower levels of awareness and treatment utilization compared to men. Therefore, using the most recent available dataset (NFHS-5; 2019–2021), the objective of this study was to investigate the associations and determinants of hypertension, awareness, and treatment utilization among women in India.

## 2. Data and methods

### 2.1. Data source

The study used data from the NFHS-5, which was conducted by the IIPS under the supervision of the MoHFW, Government of India (ICF & IIPS, 2021). The NFHS-5 collected information through a two-stage stratified sampling procedure. The primary sampling

units (PSUs) were defined as villages in rural areas and Census Enumeration Blocks in urban areas. Furthermore, a probability-proportional-to-size (PPS) sampling procedure was employed for the selection of final PSUs (ICF & IIPS, 2021). In the first phase, selected PSUs with a minimum of 300 households were segmented into units of 100–150 households, and two segments were randomly selected using PPS. In the second phase, 22 households were randomly selected through systematic sampling from each rural and urban cluster. Details of the design effect calculation have been published elsewhere (ICF & IIPS, 2021). The survey consisted of four survey questionnaires: the household questionnaire, women's questionnaire, men's questionnaire, and biomarker questionnaire (ICF & IIPS, 2021).

The NFHS-5 collected extensive information from 636,699 households, 101,839 men aged 15–54, and 724,115 eligible women aged 15–49. The dataset covers a wide variety of information regarding population, family planning, child and maternal health, and nutritional status in India, even at the district level. For the present study, a total of 661,958 women aged 15–49 years were included after excluding observations with missing data in key demographic and socioeconomic variables. Detailed information on data collection methodology, sampling frame, survey design, and data collection procedures has been published elsewhere (ICF & IIPS, 2021).

## 2.2. Outcome variables

The outcome variables of the study were the prevalence of hypertension, awareness of hypertension, and treatment utilization among women with hypertension in India. The prevalence of hypertension was assessed as a binary indicator (no=0, and yes=1). A woman was considered hypertensive if she met any of the following three conditions: (i) she was currently taking prescribed medicine to lower blood pressure, (ii) she had an average systolic blood pressure  $\geq 140$  mmHg, or (iii) she had an average diastolic blood pressure  $\geq 90$  mmHg during the survey (Dolui & Sarkar, 2025a; Whitworth, 2003).

Awareness of hypertension among women was determined based on whether respondents answered “yes” to the question about whether they had been told on two or more occasions by a doctor or other health professional that they had hypertension or high blood pressure. Similar definitions have been used in previous studies (Busingye *et al.*, 2017; Grover *et al.*, 2022; Mirzaei *et al.*, 2020; Mohanty *et al.*, 2021; Pires *et al.*, 2013). Meanwhile, treatment utilization was defined as whether the woman was currently taking prescribed medicine to lower blood pressure (Grover *et al.*, 2022; Mirzaei *et al.*, 2020).

## 2.3. Explanatory variables

Based on previous literature, we considered a set of explanatory variables that are potentially associated with the outcome variables (Boro & Banerjee, 2022; Dolui, 2024; Dolui & Sarkar, 2025a; Grover *et al.*, 2022; Mirzaei *et al.*, 2020; Rauniyar *et al.*, 2020). The variables include age of women (15–24 years, 25–34 years, 35–44 years, and 45–49 years); education (no education, primary, secondary, and higher); marital status (unmarried, married, and other); religion (Hindu, Muslim, and others); caste (Scheduled Castes, Scheduled Tribes, Other Backward Classes, and general castes); wealth index (poorest, poorer, middle, richer, and richest); region (north, central, east, northeast, west, and south); place of residence (urban and rural); BMI (underweight, normal, and overweight); diabetes status (no and yes); type of cooking fuel (clean fuel and polluting fuel); smoking status (no and yes); and use of smokeless tobacco (no and yes).

## 2.4. Statistical analysis

Descriptive statistics were used for preliminary analyses to describe the sample distribution and the prevalence of hypertension, awareness, and treatment utilization. Intergroup inequality in the prevalence of hypertension, awareness, and treatment utilization was assessed by calculating pairwise differences between the prevalence of each indicator, yielding the “hypertension–awareness (H–A) gap,” “hypertension–treatment (H–T) gap,” and “awareness–treatment (A–T) gap” among women. We used the “svyset” command for all analyses to adjust for the complex survey design, including sampling weights and design effects. To test the statistical independence between the outcome and explanatory variables, Pearson's Chi-squared test and the Rao–Scott correction test statistic were applied. Pearson's Chi-squared test provides the unadjusted test statistic for independence; to account for the survey design, this statistic was converted into an *F* statistic to obtain the Rao–Scott adjusted test statistic (Stata Corp, 2021).

Next, maps were generated at the state and district levels to show the geographic distribution of hypertension, awareness, and treatment utilization. Furthermore, to identify the factors associated with hypertension, awareness, and treatment utilization, multivariable binary logistic regression models were fitted, and the regression results were expressed as adjusted odds ratios (ORs) with 95% confidence intervals (95% CIs). Before fitting the models, we assessed multicollinearity among the independent variables using variance inflation factors (VIFs) to ensure that multicollinearity was not a concern. The VIF results were all below 5 (maximum VIF = 2.06).

and minimum VIF = 1.10). All statistical analyses were conducted using STATA version 17.0 (StataCorp, United States of America), and spatial analyses were performed using ArcGIS version 10.8.2 (ESRI, 2011; United States of America).

## 3. Results

Table 1 provides an overview of the demographic and socioeconomic profile of women in India. A large proportion of the women fall within the 15–24-year age group (33.09%) compared to other age groups. Regarding education, a higher proportion of women have a secondary education than other levels. More than three-fourths of women identified as Hindu, and a similar proportion belonged to the Other Backward Classes. In addition, 26.28% of the total study population resides in the Central region, with more than two-thirds living in rural areas. In terms of BMI, 21.99% were overweight, while 18.07% were underweight. Moreover, 2.32% had diabetes, and 49.64% used polluting cooking fuel. Regarding behavioral risk factors, 6.29% were smokers, and 4.56% reported using smokeless tobacco.

Table 2 presents the prevalence of hypertension, awareness, and treatment among women in India across different demographic and socioeconomic characteristics. The overall prevalence of hypertension, awareness, and treatment utilization among women was 11.04%, 7.31%, and 2.82%, respectively (Figure 1). The prevalence of hypertension was highest among women aged 45–49 years age group (26.84%). It was also higher among women with no education (15.76%), those belonging to other religions (13.87%), and those from general castes (11.86%). Hypertension was consistently more prevalent in urban areas (12.13%) and in the southern region (12.42%). Notably, overweight women and those with diabetes had hypertension prevalence levels of 20.55% and 33.87%, respectively. Furthermore, women who smoked or used smokeless tobacco also exhibited higher hypertension prevalence, at 15.97% and 15.84%, respectively.

Awareness of hypertension was higher among women aged 45–49 years (14.06%). Women with lower educational status and those belonging to other religions or general castes had higher levels of awareness—8.99%, 9.65%, and 8.18%, respectively. Awareness was also higher among women from the richest wealth quintile (8.48%) and those residing in urban areas (7.59%). Similarly, women with higher BMI (overweight) and diabetes showed greater awareness of hypertension, at 12.26% and 22.01%, respectively. Awareness was also higher among women who smoked (8.06%) and those who used smokeless tobacco (8.53%).

**Table 1. Demographic and socioeconomic characteristics of women in India**

| Background characteristics | Sample |          |
|----------------------------|--------|----------|
|                            | %      | <i>n</i> |
| Age (year)                 |        |          |
| 15–24                      | 33.09  | 219,064  |
| 25–34                      | 30.33  | 200,766  |
| 35–44                      | 24.9   | 164,816  |
| 45–49                      | 11.68  | 77,312   |
| Education                  |        |          |
| No education               | 23.33  | 154,419  |
| Primary                    | 11.78  | 77,946   |
| Secondary                  | 50.94  | 337,220  |
| Higher                     | 13.95  | 92,373   |
| Marital status             |        |          |
| Unmarried                  | 24.73  | 163,673  |
| Married                    | 71.04  | 470,283  |
| Others                     | 4.23   | 28,002   |
| Religion                   |        |          |
| Hindu                      | 77.47  | 512,829  |
| Muslim                     | 10.12  | 66,963   |
| Others                     | 12.41  | 82,166   |
| Caste                      |        |          |
| Scheduled castes           | 20.42  | 135,144  |
| Scheduled tribes           | 20.00  | 132,386  |
| OBC                        | 40.33  | 266,940  |
| General                    | 19.26  | 127,488  |
| Wealth index               |        |          |
| Poorest                    | 20.65  | 136,673  |
| Poorer                     | 22.24  | 147,191  |
| Middle                     | 21.16  | 140,100  |
| Richer                     | 19.33  | 127,977  |
| Richest                    | 16.62  | 110,017  |
| Regions                    |        |          |
| North                      | 20.12  | 133,195  |
| Central                    | 26.28  | 173,993  |
| East                       | 14.36  | 95,026   |
| Northeast                  | 13.26  | 87,766   |
| West                       | 9.76   | 64,634   |
| South                      | 16.22  | 107,344  |
| Residence                  |        |          |
| Urban                      | 24.17  | 159,973  |
| Rural                      | 75.83  | 501,985  |
| BMI                        |        |          |
| Underweight                | 18.07  | 119,622  |

(Cont'd)



Table 1. (Continued)

| Background characteristics | Sample |          |
|----------------------------|--------|----------|
|                            | %      | <i>n</i> |
| Normal                     | 59.94  | 396,759  |
| Overweight                 | 21.99  | 145,577  |
| Diabetes                   |        |          |
| No                         | 97.68  | 646,614  |
| Yes                        | 2.32   | 15,344   |
| Type of cooking fuel used  |        |          |
| Clean fuel                 | 50.36  | 333,378  |
| Polluting fuel             | 49.64  | 328,580  |
| Smoker                     |        |          |
| No                         | 93.71  | 620,311  |
| Yes                        | 6.29   | 41,647   |
| Uses of smokeless tobacco  |        |          |
| No                         | 95.44  | 631,775  |
| Yes                        | 4.56   | 30,183   |
| Total                      | 100    | 661,958  |

Abbreviations: BMI: Body mass index; OBC: Other Backward Classes.

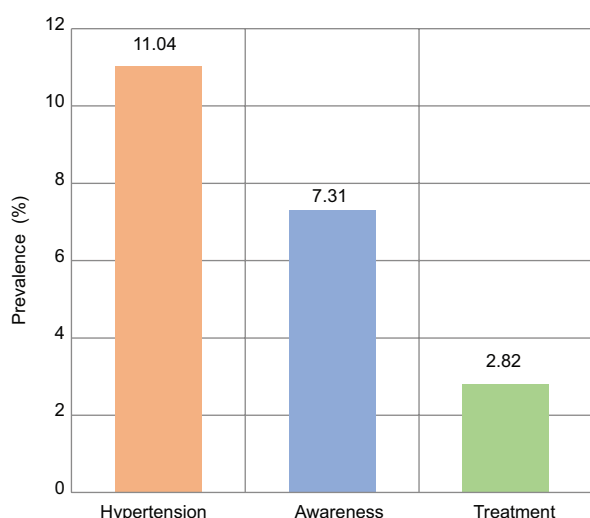


Figure 1. Status of hypertension, awareness, and treatment among women in India, 2019–2021

Treatment utilization was higher among women aged 45–49 years and among those with no or primary education. Women belonging to other religions (3.67%), general castes (3.47%), and the richest wealth quintile (3.67%) had higher rates of hypertension treatment. Women residing in urban areas (3.38%) and those with higher BMI (5.69%) also showed higher treatment rates. Moreover, women with diabetes (14.47%), smoking habits (3.45%), and smokeless tobacco consumption (3.78%) had higher treatment utilization.

Figure 2 shows intergroup differences in hypertension, awareness, and treatment among women in India. A significant gap was observed between H–A, H–T, and A–T. The results show a 3.73% gap between H–A, an 8.22% gap between H–T, and a 4.49% gap between A–T among women in India.

Figure 3 illustrates the prevalence of hypertension across various states and union territories in India. The overall prevalence of hypertension in the country stands at 11.04%. However, the highest prevalence of hypertension is observed in Sikkim (22.91%), followed by Arunachal Pradesh (18.07%) and Punjab (17.98%), while prevalence tends to be the lowest in Dadra & Nagar Haveli and Daman & Diu (7.72%).

Figure 4 illustrates the spatial distribution of the prevalence, awareness, and treatment utilization among women across the states and districts of India. Higher prevalence of hypertension (Figure 4A) was found in the northeastern states (Arunachal Pradesh, Sikkim, Mizoram, Meghalaya) and northern states (Punjab, Uttarakhand, Delhi), whereas lower rates were found in western (Gujarat) and central (Uttar Pradesh and Madhya Pradesh) regions at both state and district levels. District-level variations reveal that the central and southern regions of the country have moderate to high prevalence of hypertension among women, with some northeastern districts also showing high rates (Figure 4B). The awareness of hypertension varies significantly across states. Punjab and Sikkim display higher awareness levels, whereas states like Uttar Pradesh, Bihar, and Jharkhand have moderate levels (Figure 4C). At the district level, southern and northern regions generally report better awareness, while some districts in the north and northeast lag behind (Figure 4D). For treatment utilization (Figure 4E and F), Goa, Meghalaya, and Sikkim states show better coverage, with more women receiving treatment. In contrast, states like Rajasthan, Madhya Pradesh, Uttar Pradesh, Chhattisgarh, and Jharkhand exhibit lower treatment levels (Figure 4E). The district-level map reflects a similar trend, with southern and northern districts performing better in terms of treatment, while central and western regions remain underserved (Figure 4F).

Table 3 presents the associations and determinants of hypertension (Model 1), awareness (Model 2), and treatment (Model 3) among women using a multivariable binary logistic regression model. The results are represented by adjusted ORs with controlled explanatory variables. In Model 1, it was found that women aged 45–49 years were nearly six times more likely to have hypertension (OR: 5.90; 95% CI: 5.60–6.21) compared to those in the younger age group, and as age increased, the likelihood of hypertension

**Table 2. Prevalence of hypertension, awareness, and treatment across different sociodemographic characteristics of women in India**

| Background characteristics | Hypertension ( <i>n</i> =74,912) |                                |           | Awareness ( <i>n</i> =43,019) |                                |           | Treatment ( <i>n</i> =17,935) |                                |           | <i>N</i> =661,958 |
|----------------------------|----------------------------------|--------------------------------|-----------|-------------------------------|--------------------------------|-----------|-------------------------------|--------------------------------|-----------|-------------------|
|                            | %                                | $\chi^2$<br>( <i>p</i> -value) | Rao-Scott | %                             | $\chi^2$<br>( <i>p</i> -value) | Rao-Scott | %                             | $\chi^2$<br>( <i>p</i> -value) | Rao-Scott |                   |
| Age                        |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| 15–24                      | 3.67 (8,533)                     | <0.005                         | <0.005    | 3.67 (7,751)                  | <0.005                         | <0.005    | 1.12 (2,460)                  | <0.005                         | <0.005    | 219,064           |
| 25–34                      | 7.85 (16,725)                    |                                |           | 6.7 (13,361)                  |                                |           | 1.75 (3,529)                  |                                |           | 200,766           |
| 35–44                      | 17.25 (29,021)                   |                                |           | 9.71 (15,992)                 |                                |           | 3.97 (6,352)                  |                                |           | 164,816           |
| 45–49                      | 26.84 (20,633)                   |                                |           | 14.06 (10,462)                |                                |           | 7.93 (5,594)                  |                                |           | 77,312            |
| Education                  |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| No education               | 15.76 (24,673)                   | <0.005                         | <0.005    | 8.99 (12,952)                 | <0.005                         | <0.005    | 3.55 (5,117)                  | <0.005                         | <0.005    | 154,419           |
| Primary                    | 14.21 (11,267)                   |                                |           | 8.41 (6,422)                  |                                |           | 3.54 (2,618)                  |                                |           | 77,946            |
| Secondary                  | 9.21 (31,739)                    |                                |           | 6.61 (22,328)                 |                                |           | 2.54 (8,322)                  |                                |           | 337,220           |
| Higher                     | 7.57 (7,233)                     |                                |           | 6.23 (5,864)                  |                                |           | 2.12 (1,878)                  |                                |           | 92,373            |
| Marital status             |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| Unmarried                  | 3.85 (6,945)                     | <0.005                         | <0.005    | 2.58 (4,467)                  | <0.005                         | <0.005    | 0.99 (1,717)                  | <0.005                         | <0.005    | 163,673           |
| Married                    | 12.84 (62,318)                   |                                |           | 8.68 (40,251)                 |                                |           | 3.27 (14,796)                 |                                |           | 470,283           |
| Others                     | 20.18 (5,649)                    |                                |           | 10.13 (2,848)                 |                                |           | 5.35 (1,422)                  |                                |           | 28,002            |
| Religion                   |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| Hindu                      | 10.82 (56,275)                   | <0.005                         | <0.005    | 7.08 (34,917)                 | <0.005                         | <0.005    | 2.7 (13,044)                  | <0.005                         | <0.005    | 512,829           |
| Muslim                     | 11.38 (7,147)                    |                                |           | 7.99 (5,268)                  |                                |           | 3.37 (2,234)                  |                                |           | 66,963            |
| Others                     | 13.87 (11,490)                   |                                |           | 9.65 (7,381)                  |                                |           | 3.67 (2,657)                  |                                |           | 82,166            |
| Caste                      |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| Scheduled Castes           | 10.5 (14,524)                    | <0.005                         | <0.005    | 7.33 (10,129)                 | <0.005                         | <0.005    | 2.61 (3,463)                  | <0.005                         | <0.005    | 135,144           |
| Scheduled Tribes           | 11.32 (16,001)                   |                                |           | 4.84 (7,632)                  |                                |           | 2.02 (3,048)                  |                                |           | 132,386           |
| OBC                        | 10.87 (29,281)                   |                                |           | 7.43 (18,981)                 |                                |           | 2.81 (7,104)                  |                                |           | 266,940           |
| General                    | 11.86 (15,106)                   |                                |           | 8.18 (10,824)                 |                                |           | 3.47 (4,320)                  |                                |           | 127,488           |
| Wealth index               |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| Poorest                    | 9.68 (13,832)                    | <0.005                         | <0.005    | 6.25 (7,717)                  | <0.005                         | <0.005    | 2.11 (2,688)                  | <0.005                         | <0.005    | 136,673           |
| Poorer                     | 10.06 (15,611)                   |                                |           | 6.92 (9,727)                  |                                |           | 2.32 (3,342)                  |                                |           | 147,191           |
| Middle                     | 11.08 (16,000)                   |                                |           | 7.32 (10,094)                 |                                |           | 2.8 (3,825)                   |                                |           | 140,100           |
| Richer                     | 11.73 (15,340)                   |                                |           | 7.51 (10,035)                 |                                |           | 3.15 (4,012)                  |                                |           | 127,977           |
| Richest                    | 12.54 (14,129)                   |                                |           | 8.48 (9,993)                  |                                |           | 3.68 (4,068)                  |                                |           | 110,017           |
| Regions                    |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| North                      | 11.12 (14,686)                   | <0.005                         | <0.005    | 8.63 (11,439)                 | <0.005                         | <0.005    | 2.84 (3,847)                  | <0.005                         | <0.005    | 133,195           |
| Central                    | 10.1 (17,779)                    |                                |           | 8.88 (14,169)                 |                                |           | 2.37 (3,796)                  |                                |           | 173,993           |
| East                       | 11.11 (10,955)                   |                                |           | 6.23 (5,613)                  |                                |           | 2.82 (2,171)                  |                                |           | 95,026            |
| Northeast                  | 11.78 (11,618)                   |                                |           | 7.61 (6,874)                  |                                |           | 3.87 (2,921)                  |                                |           | 87,766            |
| West                       | 10.78 (6,590)                    |                                |           | 4.35 (2,729)                  |                                |           | 2.54 (1,535)                  |                                |           | 64,634            |
| South                      | 12.42 (13,284)                   |                                |           | 6.7 (6,742)                   |                                |           | 3.55 (3,665)                  |                                |           | 107,344           |
| Residence                  |                                  |                                |           |                               |                                |           |                               |                                |           |                   |
| Urban                      | 12.13 (20,097)                   | <0.005                         | <0.005    | 7.59 (12,972)                 | <0.005                         | <0.005    | 3.38 (5,485)                  | <0.005                         | <0.005    | 159,973           |
| Rural                      | 10.54 (54,815)                   |                                |           | 7.18 (34,594)                 |                                |           | 2.57 (12,450)                 |                                |           | 501,985           |

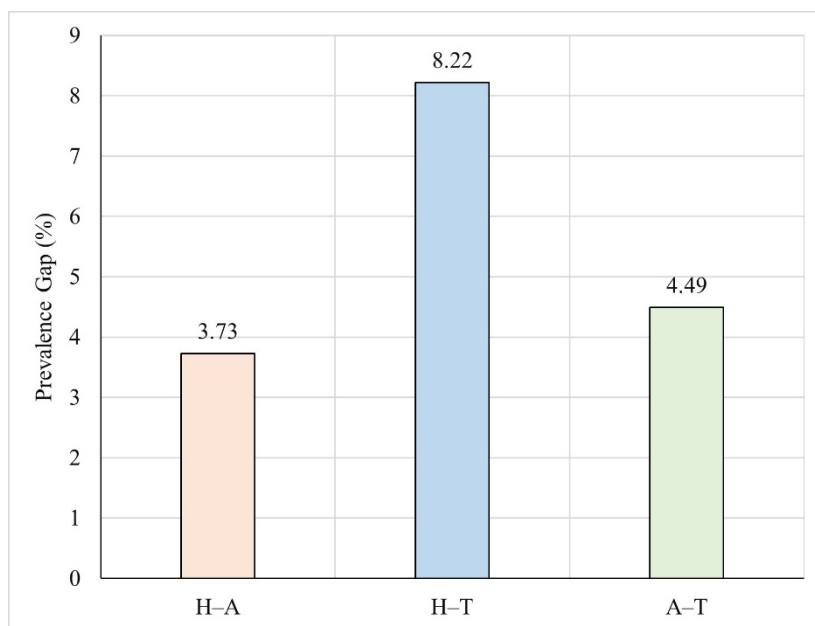
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Table 2. (Continued)

| Background characteristics | Hypertension (n=74,912) |                       |           | Awareness (n=43,019) |                       |           | Treatment (n=17,935) |                       |           | N=661,958 |
|----------------------------|-------------------------|-----------------------|-----------|----------------------|-----------------------|-----------|----------------------|-----------------------|-----------|-----------|
|                            | %                       | $\chi^2$<br>(p-value) | Rao-Scott | %                    | $\chi^2$<br>(p-value) | Rao-Scott | %                    | $\chi^2$<br>(p-value) | Rao-Scott |           |
| BMI                        |                         |                       |           |                      |                       |           |                      |                       |           |           |
| Underweight                | 5.48 (7,039)            | <0.005                | <0.005    | 4.39 (5,150)         | <0.005                | <0.005    | 1.45 (1,740)         | <0.005                | <0.005    | 119,622   |
| Normal                     | 8.89 (36,979)           |                       |           | 6.19 (24,094)        |                       |           | 2.08 (8,139)         |                       |           | 396,759   |
| Overweight                 | 20.55 (30,894)          |                       |           | 12.26 (18,322)       |                       |           | 5.69 (8,056)         |                       |           | 145,577   |
| Diabetes                   |                         |                       |           |                      |                       |           |                      |                       |           |           |
| No                         | 10.42 (69,858)          | <0.005                | <0.005    | 6.91 (44,304)        | <0.005                | <0.005    | 2.51 (15,896)        | <0.005                | <0.005    | 646,614   |
| Yes                        | 33.87 (5,054)           |                       |           | 22.01 (3,262)        |                       |           | 14.47 (2,039)        |                       |           | 15,344    |
| Type of cooking fuel used  |                         |                       |           |                      |                       |           |                      |                       |           |           |
| Clean fuel                 | 12.1 (41,394)           | <0.005                | <0.005    | 7.84 (27,034)        | <0.005                | <0.005    | 3.31 (10,940)        | <0.005                | <0.005    | 333,378   |
| Polluting fuel             | 9.71 (33,518)           |                       |           | 6.64 (20,532)        |                       |           | 2.22 (6,995)         |                       |           | 328,580   |
| Smoker                     |                         |                       |           |                      |                       |           |                      |                       |           |           |
| No                         | 10.84 (68,485)          | <0.005                | <0.005    | 7.28 (44,338)        | <0.005                | <0.005    | 2.8 (16,541)         | <0.005                | <0.005    | 620,311   |
| Yes                        | 15.97 (6,427)           |                       |           | 8.06 (3,228)         |                       |           | 3.45 (1,394)         |                       |           | 41,647    |
| Uses of smokeless tobacco  |                         |                       |           |                      |                       |           |                      |                       |           |           |
| No                         | 10.91 (70,354)          | <0.005                | <0.005    | 7.28 (45,102)        | <0.005                | <0.005    | 2.8 (16,848)         | <0.005                | <0.005    | 631,775   |
| Yes                        | 15.84 (4,558)           |                       |           | 8.53 (2,464)         |                       |           | 3.78 (1,087)         |                       |           | 30,183    |
| Total                      | 11.04 (74,912)          |                       |           | 7.31 (47,566)        |                       |           | 2.82 (17,935)        |                       |           | 661,958   |

Notes: Data are expressed as % (n).  $\chi^2$  represents Pearson's  $\chi^2$  (p-value); Rao-Scott represents Rao-Scott corrected  $\chi^2$  (p-value) after design effect in the form of F-statistics.

Abbreviations: BMI: Body mass index; OBC: Other Backward Classes.

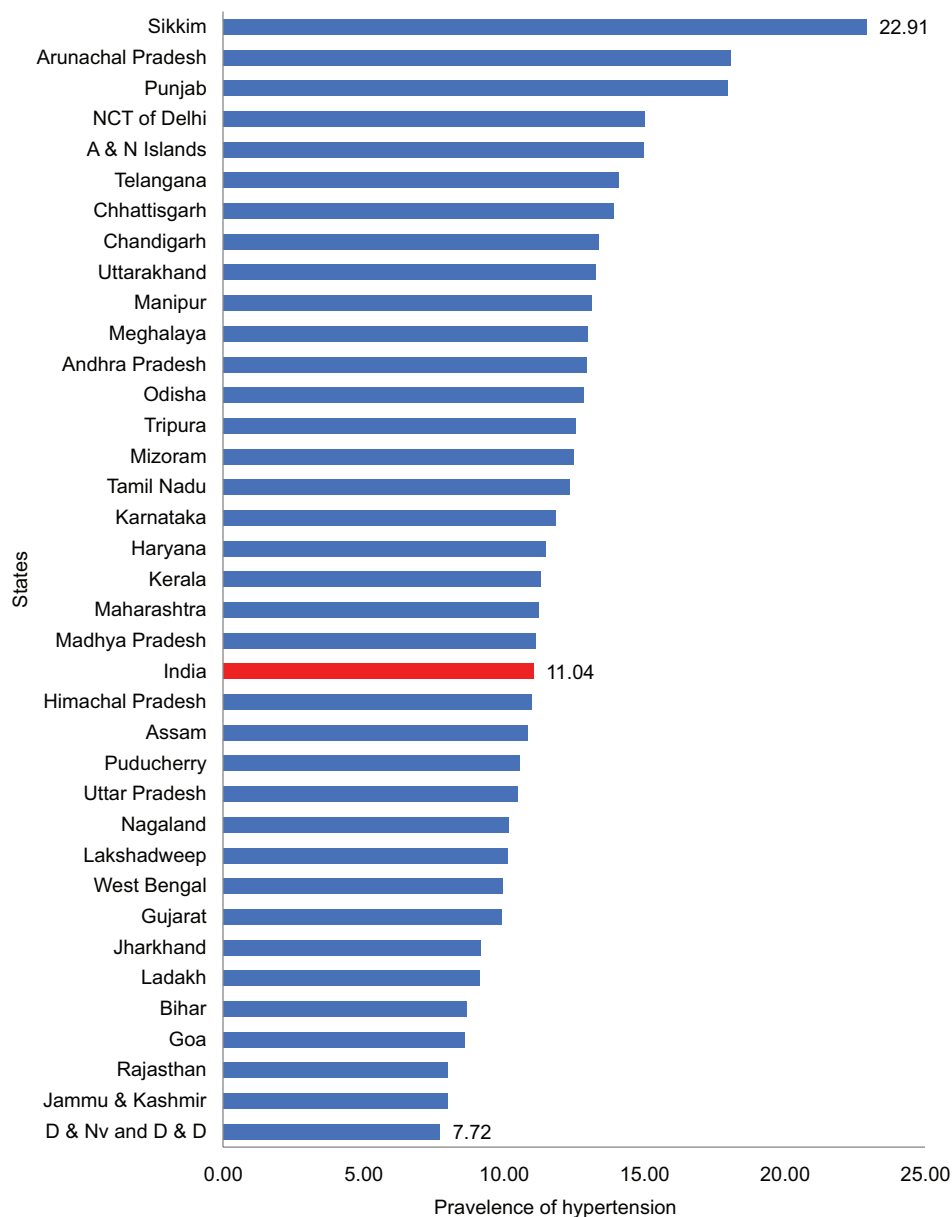


**Figure 2.** Intergroup differences in hypertension, awareness, and treatment utilization among women in India, 2019–2021

Notes: H-A = Prevalence gap between hypertension and awareness; H-T = Prevalence gap between hypertension and treatment; A-T = Prevalence gap between awareness and treatment.

also rose. Women with no education were 37% more likely (OR: 1.37; 95% CI: 1.30–1.44) to experience hypertension

than women with higher education. Furthermore, women from other religions and Scheduled Tribes were 19%



**Figure 3.** Prevalence of hypertension across different states and union territories in India, 2019–2021

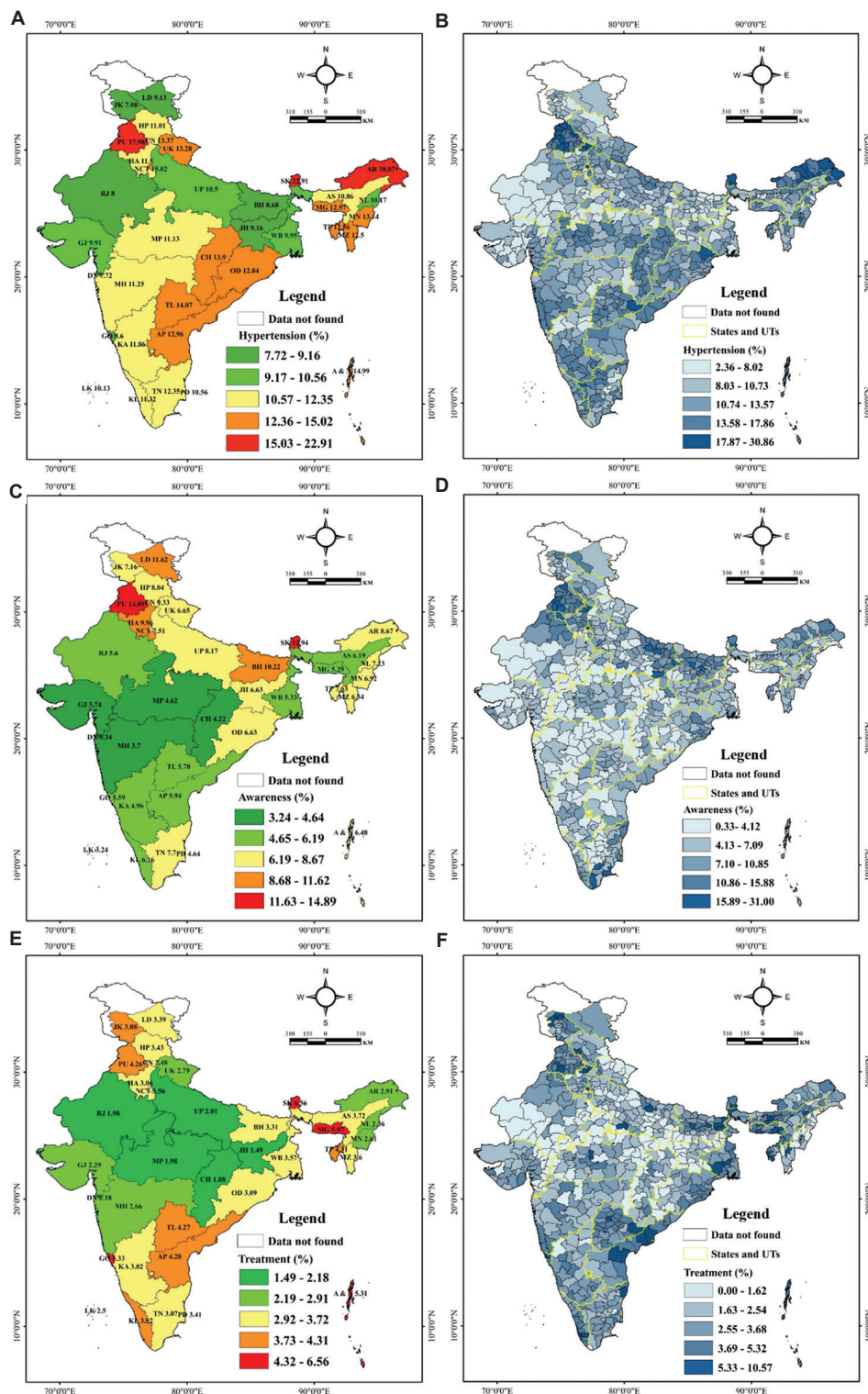
Abbreviations: A & N Islands: Andaman & Nicobar Islands; D & NV and D & D: Dadra & Nagar Haveli and Daman & Diu.

(OR: 1.19; 95% CI: 1.13–1.25) and 23% (OR: 1.23; 95% CI: 1.17–1.29) more likely to suffer from hypertension than women from the Hindu and Scheduled Castes, respectively. There was also an increasing trend in the likelihood of hypertension with rising economic status; women from the richest wealth index were 4% more likely (OR: 1.04; 95% CI: 1.01–1.11) to be hypertensive than those from the poorest households. Regionally, women from the eastern region had a slightly higher likelihood of being hypertensive (OR: 1.04; 95% CI: 0.99–1.09) than those from the northern region. Women with higher BMI

and diabetes were 1.56 times (OR: 2.56; 95% CI: 2.46–2.67) and 1.25 times (OR: 2.25; 95% CI: 2.14–2.38) had higher odds of hypertension than underweight and non-diabetic women, respectively. Moreover, women who smoked were 15% more likely (OR: 1.15; 95% CI: 1.06–1.25) to suffer from hypertension than non-smokers. However, place of residence and tobacco consumption were not significantly associated with hypertension.

In Model 2, which examined awareness of hypertension, women aged 45–49 years and those belonging to other religions were more than twice (OR: 2.52; 95% CI: 2.37–





**Figure 4.** Spatial distribution of prevalence (A and B), awareness (C and D), and treatment (E and F) of hypertension among women at the state and district levels in India, 2019–2021

Notes: The shapefile was downloaded from the *Spatial Data Repository – Boundaries*, the Demographic and Health Surveys Program, ICF International, funded by the United States Agency for International Development. Available at: <https://spatialdata.dhsprogram.com> (accessed September 05, 2023). The Spatial Data Repository provides geographically linked health and demographic data from the DHS Program and the United States Census Bureau for mapping in a Geographic Information System.

**Table 3. Associations and determinants of hypertension, awareness, and treatment among women in India**

| Background characteristics    | Odds ratio [95% confidence interval] |         |                        |         |                        |         |
|-------------------------------|--------------------------------------|---------|------------------------|---------|------------------------|---------|
|                               | Model 1<br>(hypertension)            | p-value | Model 2<br>(awareness) | p-value | Model 3<br>(treatment) | p-value |
| Age                           |                                      |         |                        |         |                        |         |
| 15–24 <sup>a</sup>            | 1                                    | -       | 1                      | -       | 1                      | -       |
| 25–34                         | 1.71 [1.63–1.79]                     | 0.000   | 1.21 [1.15–1.28]       | 0.000   | 1.05 [0.96–1.15]       | 0.246   |
| 35–44                         | 3.57 [3.40–3.75]                     | 0.000   | 1.68 [1.59–1.78]       | 0.000   | 2.04 [1.88–2.23]       | 0.000   |
| 45–49                         | 5.90 [5.60–6.21]                     | 0.000   | 2.52 [2.37–2.68]       | 0.000   | 3.91 [3.56–4.29]       | 0.000   |
| Education                     |                                      |         |                        |         |                        |         |
| No education                  | 1.37 [1.30–1.44]                     | 0.000   | 0.91 [0.85–0.96]       | 0.002   | 1.14 [1.03–1.25]       | 0.011   |
| Primary                       | 1.36 [1.29–1.44]                     | 0.000   | 0.96 [0.90–1.02]       | 0.162   | 1.19 [1.07–1.31]       | 0.001   |
| Secondary                     | 1.19 [1.14–1.25]                     | 0.000   | 1.01 [0.96–1.06]       | 0.636   | 1.14 [1.05–1.24]       | 0.002   |
| Higher <sup>a</sup>           | 1                                    | -       | 1                      | -       | 1                      | -       |
| Marital status                |                                      |         |                        |         |                        |         |
| Unmarried <sup>a</sup>        | 1                                    | -       | 1                      | -       | 1                      | -       |
| Married                       | 1.10 [1.05–1.16]                     | 0.000   | 2.69 [2.51–2.87]       | 0.000   | 1.48 [1.34–1.63]       | 0.000   |
| Others                        | 1.30 [1.21–1.39]                     | 0.000   | 2.83 [2.59–3.10]       | 0.000   | 1.72 [1.52–1.95]       | 0.000   |
| Religion                      |                                      |         |                        |         |                        |         |
| Hindu <sup>a</sup>            | 1                                    | -       | 1                      | -       | 1                      | -       |
| Muslim                        | 1.08 [1.04–1.13]                     | 0.000   | 1.14 [1.07–1.21]       | 0.000   | 1.24 [1.15–1.33]       | 0.000   |
| Others                        | 1.19 [1.13–1.25]                     | 0.000   | 1.46 [1.36–1.58]       | 0.000   | 1.16 [1.06–1.27]       | 0.001   |
| Caste                         |                                      |         |                        |         |                        |         |
| Scheduled Castes <sup>a</sup> | 1                                    | -       | 1                      | -       | 1                      | -       |
| Scheduled Tribes              | 1.23 [1.17–1.29]                     | 0.000   | 0.75 [0.70–0.80]       | 0.000   | 0.86 [0.78–0.94]       | 0.001   |
| OBC                           | 1.01 [0.98–1.05]                     | 0.494   | 0.98 [0.93–1.02]       | 0.297   | 1.01 [0.95–1.07]       | 0.741   |
| General                       | 1.01 [0.97–1.05]                     | 0.530   | 0.99 [0.93–1.04]       | 0.575   | 1.12 [1.04–1.20]       | 0.002   |
| Wealth index                  |                                      |         |                        |         |                        |         |
| Poorest <sup>a</sup>          | 1                                    | -       | 1                      | -       | 1                      | -       |
| Poorer                        | 1.00 [0.96–1.04]                     | 0.934   | 1.09 [1.04–1.15]       | 0.001   | 0.97 [0.90–1.05]       | 0.402   |
| Middle                        | 1.03 [0.99–1.07]                     | 0.209   | 1.12 [1.06–1.19]       | 0.000   | 1.02 [0.94–1.10]       | 0.713   |
| Richer                        | 1.04 [1.02–1.29]                     | 0.046   | 1.10 [1.03–1.17]       | 0.006   | 1.04 [0.95–1.13]       | 0.459   |
| Richest                       | 1.04 [1.01–1.11]                     | 0.054   | 1.09 [1.01–1.18]       | 0.027   | 1.11 [1.00–1.23]       | 0.056   |
| Regions                       |                                      |         |                        |         |                        |         |
| North <sup>a</sup>            | 1                                    | -       | 1                      | -       | 1                      | -       |
| Central                       | 1.04 [1.00–1.08]                     | 0.052   | 1.20 [1.13–1.28]       | 0.000   | 0.99 [0.93–1.06]       | 0.864   |
| East                          | 1.04 [0.99–1.09]                     | 0.084   | 0.76 [0.71–0.82]       | 0.000   | 1.12 [1.03–1.22]       | 0.007   |
| Northeast                     | 1.04 [0.98–1.10]                     | 0.184   | 0.86 [0.79–0.93]       | 0.000   | 1.63 [1.49–1.78]       | 0.000   |
| West                          | 0.95 [0.90–1.00]                     | 0.048   | 0.43 [0.40–0.46]       | 0.000   | 0.88 [0.81–0.97]       | 0.009   |
| South                         | 0.92 [0.88–0.96]                     | 0.000   | 0.61 [0.57–0.66]       | 0.000   | 1.02 [0.95–1.10]       | 0.543   |
| Residence                     |                                      |         |                        |         |                        |         |
| Urban <sup>a</sup>            | 1                                    | -       | 1                      | -       | 1                      | -       |
| Rural                         | 1.00 [0.97–1.04]                     | 0.862   | 1.07 [1.01–1.13]       | 0.035   | 1.01 [0.95–1.07]       | 0.861   |
| BMI                           |                                      |         |                        |         |                        |         |
| Underweight <sup>a</sup>      | 1                                    | -       | 1                      | -       | 1                      | -       |

(Cont'd)

Table 3. (Continued)

| Background characteristics | Odds ratio [95% confidence interval] |         |                        |         |                        |         |
|----------------------------|--------------------------------------|---------|------------------------|---------|------------------------|---------|
|                            | Model 1<br>(hypertension)            | p-value | Model 2<br>(awareness) | p-value | Model 3<br>(treatment) | p-value |
| Normal                     | 1.26 [1.21–1.30]                     | 0.000   | 1.11 [1.06–1.16]       | 0.000   | 1.04 [0.97–1.12]       | 0.238   |
| Overweight                 | 2.56 [2.46–2.67]                     | 0.000   | 1.91 [1.82–2.01]       | 0.000   | 2.06 [1.92–2.22]       | 0.000   |
| Diabetes                   |                                      |         |                        |         |                        |         |
| No <sup>a</sup>            | 1                                    | -       | 1                      | -       | 1                      | -       |
| Yes                        | 2.25 [2.14–2.38]                     | 0.000   | 2.49 [2.34–2.64]       | 0.000   | 3.30 [3.07–3.54]       | 0.000   |
| Type of cooking fuel used  |                                      |         |                        |         |                        |         |
| Clean fuel <sup>a</sup>    | 1                                    | -       | 1                      | -       | 1                      | -       |
| Polluting fuel             | 0.93 [0.90–0.96]                     | 0.000   | 0.87 [0.84–0.91]       | 0.000   | 0.89 [0.84–0.94]       | 0.000   |
| Smoker                     |                                      |         |                        |         |                        |         |
| No <sup>a</sup>            | 1                                    | -       | 1                      | -       | 1                      | -       |
| Yes                        | 1.15 [1.06–1.25]                     | 0.001   | 0.94 [0.83–1.05]       | 0.276   | 0.84 [0.71–1.00]       | 0.044   |
| Uses of smokeless tobacco  |                                      |         |                        |         |                        |         |
| No <sup>a</sup>            | 1                                    | -       | 1                      | -       | 1                      | -       |
| Yes                        | 0.95 [0.86–1.05]                     | 0.278   | 1.12 [0.98–1.28]       | 0.105   | 1.20 [0.99–1.46]       | 0.070   |

Note: <sup>a</sup>Reference category.

Abbreviations: BMI: Body mass index; OBC: Other Backward Classes.

2.68) and 46% (OR: 1.46; 95% CI: 1.36–1.58) as likely to be aware of hypertension compared to women aged 15–24 years and those of the Hindu religion, respectively. Women from Scheduled Tribes had a 25% lower chance of being aware of hypertension (OR: 0.75; 95% CI: 0.70–0.80) than those from Scheduled Castes. Awareness of hypertension increased across all economic groups compared to the poorest. In addition, women residing in the central region and rural areas were 20% (OR: 1.20; 95% CI: 1.13–1.28) and 7% (OR: 1.07; 95% CI: 1.01–1.13) more likely to be aware of hypertension than those in the northern region and urban areas, respectively. Overweight and diabetic women were 91% (OR: 1.91; 95% CI: 1.82–2.01) and 1.49 times (OR: 2.49; 95% CI: 2.34–2.64) more likely to be aware of hypertension than underweight and non-diabetic women. Tobacco consumption was not significantly associated with awareness.

In Model 3, women aged 45–49 years and those with primary education were nearly four times (OR: 3.91; 95% CI: 3.56–4.29) and 19% (OR: 1.19; 95% CI: 1.07–1.31) more likely to have received treatment for hypertension than women aged 15–19 years and those with no education. Women belonging to the Muslim religion and the general caste were 24% (OR: 1.24; 95% CI: 1.15–1.33) and 12% (OR: 1.12; 95% CI: 1.04–1.20) more likely to receive treatment than women from the Hindu religion and the Scheduled Castes. Similarly, women in the richest wealth quintile and those residing in the northeastern region were 11% (OR: 1.11; 95% CI: 1.00–1.23) and 63% (OR: 1.63;

95% CI: 1.49–1.78) more likely to receive treatment than those from the poorest households and northern region, respectively. Women with higher BMI and diabetes were about twice (OR: 2.06; 95% CI: 1.92–2.22) and more than three times (OR: 3.30; 95% CI: 3.07–3.54) as likely to receive treatment for hypertension as women with lower BMI and no diabetes. However, the place of residence was not significantly associated with the treatment of hypertension.

## 4. Discussion

The results revealed several significant risk factors associated with hypertension among women in India, a condition that often leads to multimorbidity (Dolui *et al.*, 2023; Mohanty *et al.*, 2021). Notably, a study conducted in India highlighted that hypertension had the highest prevalence among the morbidities examined (Dolui *et al.*, 2023). We investigated the prevalence of hypertension and its demographic and socioeconomic determinants among women in India. The study found that the odds of hypertension were significantly higher among older women compared to younger ones, which aligns with another study (Pires *et al.*, 2013). As women's age increases, the rate of hypertension tends to rise. This finding aligns with observations from other studies in India, where the likelihood of hypertension is higher among adults aged 45 years and above (Geldsetzer *et al.*, 2018; Meshram *et al.*, 2022; Mohanty *et al.*, 2021). This trend can be attributed to the progressive increase in mean systolic

blood pressure throughout adulthood, with a steeper rise observed among women compared to men (Kearney *et al.*, 2023; Ong *et al.*, 2008; Pimenta, 2011; Roger *et al.*, 2011; Westheim *et al.*, 2001). Simultaneously, awareness and treatment utilization were also found to be higher among older women, possibly due to their increased awareness of hypertension. In contrast, younger women were less likely to utilize treatment even when aware of their hypertensive condition.

Moreover, education level was positively and significantly associated with hypertension. Women with no education or low educational attainment had higher odds of hypertension. These findings align with a previous study, which demonstrated that individuals with below-average educational levels have a higher risk of hypertension (Sun *et al.*, 2022). Furthermore, another study revealed that each additional year of education corresponded to a decrease in systolic blood pressure, thereby reducing the likelihood of hypertension (Liu *et al.*, 2011). However, awareness of hypertension was significantly lower among less-educated women compared to their educated counterparts. In addition, women belonging to Scheduled Tribes had higher odds of hypertension but exhibited lower awareness and treatment utilization. Prior studies have also highlighted that women from Scheduled Tribes are more likely to have higher hypertension prevalence (Anchala *et al.*, 2014; Chakma *et al.*, 2017; Gupta, 2004; Laxmaiah *et al.*, 2015; Rizwan *et al.*, 2014). Similarly, several studies demonstrated that women from tribal backgrounds with limited or no education face a higher risk of hypertension (Gupta *et al.*, 1994; Hajjar *et al.*, 2001; Kopp, 2005; Laxmaiah *et al.*, 2015; Stamler *et al.*, 1996; Stamler *et al.*, 2002). The lower levels of awareness and treatment utilization among these groups may be attributed to limited education and social neglect. The wealth index was also significantly associated with hypertension, revealing that women belonging to higher-income (richer) groups and socioeconomically advantaged segments of the population were more likely to suffer from hypertension (Mohanty *et al.*, 2021).

Likewise, our study showed that the central region of the country had higher hypertension prevalence than other regions, consistent with a previous study (Chakma *et al.*, 2017). Districts in the northeastern and northern states exhibited a higher prevalence of hypertension, corroborating findings from other studies (Borah *et al.*, 2020; Jonas *et al.*, 2010; Meshram *et al.*, 2016; Meshram *et al.*, 2022). Although women from the eastern and northeastern regions were more likely to suffer from hypertension, their awareness and treatment utilization were significantly lower. Our findings further indicated that the level of awareness of hypertension was significantly higher in rural areas compared to urban areas; however,

hypertension prevalence and treatment rates were not significantly predicted by place of residence. While one study has found significant associations between residence and both hypertension and treatment (Sharma *et al.*, 2023), our results did not show such significance. Another study reported that urban residents were more likely to have hypertension than rural residents (Amarchand *et al.*, 2023), which contrasts with our findings.

Nevertheless, our study revealed that obese or overweight women had higher odds of hypertension than underweight women. A similar study reported that obese individuals with hypertension are at a greater risk of developing coronary heart disease than non-obese individuals, and their mortality rates are higher than those of individuals with either obesity alone or hypertension alone (Chiang *et al.*, 1969). On the contrary, some studies have suggested that lower BMI can also be a contributing risk factor for hypertension, particularly among rural populations who may have low BMI due to chronic micronutrient deficiencies, leading to NCDs, including hypertension (Chakma *et al.*, 2017; Dolui *et al.*, 2023; Goldbourt *et al.*, 1987; Hu *et al.*, 2000; Tesfaye *et al.*, 2007). In our study, women with higher BMI were more aware of their condition and more likely to utilize hypertension treatment. Diabetic women also had substantially higher odds of hypertension compared to non-diabetic women, and they demonstrated higher levels of awareness and treatment utilization. These findings are consistent with previous research (Chauhan *et al.*, 2021; Dolui & Sarkar, 2025b; Geldsetzer *et al.*, 2018). In addition, smoking among women was one of the significant predictors of hypertension in India. Earlier studies have shown that maternal smoking or smoking during pregnancy increases the risk of hypertension through genetic mechanisms (Liang *et al.*, 2022; Seal *et al.*, 2013). However, among women who smoked, awareness of hypertension and treatment utilization were considerably lower.

Moreover, tobacco consumption was not significantly associated with hypertension or awareness in our study, but it has been significantly associated in some other studies (Amarchand *et al.*, 2023; Priyadarsini Satapathy *et al.*, 2022). Moreover, studies have shown that consumption of tobacco in smoke or smokeless forms has been significantly associated with a higher risk of hypertension, and tobacco use in any form has been reported to be strongly (29 times more likely) associated with hypertension among women (Priyadarsini Satapathy *et al.*, 2022). This association was not observed in our study, although tobacco use may still influence hypertension risk.

A key finding of the study is that women aged 45–49 years, those with lower levels of education, women



residing in rural areas, and those with higher BMI and who smoked are more vulnerable to hypertension, whereas awareness and treatment of hypertension were much lower among less-educated women, women from Scheduled Tribes, women from eastern and northeastern districts, and those who smoked.

India has implemented a nationwide program, the “India Hypertension Control Initiative,” under the MoHFW to raise awareness and reduce hypertension in the population (MoHFW, n.d.). Given the determinants identified in our study, addressing the risk factors for hypertension is essential for achieving Sustainable Development Goal 3, especially in reducing the burden of NCDs. Targeted interventions are needed to reduce premature mortality from NCDs. Tobacco control, diabetes treatment, women’s health education, local group formation, identification of vulnerable regions and outreach efforts, and awareness campaigns on NCDs may be among the most effective interventions for the control of hypertension. The government and policymakers need to strengthen hypertension management frameworks and the continuum of hypertension care in India.

However, this study has certain limitations that must be acknowledged. First, the study was based on cross-sectional data, which did not capture long-term trends or the causal relationship between hypertension and behavioral changes related to treatment utilization. Second, this research was limited to women and therefore does not represent the entire population. Third, the absence of certain traditional risk factors for hypertension, such as cholesterol levels, family history, and stress, due to their unavailability in the present dataset, limits the comprehensiveness of the analysis. Including these factors in future studies would enable a more comprehensive understanding of hypertension risk. These limitations should be considered when interpreting the findings, and they highlight opportunities for further research and data collection to address these gaps.

## 5. Conclusion

This study investigated the associations of socioeconomic, demographic, and health-related factors with hypertension, awareness, and treatment utilization among women aged 15–49 years in India. The findings indicate that older age (45–49), higher BMI, and comorbid diabetes were strongly associated with an increased likelihood of hypertension, while education, wealth, and regional variations also influenced both the prevalence and awareness of the condition. Awareness and treatment utilization were higher among women aged 45–49 years, those with higher education, wealthier households, and those residing in

certain regions, whereas women from the Scheduled Tribes exhibited lower awareness levels. Behavioral factors, such as smoking, were also associated with a higher risk of hypertension. These findings underscore the need for targeted public health interventions focusing on high-risk and socioeconomically disadvantaged groups, promoting awareness, early detection, and equitable access to hypertension treatment, while acknowledging that causality cannot be inferred due to the cross-sectional design.

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## Conflict of interest

The authors declare that they have no competing interests.

## Author contributions

*Conceptualization:* All authors

*Data curation:* All authors

*Formal analysis:* All authors

*Investigation:* All authors

*Methodology:* All authors

*Supervision:* All authors

*Validation:* All authors

*Writing—original draft:* All authors

*Writing—review & editing:* All authors

## Ethics approval and consent to participate

This study is based on secondary data from the 2019–2021 National Family and Health Survey, round five (NFHS-5), which is the Indian version of the DHS. The dataset contains no personal identifiers or information that could reveal the identity of survey participants, and the data were collected with prior informed consent from participants by the DHS program. Therefore, no separate ethical approval or participant consent was required for this secondary analysis. The data can be accessed by submitting a request through the official DHS website: <https://dhsprogram.com/data/new-user-registration.cfm>.

## Consent for publication

This study is based entirely on secondary data that are publicly available in the DHS repository and do not include any identifiable individual information. Hence, consent for publication is not applicable.



## Availability of data

The present study used data from the NFHS-5, which is freely available in the DHS repository at <https://dhsprogram.com>. The dataset is open access and can be easily retrieved by registered users with a legitimate research purpose. Registration and an online data request are required to obtain access.

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