Regional Disparities & Trends in Hypertension Among Women in India: A Comprehensive Alaysis Based on NHFS-5

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Abstract:
Hypertension remains a significant health challenge and a key risk factor for cardiovascular diseases worldwide. Among Indian women aged 15 to 49 years, the prevalence of hypertension is increasing, yet many cases remain undiagnosed and untreated, particularly across various regions of the country. This study utilizes data from the National Family Health Survey (NFHS-5, 2019–21) to examine the prevalence of hypertension among reproductive-age women and investigate the influence of socio-demographic factors such as age, education, place of residence, and economic status on hypertension risk. Analyzing a sample of 724,115 women through cross-sectional secondary data analysis and multivariate logistic regression, the research identifies an overall hypertension prevalence of 18.7%, with notable regional differences—Kerala and Punjab reporting the highest rates. The analysis further reveals that older age, urban living, higher wealth, and lower education levels significantly increase the likelihood of hypertension. For instance, women aged 45–49 years face over five times greater odds of hypertension compared to younger women aged 15–24. Urban residents and those without formal education also show elevated risks. These findings emphasize the urgent need for region-specific health interventions, enhanced screening efforts, and improved access to hypertension care to address the disparities affecting vulnerable populations across India.

Keywords: Hypertension, Indian women, reproductive age, regional disparities, socio-demographic factors, NFHS-5, cardiovascular risk, urban-rural differences, health inequality, public health intervention.

Chapter 1: Introduction

Hypertension is a long-term health condition that impacts the heart and various organs, often developing without noticeable symptoms in its initial stages. Approximately 1.28 billion adults worldwide are affected by elevated blood pressure, yet less than half are properly diagnosed or treated (World Health Organization, 2021). Often referred to as the "silent killer," hypertension is a leading contributor to the global disease burden, responsible for nearly 10 million deaths each year through its association with heart, kidney, eye, and brain-related complications (Mills et al., 2020).

Among women worldwide, including those affected by pregnancy-related hypertensive disorders, hypertension poses a major health threat, contributing to maternal mortality and long-term cardiovascular risks. In India, approximately 200 million people are estimated to have hypertension, with recent surveys indicating that around 16% of working-age men are affected (Indian Council of Medical Research [ICMR], 2021). However, hypertension among women is a growing concern marked by complex

interactions of physiological aging, socioeconomic status, and gender-specific factors. Research shows that women, particularly those aged 40 to 49, experience higher hypertension prevalence than men in comparable age groups, and socio-demographic factors such as education, income, and residential deprivation further influence this burden (International Institute for Population Sciences [IIPS] & ICF, 2021).

Hypertension acts as a critical modifiable risk factor for numerous non-communicable diseases, including heart attacks, strokes, and chronic kidney disease (Forouzanfar et al., 2017). In women, hypertensive disorders during pregnancy increase risks for both maternal and neonatal complications and predispose affected women to future cardiovascular issues. Besides traditional risk factors like obesity, physical inactivity, and smoking, unique female-related factors—such as age at menarche, childbirth history, and exposure to domestic violence, have also been linked to hypertension development (Gupta et al., 2019).

India experiences significant differences in hypertension rates between urban and rural areas. Women living in urban settings, particularly in states like Kerala and Tamil Nadu, tend to have higher reported cases of hypertension. However, there is also an increasing trend of hypertension among rural women in some regions, pointing to an emerging health concern. These patterns are shaped by disparities in access to healthcare, levels of awareness, and varying socioeconomic backgrounds (IIPS & ICF, 2021).

Socioeconomic position plays a pivotal role in hypertension risk and management. While higher socioeconomic status (SES) typically reduces hypertension risk in high-income countries due to better healthcare access and awareness, in low- and middle-income countries like India, higher SES may sometimes correlate with increased hypertension risk due to lifestyle changes (Subramanian et al., 2009). Access to healthcare facilities, such as proximity to public health centers and availability of affordable medication, substantially affects hypertension diagnosis and treatment, particularly among economically disadvantaged groups.

The reproductive age group of women (15–49 years) is of special importance, as early detection and control of hypertension in this demographic not only improve women's health but also positively impact maternal and child health outcomes. Evidence highlights the relationship between early childbearing and increased hypertension risk later in life, underscoring the need for integrated care models addressing both chronic and reproductive health (Balarajan et al., 2011).

This study is motivated by observed regional variations and socioeconomic disparities in hypertension prevalence among Indian women, as reported in national surveys like NFHS-5 and the National NCD Monitoring Survey. Despite progress in public health initiatives such as the India Hypertension Control Initiative, which has improved blood pressure control among hypertensive patients (NCD Cell, Ministry of Health and Family Welfare, 2021), gaps remain in awareness, treatment, and control, particularly in underserved regions.

This study seeks to address existing knowledge gaps by thoroughly examining regional patterns, socioeconomic influences, and healthcare-related factors affecting hypertension among Indian women aged 15 to 49. It aims to explore how these inequalities contribute to differences in both the prevalence and management of hypertension, thereby supporting the development of gender-responsive and regionally tailored public health strategies. The research aligns with Sustainable Development Goal 3 (SDG 3), which advocates for "healthy lives and well-being for all at all ages," with particular emphasis on Target 3.4—reducing premature deaths from non-communicable diseases through effective prevention and treatment.

This research poses key questions regarding the prevalence and trends of hypertension among women in different regions, the role of socioeconomic and healthcare factors in creating regional disparities, and the critical determinants influencing hypertension risk. By analyzing NFHS-5 data, the study seeks to illuminate inequities in hypertension diagnosis, treatment, and control across various social strata, including education, caste, wealth, and geographic location. Understanding these disparities is essential for policymakers and healthcare providers to design targeted public health strategies that improve hypertension management and reduce health inequities among Indian women.
While the study leverages robust national data, it acknowledges limitations such as reliance on cross-sectional and self-reported information, potential underrepresentation of marginalized populations, and the inability to comprehensively assess long-term trends or comorbid conditions. Nonetheless, it strives to offer valuable insights into the epidemiology of hypertension among women in India and emphasizes the importance of early detection, awareness programs, and equitable access to healthcare services for effective hypertension control.

Review of Literature

Hypertension remains a critical global health challenge and a major contributor to cardiovascular diseases, strokes, and kidney failure worldwide. Recent estimates indicate that over 1.28 billion adults suffer from hypertension, with a significant proportion residing in low- and middle-income countries where access to care and awareness are limited (World Health Organization [WHO], 2021). In India, the prevalence of hypertension has surged due to rapid urbanization, lifestyle changes such as increased consumption of processed and high-salt foods, decreased physical activity, rising obesity, and heightened stress levels (Gupta et al., 2019).
Women face unique risks owing to biological factors like pregnancy-related hypertensive disorders, menopause, and hormonal fluctuations, compounded by sociocultural barriers including restricted healthcare access and gendered health-seeking behaviors (Khan et al., 2019). National data from NFHS-5 reveal a notable rise in hypertension among women aged 15–49, especially in urban settings and older age groups, underscoring the urgent need for gender-sensitive health strategies (International Institute for Population Sciences [IIPS] & ICF, 2021).
Epidemiological trends show a worrying increase not only among older women but also younger age groups, indicating an earlier onset of cardiovascular risks. Urbanization and socioeconomic factors have fostered lifestyle changes that elevate risks, such as obesity, delayed childbirth, and sedentary habits. Additionally, coexisting conditions like diabetes and dyslipidemia are becoming more common among women of reproductive age, with vulnerable populations, such as urban slum dwellers, experiencing exacerbated health risks due to poor healthcare access, psychosocial stress, and unsafe living conditions (Agrawal & Fledderjohann, 2016).
Studies such as LASI (Longitudinal Ageing Study in India) highlight the prevalence of undiagnosed and uncontrolled hypertension among aging women, particularly those in socioeconomically disadvantaged groups, emphasizing the need for continuous screening and life-course approaches (Bloom et al., 2021). Biological factors related to reproductive stages and hormonal changes, alongside socioeconomic determinants such as early marriage, limited education, and poverty, further influence hypertension risk. Lifestyle factors—sedentary behavior, unhealthy diets, and increasing tobacco and alcohol use—intersect with systemic challenges like insufficient health infrastructure and low awareness levels (Subramanian et al., 2009).

Gender disparities, including caregiving responsibilities and financial dependence, often delay women's health-seeking actions. Regional disparities are also prominent; southern states like Kerala and Tamil Nadu report better awareness and treatment coverage due to stronger healthcare systems and higher female literacy, whereas northern and northeastern regions lag with poor hypertension management, cultural barriers, and low service availability (IIPS & ICF, 2021). Urban women generally show higher hypertension prevalence due to lifestyle stressors, while rural women face challenges in treatment and control because of inadequate health services and low outreach.

National initiatives like the India Hypertension Control Initiative (IHCI) and Ayushman Bharat aim to improve hypertension management, focusing on early detection, uninterrupted treatment, and community-level care. However, implementation remains uneven, with gaps in gender-sensitive and region-specific interventions (Ministry of Health and Family Welfare [MoHFW], 2021).

Although awareness around hypertension is growing, significant research gaps remain, especially concerning the distinct biological and social contexts of women, regional imbalances, changes over time, and the impact of national health initiatives targeted at women. To effectively understand and respond to these complexities, it is crucial to incorporate diverse data sources and apply an intersectional lens. This study seeks to bridge these gaps by offering a detailed, gender-sensitive, and region-focused examination of hypertension among women in India, based on NFHS-5 data, thereby supporting data-driven public health strategies.

The focus of this analysis aligns with the Sustainable Development Goal (SDG) 3: Ensure healthy lives and promote well-being for all at all ages, specifically Target 3.4, which seeks to reduce by one-third premature mortality from non-communicable diseases through prevention and treatment by 2030. Addressing hypertension among women is crucial to achieving this goal and ensuring health equity and empowerment across all socioeconomic and geographic groups.

METHODOLOGY

Study Design

This study employs a cross-sectional secondary data analysis design, utilizing existing data from the National Family Health Survey-5 (NFHS-5). The use of secondary data allows for a comprehensive, population-level assessment of hypertension prevalence and its determinants among women aged 15 to 49 years across India, without the need for time-consuming and resource-intensive primary data collection. This design provides a snapshot of the hypertension burden and its associated factors based on nationally representative data collected between 2019 and 2021.

Study Area and Population

The study area covers the entire geographical landscape of India, including all states and union territories as represented in the NFHS-5 dataset. The population under study consists of women aged 15 to 49 years. The NFHS-5 dataset includes a weighted sample size of 724,115 women, providing a large and statistically powerful dataset to analyze regional disparities and socio-demographic differences in hypertension prevalence.

Sampling Technique and Sample Size

The NFHS-5 survey employed a multistage stratified cluster sampling technique to ensure a representative sample of the population. In the first stage, clusters—defined as villages in rural areas or urban blocks in cities—were selected based on probability proportional to size. In the second stage, households within these clusters were randomly selected for participation. This sampling methodology effectively captures

the diversity of India's population, facilitating robust population-level estimates. The sample size of 724,115 women is sufficiently large to detect variations in hypertension prevalence across different regions and socio-economic groups.

Data Sources

This study utilizes secondary data obtained from the Fifth National Family Health Survey (NFHS-5), carried out by the Ministry of Health and Family Welfare, Government of India. The NFHS-5 provides detailed data on blood pressure readings, self-reported hypertension diagnoses, medication usage, and a wide range of socio-demographic variables. Its standardized methodology and rigorous quality assurance protocols enhance the credibility and accuracy of the data.

Data Collection Tools

Data were collected using NFHS-5 questionnaires and biomarker assessments. Blood pressure measurements were taken following standard protocols and recorded through specific survey items (SB18S/SB18D, SB25S/SB25D, SB29S/SB29D). Self-reported data on hypertension diagnosis (SB20) and medication use (SB21) were also collected to complement the objective blood pressure readings. Socio-demographic variables, including age (V012), education level (V106), wealth index (V190), and rural-urban residence (V025), were incorporated to explore their association with hypertension prevalence.

Inclusion and Exclusion Criteria

The study included women aged 15-49 years who had at least one valid blood pressure measurement or self-reported hypertension information. Additionally, only cases with complete socio-demographic data were retained for analysis. Women with missing or implausible blood pressure readings—such as outliers identified during the NFHS-5 data cleaning process—and those with noted age discrepancies (99,777 cases as per NFHS-5 documentation) were excluded to maintain data integrity and accuracy.

Data Analysis Plan

Statistical analysis was performed using SPSS software, while Excel and Tableau were utilized for data visualization. The analysis began with data cleaning, which involved removing outliers (for example, blood pressure readings exceeding 300 mmHg) and applying sampling weights (SHWEIGHT and SWEIGHT) to adjust for survey design and ensure representativeness. Hypertension was defined as having an average blood pressure reading of 140/90 mmHg or higher, or reporting a prior diagnosis of hypertension coupled with current medication use (SB20 = 1 and SB21 = 1).

Hypertension prevalence was analyzed using descriptive statistics, disaggregated by major socio-demographic indicators, including region (V101), age group (V012), education level (V106), wealth quintile (V190), and residence type (urban/rural, V025). To identify key factors associated with hypertension, multivariate logistic regression models were applied, producing adjusted odds ratios while controlling for confounding variables such as age and economic status. Furthermore, chi-square tests were conducted to assess the significance of differences between categorical groups, for instance, between urban and rural populations, with a significance threshold set at a p-value below 0.05.

RESULTS

Prevalence of Hypertension by Background Characteristics

This section presents an analysis of hypertension prevalence among women aged 15–49 across various demographic and socioeconomic factors, such as region, age, education, wealth, and residence, based on NFHS-5 data.

National Prevalence and Regional Variations

The overall prevalence of hypertension among women in this age group across India stands at 18.7%. However, this prevalence varies notably by region. Kerala reports the highest prevalence at 26.8%, with an odds ratio (OR) of 1.65 (95% Confidence Interval [CI]: 1.50–1.82, p<0.001), indicating significantly greater risk relative to the national average. Punjab follows with a prevalence of 24.3% (OR: 1.45, 95% CI: 1.32–1.59, p<0.001), and Maharashtra at 22.1% (OR: 1.25, 95% CI: 1.13–1.38, p<0.01). States like Assam (17.5%, OR: 0.92, 95% CI: 0.83–1.02, p=0.10) do not show a statistically significant difference from the national average, whereas Bihar demonstrates a lower prevalence of 16.2% (OR: 0.85, 95% CI: 0.77–0.94, p<0.01), indicating reduced risk compared to the national average.

Age and Hypertension Risk

Hypertension prevalence increases sharply with age. Women aged 15–24 serve as the reference group with a prevalence of 8.2%. Prevalence nearly doubles to 16.5% in the 25–34 age group (OR: 2.20, 95% CI: 2.05–2.36, p<0.001), rises further to 24.7% in women aged 35–44 (OR: 3.75, 95% CI: 3.50–4.02, p<0.001), and peaks at 31.3% in the 45–49 age group (OR: 5.10, 95% CI: 4.75–5.48, p<0.001). This demonstrates a strong, dose-response relationship between advancing age and hypertension risk.

Education, Wealth, and Residence

Educational attainment is inversely associated with hypertension prevalence. Women with no education exhibit a higher prevalence of 22.1% (OR: 1.50, 95% CI: 1.38–1.63, p<0.001) compared to those with higher education (15.9%, reference group). Wealthier women, particularly those in the richest quintile, show higher hypertension rates (21.7%, OR: 1.40, 95% CI: 1.28–1.53, p<0.001) than the poorest quintile (16.2%). Urban women have a significantly greater prevalence (21.3%) than rural women (17.1%), with an OR of 1.30 (95% CI: 1.20–1.41, p<0.001), potentially reflecting lifestyle differences or access to healthcare.

Table 1: Prevalence of Hypertension Among Women Aged 15–49 by Background Characteristics, India (NFHS-5)

Category	Subgroup	Prevalence (%)	Odds Ratio (OR)	95% CI	p-value
National	All women (15–49)	18.7	-	-	-
Region	Kerala	26.8	1.65	1.50–1.82	<0.001
	Punjab	24.3	1.45	1.32–1.59	<0.001
	Maharashtra	22.1	1.25	1.13–1.38	<0.01
	Assam	17.5	0.92	0.83–1.02	0.10
	Bihar	16.2	0.85	0.77–0.94	<0.01
Age Group	15–24	8.2	Ref	-	-
	25–34	16.5	2.20	2.05–2.36	<0.001
	35–44	24.7	3.75	3.50–4.02	<0.001
	45–49	31.3	5.10	4.75–5.48	<0.001
Education	No education	22.1	1.50	1.38–1.63	<0.001
	Higher education	15.9	Ref	-	-

Wealth Index	Poorest quintile	16.2	Ref	-	-
	Richest quintile	21.7	1.40	1.28–1.53	<0.001
Residence	Rural	17.1	Ref	-	-
	Urban	21.3	1.30	1.20–1.41	<0.001

4.2 State and Union Territory-Wise Hypertension Prevalence

A region-wise breakdown reveals substantial heterogeneity in hypertension prevalence among women aged 15–49 across India.

In South India, Kerala records the highest prevalence at 26.8%, followed by Tamil Nadu (21.8%), Karnataka (19.7%), and Andhra Pradesh (19.4%), indicating a significant burden in the region.

In North India, high prevalence is observed in Punjab (24.3%), Delhi (21.4%), and Haryana (20.9%), while states like Uttar Pradesh (18.6%), Rajasthan (18.0%), and Himachal Pradesh (15.2%) show moderate levels. Jammu & Kashmir (15.4%) and Ladakh (8.7%) report some of the lowest figures within the northern zone.

In West India, Maharashtra (22.1%) and Gujarat (20.4%) have relatively high prevalence, whereas Goa (14.7%), Daman & Diu (10.2%), and Dadra & Nagar Haveli (9.8%) report lower levels.

Central India shows moderate hypertension levels, with Madhya Pradesh (18.3%), Jharkhand (16.8%), Bihar (16.2%), and Chhattisgarh (15.9%), all below the national high.

In East India, Odisha (17.8%) and West Bengal (17.1%) show moderate prevalence, while Sikkim (12.2%) reports comparatively lower figures.

Northeast India exhibits generally lower hypertension prevalence, ranging from Assam (17.5%) to Arunachal Pradesh (12.5%), with Mizoram (12.7%), Nagaland (12.9%), Manipur (13.4%), Meghalaya (13.8%), and Tripura (14.3%) falling within this lower spectrum.

Among the Union Territories and Islands, the lowest prevalence is found in Ladakh (8.7%), Lakshadweep (9.1%), and Andaman & Nicobar Islands (10.8%).

This wide range, from 8.7% in Ladakh to 26.8% in Kerala, reflects significant regional disparities in hypertension burden across India. These differences may stem from variations in lifestyle, dietary patterns, genetic predispositions, health infrastructure, public awareness, and screening practices across regions.

Table 2: Region-Wise Prevalence of Hypertension Among Women Aged 15–49 in India (NFHS-5)

North India

State/UT	Prevalence (%)
Punjab	24.3
Delhi	21.4
Haryana	20.9
Uttar Pradesh	18.6
Rajasthan	18.0
Jammu & Kashmir	15.4
Himachal Pradesh	15.2
Uttarakhand	14.9

Chandigarh (UT)	11.9
Ladakh (UT)	8.7

South India

State/UT	Prevalence (%)
Kerala	26.8
Tamil Nadu	21.8
Karnataka	19.7
Andhra Pradesh	19.4
Telangana*	—
Puducherry (UT)	11.6
Lakshadweep (UT)	9.1

West India

State/UT	Prevalence (%)
Maharashtra	22.1
Gujarat	20.4
Goa	14.7
Daman & Diu (UT)	10.2
Dadra & Nagar Haveli (UT)	9.8

Central India

State/UT	Prevalence (%)
Madhya Pradesh	18.3
Chhattisgarh	15.9
Bihar	16.2
Jharkhand	16.8

East India

State/UT	Prevalence (%)
Odisha	17.8
West Bengal	17.1
Sikkim	12.2

Northeast India

State/UT	Prevalence (%)
Assam	17.5
Tripura	14.3
Meghalaya	13.8
Manipur	13.4
Nagaland	12.9
Mizoram	12.7

Arunachal Pradesh	12.5

Islands & Other UTs

State/UT	Prevalence (%)
Andaman & Nicobar Islands	10.8

4.3 Factors Associated with Hypertension: Binary Logistic Regression Analysis

To identify independent factors associated with hypertension, a binary logistic regression was performed, adjusting for multiple variables.

- **Age:** Older age groups have significantly higher odds of hypertension. Compared to the 15–24 reference group, the odds increase progressively, 25–34 years (OR: 2.20), 35–44 years (OR: 3.75), and 45–49 years (OR: 5.10) — all highly significant (p<0.001). This demonstrates age as the strongest predictor.
- **Education:** Women with no education have 50% higher odds of hypertension compared to those with higher education (OR: 1.50, p<0.001), underscoring the impact of health literacy.
- **Wealth:** The richest quintile has 40% higher odds than the poorest (OR: 1.40, p<0.001), potentially linked to lifestyle and healthcare access differences.
- **Residence:** Urban women have 30% higher odds compared to rural women (OR: 1.30, p<0.001), consistent with urban lifestyle risk factors.
- **Region:** Women in Kerala have significantly higher odds of hypertension (OR: 1.65, p<0.001), while Bihar shows lower odds (OR: 0.85, p<0.01) relative to the national average.

Table 3: Binary Logistic Regression – Factors Associated with Hypertension Among Women Aged 15–49, India (NFHS-5)

Factor	Reference Category	Odds Ratio (OR)	95% CI	p-value
Age: 25–34	15–24	2.20	2.05–2.36	<0.001
Age: 35–44	15–24	3.75	3.50–4.02	<0.001
Age: 45–49	15–24	5.10	4.75–5.48	<0.001
No education	Higher education	1.50	1.38–1.63	<0.001
Richest quintile	Poorest quintile	1.40	1.28–1.53	<0.001
Urban	Rural	1.30	1.20–1.41	<0.001
Kerala	National average	1.65	1.50–1.82	<0.001
Bihar	National average	0.85	0.77–0.94	<0.01

4.4 Broad Insights and Public Health Implications

Demographic and Socioeconomic Patterns

Hypertension prevalence rises with age, reflecting physiological factors like arterial stiffness and longer exposure to risk factors. Socioeconomic factors such as wealth and urban residence are linked with higher prevalence, possibly due to lifestyle changes such as sedentary behavior, diet, and stress, as well as better

health screening in these populations. Education emerges as a protective factor, highlighting the importance of health literacy in disease prevention.

Regional Disparities

Higher prevalence in southern and some northern states (Kerala, Punjab) may be influenced by urbanization, dietary habits (e.g., salt intake), and superior healthcare access that facilitates detection. Conversely, northeastern states and smaller Union Territories report lower prevalence, which may reflect underdiagnosis, protective lifestyle factors, or genetic differences.

Public Health Recommendations

- **Targeted interventions** focusing on older women, urban residents, and affluent groups are critical.
- **Region-specific strategies** should address local risk factors, such as salt reduction programs in Kerala and increased screening in lower-prevalence states like Bihar.
- **Educational initiatives** to improve awareness among less-educated women could reduce hypertension risk and disparities.

Statistical Strength

The use of odds ratios with confidence intervals and p-values, alongside multivariable logistic regression, ensures robust and reliable identification of factors associated with hypertension, adjusting for potential confounders.

DISCUSSION

The national prevalence of hypertension among women aged 15–49 in India, as reported by NFHS-5, stands at 18.7%, highlighting a significant and growing public health concern (IIPS & ICF, 2021). This burden is unevenly distributed across regions and socio-demographic groups, reflecting complex interactions between healthcare access, population characteristics, and lifestyle factors. Notably, southern states like Kerala exhibit the highest prevalence at 26.8% (OR = 1.65), followed by northern states such as Punjab (24.3%, OR = 1.45). These elevated rates are influenced by several factors including better healthcare infrastructure leading to higher detection rates, older population demographics (with Kerala's mean age around 33) (GoI, 2021), and lifestyle changes associated with urbanization—such as dietary patterns high in salt, especially in Punjab (Intersalt Cooperative Research Group, 1988; Misra et al., 2011). In contrast, eastern states like Bihar (16.2%, OR = 0.85) and northeastern regions like Assam (17.5%, OR = 0.92) report lower hypertension rates, which may largely reflect underdiagnosis due to limited healthcare access and younger, more rural populations (WHO, 2021). These regional variations underscore how economic development, healthcare system capacity, and demographic structures influence the epidemiology of hypertension in India (Gupta et al., 2019).

Age and Hypertension

Age is a significant determinant of hypertension, with women aged 45–49 exhibiting more than five times the likelihood (OR = 5.10) of having hypertension compared to those aged 15–24. This trend reflects known biological changes associated with aging, including the hardening of arteries, reduced estrogen levels, and prolonged exposure to risk factors such as excess weight, psychological stress, and physical inactivity (Franklin et al., 1997; NCD Risk Factor Collaboration, 2021). These results support the understanding that hypertension typically progresses with age, especially after the reproductive phase when hormonal protection diminishes (Mills et al., 2016).

Socioeconomic Factors: Wealth, Education, and Urbanization

Socioeconomic status shows a complex relationship with hypertension prevalence. Wealthier women have

a higher likelihood of hypertension (OR = 1.40 comparing the richest to the poorest quintiles), a phenomenon described as the "modernization penalty" (Dandona et al., 2017). This reflects increased risk linked to sedentary lifestyles, processed foods, and psychosocial stress common in affluent, urban settings. Nevertheless, the 16.2% prevalence in the poorest group suggests that chronic stress, undernutrition, and anemia may also contribute to hypertension risk, complicating the narrative that wealth alone drives hypertension (Peters et al., 2018). Education has a protective effect, with women having no formal education showing 1.5 times greater odds of hypertension than those with higher education. Educated women are more likely to engage in preventive behaviors, including healthier diets, blood pressure monitoring, and medication adherence, while uneducated women face barriers in health literacy and access to care (WHO, 2013). Urban residence is associated with higher hypertension prevalence (OR = 1.30), reinforcing findings that urban environments promote dietary shifts toward high sodium intake, increased psychosocial stress, and reduced physical activity (Gupta & Xavier, 2018). In contrast, rural areas report lower prevalence, though this may reflect underdiagnosis and limited healthcare availability rather than actual lower disease burden (IIPS & ICF, 2021).

Treatment and Control Gaps

Despite the relatively high prevalence, management of hypertension in India remains poor. Only 28.7% of hypertensive women reported taking medication, and a mere 19.1% achieved controlled blood pressure (IIPS & ICF, 2021). These figures fall below global averages for low- and middle-income countries (LMICs), indicating systemic weaknesses in follow-up care and healthcare access (Mills et al., 2016). The treatment gap is especially pronounced among rural and less educated populations, where both awareness and continuity of care are limited. This creates a dual burden: while urban, affluent populations may get diagnosed but struggle with control, rural, disadvantaged groups often remain undiagnosed or untreated (Geldsetzer et al., 2019).

Comparison with Existing Literature

The observed 18.7% prevalence aligns closely with NFHS-5 but marks an increase from the 13% prevalence reported in NFHS-4 (2015–16), consistent with India's ongoing epidemiological transition towards non-communicable diseases (NCDs) (IIPS & ICF, 2021; Bloom et al., 2011). Kerala's high burden matches prior studies linking obesity, aging, and urban lifestyle with hypertension (Misra et al., 2011). Bihar's lower prevalence aligns with WHO reports indicating underdiagnosis in less developed states (WHO, 2021). Punjab's high salt consumption aligns with findings from regional nutrition surveys (Intersalt Cooperative Research Group, 1988). The age pattern parallels global trends, where hypertension prevalence doubles every decade after age 30, though the Indian increase appears steeper due to rapid urbanization and health system limitations (NCD-RisC, 2021). The wealth gradient in India contrasts with Western patterns, where lower SES is more associated with hypertension. In India, richer, urban women face a higher risk, though stress and undernutrition among the poor complicate this relationship (Peters et al., 2018). Educational disparities align with global literature on the role of health literacy in reducing NCD risk (WHO, 2013). Finally, India's low treatment and control rates lag behind comparable LMICs such as Brazil and South Africa, underscoring the need for system-wide improvements in screening, awareness, and medication adherence (Mills et al., 2016).

Strengths and Limitations

Strengths of this study include:

- Large sample size (>700,000 women), enabling robust subgroup analysis.
- Use of multiple BP measurements and self-reported medication data to minimize bias.

- Application of weighted analysis to ensure representativeness.
- Adjustments for key confounders (age, SES, education) improve internal validity.

Limitations include:

- Cross-sectional design, which limits causal inferences.
- COVID-19-related disruptions, potentially affecting sample representation.
- Underdiagnosis in rural/remote areas due to a lack of screening.
- Lack of detailed lifestyle data (e.g., diet, physical activity).
- Self-reported variables are prone to recall bias.
- Limited geographic resolution due to cluster-level coding issues.

Additional Considerations and SDG Linkage

This study directly relates to Sustainable Development Goal 3 (SDG 3): *"Ensure healthy lives and promote well-being for all at all ages."* Specifically:

- **Target 3.4**: Reduce by one third premature mortality from NCDs through prevention, treatment, and promotion of mental health and well-being by 2030.
- **Target 3.8**: Achieve universal health coverage, including financial risk protection and access to quality essential healthcare services. To meet these goals, India must address the structural determinants of hypertension, expand rural and primary care services, and launch gender-sensitive NCD programs that focus on early detection, awareness, and long-term management.

CONCLUSION

This analysis highlights hypertension as a significant public health challenge among Indian women aged 15-49, with a national prevalence of 18.7%. There are stark regional disparities, with Kerala (26.8%) and Punjab (24.3%) showing the highest rates, while states like Bihar (16.2%) and Assam (17.5%) report comparatively lower prevalence. The study identifies key determinants driving this burden: age is the strongest predictor, with women aged 45-49 facing over five times higher risk than those aged 15-24 (OR = 5.10), reflecting both physiological aging and lifestyle accumulation of risk factors. Education plays a protective role, as uneducated women have 50% higher odds of hypertension (OR = 1.50), emphasizing the importance of literacy in health awareness and preventive behaviors. Wealth also increases risk, with the richest quintile having 40% higher odds (OR = 1.40), largely due to sedentary urban lifestyles and possible detection biases. Urban residence itself raises hypertension risk by 30% (OR = 1.30), linked to lifestyle factors inherent in urbanization. Despite this substantial burden, treatment and control remain inadequate, with only 28.7% of hypertensive women on medication and just 19.1% achieving blood pressure control, exposing critical gaps in hypertension management.

Implications for Policy, Practice, and Future Research

These findings reflect a complex epidemiology shaped by India's socioeconomic diversity and healthcare inequities. From a policy perspective, the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) must prioritize hypertension as a key women's health issue, especially in high-prevalence states and in addressing rural-urban disparities. Strategic allocation of resources is essential to expand screening services and improve access to affordable medication, aiming to close the large untreated gap of 71.3%. In practice, healthcare providers should integrate routine blood pressure screening into primary care, particularly targeting women above 35 years, who face a substantially higher risk. Community health workers such as ASHAs are critical in bridging rural healthcare gaps by conducting screenings and facilitating referrals. Urban interventions need to focus

on modifiable lifestyle risk factors, such as unhealthy diets and physical inactivity, leveraging existing public health infrastructure for greater impact. Future research should focus on longitudinal cohort studies that follow blood pressure trends from reproductive years through menopause, including detailed data on diet and psychosocial stressors, to better understand causal pathways. Randomized controlled trials evaluating low-cost, scalable interventions like salt substitutes and community exercise programs can offer evidence-based strategies to reduce the hypertension burden effectively.

Recommendations

1. **Enhanced Screening Programs:** Mobile blood pressure screening units should be deployed in high-prevalence states like Kerala and Punjab, focusing on women over 35. Given the fivefold increased risk with age, early detection can prevent severe complications such as stroke. Collaborations with NPCDCS to train and mobilize ASHAs for widespread blood pressure monitoring can target achieving 80% screening coverage within five years.
2. **Urban Lifestyle Modification:** Public health campaigns in urban areas should promote low-sodium diets (aligned with the WHO recommendation of less than 5 grams per day) and encourage at least 150 minutes of moderate physical activity weekly. Targeting community groups through media and workplace wellness initiatives can help reduce urban hypertension prevalence, currently at 21.3%, by 10% over the next decade.
3. **Rural Healthcare Expansion:** Rural health centers need to be equipped with adequate blood pressure monitoring tools and ensure free access to antihypertensive medications, potentially supported by telemedicine and Anganwadi networks. Recognizing that rural prevalence (17.1%) likely underestimates the true burden due to underdiagnosis, especially in Bihar and Assam, at least 20% of NPCDCS funding should be allocated toward rural healthcare strengthening.
4. **Education-Driven Awareness:** To effectively engage women with low or no educational background, it is crucial to adopt user-friendly and inclusive communication methods. Utilizing platforms like radio programs and leveraging the efforts of ASHA workers can help spread essential information at the grassroots level. These outreach activities should focus on helping women identify symptoms of high blood pressure, understand the importance of routine check-ups, and adhere to prescribed treatments. With a focused approach to improving health awareness, it is possible to reduce the current 22.1% prevalence among illiterate women by 5% within three years.
5. **Research and Data Enhancement:** Investment is needed in longitudinal studies linking existing NFHS-5 variables, such as BMI and hypertension diagnosis, with lifestyle factors like diet and stress. Randomized controlled trials testing salt reduction interventions in high-prevalence states such as Punjab and Kerala should be prioritized. Partnerships with institutions like ICMR and WHO can facilitate these efforts, with baseline dietary data expected by 2027 and trial outcomes by 2030.

Broader Impact

Enhancing blood pressure control among women plays a vital role in achieving the Sustainable Development Goals, especially SDG 3 (ensuring healthy lives) and SDG 5 (promoting gender equality). Better management of hypertension can significantly lower the high rates of cardiovascular-related deaths among women in India, which currently account for 8–10% of female mortality each year. Additionally, improved women’s health supports greater workforce participation, potentially driving a 5–7% rise in GDP by 2030. Bridging the treatment gap for hypertension could prevent nearly half a million female deaths annually, making early diagnosis and consistent care a crucial and cost-effective public health strategy for the country.

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