ORIGINAL RESEARCH ARTICLE

Predictors of Hypertension among Indian Women of Reproductive Age Group: An Analysis from NFHS -5 Data

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ABSTRACT

Introduction: Hypertension among women not only augments the risk of cardiovascular diseases but also leads to antenatal and intra-natal complications.

Materials and Methods: A subset of data collected during National Family Health Survey-5, comprising of 7,24,115 women, 15–49 years of age was analysed to identify key predictors of hypertension, using Probit Regression Model (PRM) which was run separately for rural and urban women.

Results: Overall prevalence of hypertension among women of reproductive age group was 11% (10.4% and 12% in rural and urban areas respectively). 5% and 13.41% of women were obese and 1.2% and 2.6% were diabetic in rural and urban areas respectively. Obese, uneducated, rich women and those on medications showed higher prevalence, while women consuming milk, eggs, chicken, fruits, and vegetables daily showed lower prevalence. On using PRM, significant predictors of hypertension were increasing age, rural residence, pregnancy, increasing weight, diabetes, illiteracy, access to medical insurance, and indulgence in alcohol and smoking.

Conclusion: Findings from the study contribute to the body of evidence favouring multifactorial causation. Hypertension awareness should be promoted especially among rural residents, older women, with emphasis on intake of balanced diet with less consumption of sodium and increased intake of fruits and vegetables.

Keywords: Hypertension, Obesity, Socioeconomic Factors, Health Status Disparities, Rural Population, Urban Population

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INTRODUCTION

Global Burden of Disease study reported that Cardio Vascular Diseases(CVD) increased by 34.3% from 2007 to 2017.[1] Elevated blood pressure or hypertension is the most common risk factor for CVD.[2] that leads to the highest mortality worldwide.[3] A study conducted in 154 countries found that hypertension caused 106.3 deaths per 100,000 population in 2015.[4] The prevalence of hypertension in India doubled between 2004–05 and 2011–12.[5] and accounts for 5.1% of total mortality and, as a proximal determinant, contributes to 15% of all cardiovascular deaths.[6] A systematic review documented that hypertension prevalence was 29.8% in India, ranging from 27.6% to 33.8% in rural and urban populations, respectively.[7] The aforementioned findings reiterate the public health concern on hypertension in India. Additionally, elevated blood pressure among women of the reproductive age group not only increases the risk of CVD but also leads to complications during pregnancy and childbirth.[8]

Few previous studies on hypertension have examined awareness among the reproductive age group women, its prevalence in rural-urban settings, cross–country differences in prevalence, prevalence, and risk factors associated with undiagnosed hypertension, and the association of elevated blood pressure with obesity, socioeconomic status, etc.[9-14] Although National Family Health Survey (NFHS) data is available for the entire country, it is not systematically looked into by the academicians and the researchers to answer the prevailing research questions especially on hypertension and its associated risk factors among women of reproductive age.

Since hypertension has multi-factorial etiology, there is a compelling need to study the multifarious factors which have a bearing on the development of hypertension at an individual level. Furthermore, this shall be the first dedicated investigation that would investigate not only the distribution of hypertension and its risk factors exclusively among women of reproductive age-group in India but will also study the influence of micro-level factors on hypertension, an issue that is barely addressed by the existing empirical works. We propose to conduct a study based on the NFHS which systematically collects information on hypertension across the country with a huge and almost equally representative sample.

The objective of our study is to determine the predictive risk factors for hypertension among women of reproductive age group, across the country, based on NFHS data, 2019-21.

METHODOLOGY

Data Source and Sample Size: The present study used data from 7,24,115 women (15–49 years), recorded during the fifth round of the NFHS (2019-21), which is nationally representative of the Indian population. The NFHS uses two-stage cluster sampling methods wherein villages in rural areas and Census Enumeration Blocks in urban areas with probability Proportion to Population Size are selected in the first stage, followed by the selection of households in each Primary Sampling Unit. Using "Biomarker Questionnaire", NFHS collects essential information on blood pressure measurement and other health details for women of reproductive age, such as anthropometric characteristics like height and body weight, anemia, HIV status, blood glucose, etc.

Dependent Variable: The outcome variable was blood pressure (BP) categorized as hypertension and non- hypertension. As per the standard protocol of recording measurement under NFHS, blood pressure measurements for each woman were taken by trained health professionals, thrice with five minutes intervals using an OMRON Blood Pressure Monitor (HEM-7113 model). The final blood pressure reading was estimated by taking the mean of three systolic and diastolic measurements.

Predictor Variables: This study considered demographic, socioeconomic, and health behaviors as predictors to identify significant determinants associated with elevated blood pressure among women. Age-groups were categorized as 15-24, 25-34, and 35-49 years. Other variables included place of residence (rural and urban), women's education (illiterate, primary, secondary, and higher education), body mass index (<18.5 Kg/m^2, 18.5-24.9 Kg/m^2, 25-29.9 Kg/m^2 and >30 Kg/m^2), medication for controlling elevated blood pressure (yes or no), having diabetes (yes or no), consuming alcohol (yes or no), smoking bidi/cigarette per day (<=1 or >1), violence against women (yes or no), consuming fish, eggs, chickens daily (yes or no), drinking milk (yes or no), eating fruits and vegetables daily (yes or no), having health insurance (yes or no), mass media exposure (high degree or low degree) and wealth quintiles (poorest, poorer, middle, richer, richest). This study used Principal Component Analysis (PCA) to generate a composite index of mass media exposure including listening to the radio, watching television, and reading newspapers once a week.

Data Analysis: This study used descriptive statistics to present the prevalence of hypertension among women. Any woman whose mean systolic blood pressure was greater than or equal to 140 mmHg or mean diastolic blood pressure was greater than or equal to 90 mmHg was considered hypertensive. Since the outcome variable is binary, it was categorized as '1' if women had elevated blood pressure and '0' otherwise. We adopted Probit Regression Model (PRM) to identify the predictors and it was run separately for rural and urban women. All statistical estimations were performed using analytical software STATA version 16 (STATA Corporation, College Station, Texas, USA).

Econometric Model: We assume that error term u_i

is normally distributed with zero mean and constant variance σ^2 i.e., $u_i \sim N(0, \sigma^2)$, the $\emptyset(.)$ will be normal Cumulative Distribution Function (CDF) and the functional form of $\emptyset(.)$ is identified with a Probit Model if the outcome variable is binary. The outcome variable is the prevalence of hypertension (H_i), which takes the value '1' if women have hypertension and '0' otherwise. Having predictors X influencing the prevalence of hypertension (H_i), the multivariate Probit Regression Model (PRM) can be written as:

$$P_r(H_i = 1/X) = \emptyset(X_i^T \psi) \quad \text{.....(I)}$$

Where P_r is the probability and $\emptyset$ is the CDF of the standard normal distribution. The parameter ψ is usually estimated by the maximum likelihood method. There is a way to denote the PRM as a latent variable model by introducing an auxiliary random variable H_i^* as:

$$H_i^* = X_i^T \psi + \varepsilon_i \quad \text{.....(II)}$$

Since the error term follows a standard normal distribution, i.e. $\varepsilon_i \sim N(0,1)$,$H_i$ can be measured as an indicator of whether this latent variable is positive or not. So, the model can be written as:

$$H_i = \begin{cases} 1 \; if \; H_i^* > 0 \\ 0 \; otherwise \end{cases} = \begin{cases} 1 \; if \; X_i^T \psi + \varepsilon_i > 0 \\ 0 \; otherwise \end{cases} \quad \text{.....(III)}$$

Where $H = 1$ if the hypertension is present among women and $H = 0$ otherwise.

The log-likelihood function can be written as:

$$\ln L = \sum_{H_i=1} H_i \, ln\emptyset(X_i^T \psi) + \sum_{H_i=0} (1 - H_i) ln[1 - \emptyset(X_i^T \psi)] \text{..(IV)}$$

The estimator $\hat{\psi}$ which maximizes the log-likelihood function will be consistent, asymptotically normal, and provide an efficient estimator i.e., $H[XX^T]$ exist and is not singular. This log-likelihood χ^2 test is widely used to judge whether a discrete choice model is statistically significant. The log-likelihood χ^2 model can be written as:

$$\chi^2(n) = -2 \log\left(\frac{L_R}{L_U}\right) = -2(logL_R - logL_U) \quad \text{.....(V)}$$

Where $logL_R$ and $logL_U$ are restricted and unrestricted log-likelihood values respectively.

RESULTS

Table 1 indicates substantial differences between rural and urban women in the distribution of health characteristics. A quarter of women were underweighted in rural areas, which was almost double as compared to urban areas. However, almost half the females had normal body weight in both rural and urban areas. Moreover, only around 5% of women were obese in rural areas, while it was almost three times (13.41%) in urban areas. Women belonging to rural and urban areas reported 10.4% and 12% hypertension respectively while 1.2% and 2.6% of women in rural and urban areas respectively, were diabetic.

Table 1: Percentage Distribution of health characteristics and health behaviours among the surveyed women

Characteristics	Rural (N=52292)(%)	Urban (N= 27360)(%)
Health Characteristics		
Underweight	13491 (25.8)	4016 (14.68)
Normal	30172 (57.7)	13924 (50.89)
Overweight	6066 (11.6)	5751 (21.02)
Obesity	2609 (4.99)	3669 (13.41)
Hypertension	5438 (10.4)	3283 (12)
Medication	1464 (2.8)	1067 (3.9)
Diabetes	628 (1.2)	711 (2.6)
Health Behaviours		
Smoking <=1 per day	4759 (9.1)	3967 (14.5)
Smoking >=1 per day	47533 (90.9)	23393 (85.5)
Alcohol Consumption	790 (1.51)	194 (0.71)
Milk Consumption	21440 (41)	10670 (39)
Fruits & vegetables intake	14642 (28)	8755 (32)
Fish, Eggs, Chicken intake	1569 (3)	739 (2.7)

Source: Authors estimates based on NFHS data 2019-21

Table 2: Prevelance of Hypertension among women by Demographic and Socioeconomic Characteristics

Characteristics	Cases of Hypertension (Prevalence)	
	Rural (N=52292)(%)	Urban (N= 27360)(%)
Overall	5438 (10.4)	3283 (12)
Age		
15-24 Years	1673 (3.2)	766 (2.8)
25-34 Yeas	3922 (7.5)	1997 (7.3)
35-49 Years	8890 (17)	5171 (18.9)
Education		
No Education	6537 (12.5)	4104 (15)
Up to Primary	5700 (10.9)	3639 (13.3)
Up to Secondary	3713 (7.1)	2517 (9.2)
Higher Education	2824 (5.4)	1915 (7)
Economic Status		
Poorest	3242 (6.2)	2490 (9.1)
Poorer	4863 (9.3)	2490 (9.1)
Middle	4497 (8.6)	2408 (8.8)
Richer	5595 (10.7)	3010 (11)
Richest	5752 (11)	3557 (13)

Source: Authors estimates based on NFHS data 2019-21

As observed in table 1, an overwhelming 90.9% of women in rural areas and 85.5% in urban areas smoked greater than one bidi/cigarette per day. However, alcohol drinking was observed only1.51%of women in rural areas and 0.71% in urban areas. Dietary analysis reveals that an almost equal number of women were consuming milk or curd; fresh fruits and vegetables; and fish, eggs, and chicken daily in rural and urban areas respectively.

Table 2 shows that the overall prevalence of hypertension was higher among urban women. Prevalence of hypertension showed an increasing trend with women's age in both rural and urban areas. Older women (35-49 years) had the highest prevalence in both areas. Uneducated women showed almost double prevalence (12.5% in rural areas and 15% in

Table 3: Prevalence of hypetrtension among women by health characteristics and health behaviours

Characteristics	Cases of Hypertension (Prevalence)	
	Rural (N=52292)(%)	Urban (N= 27360)(%)
Health characteristics		
Body Mass Index (Kg/m²)		
Underweight	1883 (3.6)	1477 (5.4)
Normal	3870 (7.4)	2298 (8.4)
Overweight	8628 (16.5)	4761 (17.4)
Obesity	14067 (26.9)	7962 (29.1)
Medication		
No	4602 (8.8)	2517 (9.4)
Yes	16263 (31.1)	10178 (37.2)
Health behaviors		
Smoking		
<=1	6746 (12.9)	739 (2.7)
>1	7687 (14.7)	5445 (19.9)
Alcohol Consumption		
No	4811 (9.2)	2736 (10)
Yes	9413 (18)	4077 (14.9)
Fish, Eggs and Chicken daily		
No	5229 (10)	2873 (10.5)
Yes	4915 (9.4)	2244 (8.2)
Milk/Curd Consumption daily		
No	5229 (10)	3283 (12)
Yes	4968 (9.5)	2845 (10.4)
Fruits & Vegetables daily		
No	5595 (10.7)	3064 (11.2)
Yes	4497 (8.6)	2818 (10.3)

Source: Authors estimates based on NFHS data 2019-21;
* Number of bidis or cigarettes smoked per day

urban areas) in comparison to women with higher education (5.4% in rural areas and 7% in urban areas). The prevalence of hypertension increased gradually from the poorest wealth quintile to the richest wealth quintile in both areas.

Table 3 depicts that the prevalence of hypertension increased as the BMI increased in both rural and urban women. Almost one-quarter to one-third of females who were obese were hypertensive. A higher prevalence of hypertension was also seen among rural and urban women who had taken any medication.

Women who smoked more than one bidi/cigarette per day and who consumed alcohol were at a higher risk of hypertension as is represented in table 3. Likewise, women not consuming fish, eggs, and chicken per day (10% for rural women and 10.5% for urban women); not taking milk/curd daily (10% for rural women and 12% for urban women), and not consuming fruits and vegetables daily (10.7% for rural women and 11.2% for urban women) showed a higher prevalence of hypertension.

To examine the effect of various demographic, socioeconomic, and health predictors on hypertension among rural and urban women, Probit Regression Model was applied as seen in Table 4. Younger women had a lower risk of hypertension than older women in both rural and urban areas. Level of education emerged as a significant predictor of hypertension. Women with lower levels of education showed higher prevalence in rural as well urban areas. We observed that women who were overweight and obese respectively, were 42% and 46.8% more likely to be hypertensive, while an even higher risk of hypertension (54.9%) was observed for obese females in urban areas. A higher prevalence of hypertension was significantly associated with the consumption of medicines, alcohol, and smoking in both areas. The study documented that those women who faced violence or were diabetic had a slightly higher risk of hypertension.

A lower prevalence of hypertension was significantly associated with good dietary behavior. The results show that women who had taken fresh fruits, vegetables, milk, fish, eggs, and chicken daily were less likely to be hypertensive compared to their counterparts in both areas. Women with mass media exposure were less likely to be hypertensive in both rural and urban areas. However, women who were currently pregnant and who were insured were more likely to have hypertension in rural and urban areas. Finally, this study found that women with richer and richest wealth quintiles were less likely to be hypertensive in rural areas, while there was no significant difference in urban areas.

DISCUSSION

It is one of the few studies in recent years among the Indian population that determined the prevalence of hypertension among the women of reproductive age group (15-49 years) and study findings reveal that 11% of women had elevated blood pressure.

The present study shows a relatively high prevalence of hypertension when equated with studies in the USA, which reported a prevalence of 8% and 8.5% respectively.[15,16] However, this is lower in comparison to studies conducted in rural Haiti (30%)and in Brazil where it was 14.7% in 2015.[17,18] We observed that the prevalence of hypertension rises with the increasing age of women which is consistent with other studies.[19] The high prevalence of hypertension among older women could be attributed to low physical activity and hormone-related (menopausal) fat deposition. This may also be related to age-induced biological arterial changes like endothelial dysfunction, vascular stiffening, calcification, and collagen deposition in the ventricle walls.[20]

The study revealed that women with secondary and higher education had a lower prevalence of hypertension in both rural and urban areas. This finding is in tune with the study done in Malaysia but contrary to studies conducted in Bangladesh.[21,22] This gap may be ascribed to variations in the level of education among countries. It is widely accepted that those with a greater degree of education are better equipped with knowledge about unhealthy health behaviors and, as a result, live healthier lifestyles.

Table 4: Probit Model: Determinants of Hypertension among women of reproductive age-in India

Predictors	Rural			Urban		
	Coeff.	SE.	Z Values	Coeff.	SE.	Z Values
Women's Age (Ref. - 35-49 Years)						
15-24 Years	-0.724*	0.027	-26.650	-0.727*	0.040	-17.970
25-34 Years	-0.478*	0.021	-22.630	-0.452*	0.030	-15.020
Women's Education: (Ref. - Higher Education)						
No Education	0.192*	0.045	4.300	0.165*	0.046	3.600
Primary Education	0.200*	0.046	4.330	0.147*	0.049	2.960
Secondary Education	0.117*	0.041	2.840	0.061***	0.035	1.750
Body Mass Index: (Ref. – Underweight)						
Normal	0.103*	0.025	4.160	0.157*	0.049	3.230
Overweight	0.420*	0.035	12.120	0.393*	0.056	7.000
Obesity	0.468*	0.049	9.520	0.549*	0.067	8.160
Medication: Yes (Ref - No)	0.653*	0.039	16.790	0.700*	0.050	13.960
Diabetic: Yes (Ref - No)	0.033**	0.014	2.410	0.012*	0.018	3.020
Alcohol: Yes (Ref - No)	0.236*	0.043	5.440	0.227*	0.088	2.590
Smoker: Yes (Ref - No)	0.341**	0.173	1.970	0.212	0.159	1.340
Violence against Women: Yes (Ref - No)	0.020*	0.003	5.880	0.023*	0.005	4.920
Fish, Eggs, Chicken: Yes (Ref - No)	-0.008*	0.040	-2.200	-0.063*	0.066	-2.960
Drank Milk: Yes (Ref - No)	-0.003*	0.001	-4.180	-0.002***	0.001	-1.870
Fruits & Vegetables: Yes (Ref - No)	-0.027*	0.008	-3.260	-0.025***	0.014	-1.820
Currently Pregnant: Yes (Ref - No)	0.119*	0.012	9.630	0.140*	0.019	7.550
Health Insurance: Yes (Ref - No)	0.39**	0.031	2.270	0.023**	0.031	2.750
Mass Media Exposure: Yes (Ref - No)	-0.066*	0.022	-2.960	-0.024*	0.032	-4.740
Wealth Quintiles: (Ref. – Poorest)						
Poor	-0.238	0.167	-1.420	-0.009	0.271	-0.030
Middle	-0.079	0.042	-1.460	-0.299	0.189	-1.580
Richer	-0.230**	0.219	-1.970	-0.079	0.156	-0.510
Richest	-0.273*	0.134	-3.530	-0.082	0.210	-0.390
LR Chi2	3282.96			1826.52		
Pseudo R2	0.1124			0.1278		
Number of observations	52292			27360		

Source: Authors' estimates based on NFHS data 2019-21; The asterisks (*), (**) and (***) indicate significance at 1%, 5% and 10%.

A cross-sectional study conducted in Latin America found that individuals with higher levels of education were more likely to have controlled blood pressure than those with lower education.[23] Awareness about healthcare and health-seeking behavior may be responsible for the lower prevalence of hypertension among educated women.

We observed that more than half of the women in both rural and urban areas had normal BMI. This finding is in agreement with another study conducted in Punjab that reported 46.3% of women had normal BMI.[24] We noticed that BMI was significantly associated with hypertension. This finding is coherent with the results from past studies.[25] There is already enough compelling evidence on the health benefits of losing weight.[26] Furthermore, our results show a significant association between medication and hypertension. This finding is also reiterated in other studies.[27] Our study revealed that diabetic women had a higher prevalence of hypertension. Diabetes may be caused by unhealthy food habits, lack of physical activity, and a sedentary lifestyle, all of which are also common risk factors for high blood pressure. Similar results have been found in the literature.[28]

The findings of this study show a significant association between alcohol consumption and the risk of hypertension in both rural and urban areas. Several past studies reinforce our findings that the risk of hypertension tends to rise with alcohol consumption.[29] In the present study, healthy dietary habits (like taking fish, eggs, chicken, drinking milk, and consuming fruits and vegetables daily) were associated with a lower risk of hypertension. Our findings are consistent with expectations since consumption of vegetables and fruits is frequently suggested as one of the components of healthy eating as it increases the consumption of dietary fiber which has an established role in the reduction of high blood pressure.[30-32] It is evident from the literature that daily fish consumption reduces the prevalence of hypertension and a reduction in blood pressure was observed after taking milk regularly.[33,34] Furthermore, our results show that smoking is significantly associated with hypertension in rural areas, but not in urban areas as opposed to the findings from a meta-analysis which revealed that the prevalence of hypertension was high in urban areas.[7] This is also in contradiction to some studies that found habitual smokers had lower hypertension compared to non-smokers.[35] Further, increasing screen time among rural residents, use of tobacco, alcohol, automated technology for transport, and agricultural activities in rural areas alongside increasing sedentary lifestyle results in an increase in the occurrence of overweight and obesity which are known risk factors of hypertension.

Our findings reveal that intimate partner violence is positively associated with the prevalence of hypertension in rural as well as urban areas. This finding is consistent with the other studies.[36] We observed that being pregnant increased the likelihood of hypertension among women. A study observed that during the first trimester, there was a tendency towards a decline in hypertension while another study reported high blood pressure among pregnant women in Nigeria.[37,38] Our findings divulge that those women who had health insurance were more likely to have high blood pressure than those who did not. This is in tune with our expectations, as women with high blood pressure are more likely to choose health insurance. It has been observed that not being medically insured is a significant barrier to receiving effective blood pressure treatments.[39,40] However, Brooks found no significant association between high blood pressure treatments and medical insurance.[41] Finally, our study found that mass media exposure was negatively associated with the prevalence of hypertension among rural and urban women.

At the national level, the administration should advocate and encourage high-risk population screening coupled with health promotion activities, especially about the consumption of a low salt diet besides regular physical activity on top of training grass root level workers considering the local milieu of the various communities. Targeted efforts are required to develop novel plans at the local level to augment primary healthcare efforts for the prevention of hypertension wherein primary health care centers and sub-centers can serve as useful local delivery points for surveillance of hypertensive population and promotion of healthy lifestyles. Our findings could be utilized as a quick reference for stakeholders involved in the formulation and implementation of health policies especially focused on hypertension among women across India.

The main strength of the study is that it is based on nationally representative data with a huge sample size providing robust estimates using standardized questionnaires. We also acknowledge few limitations. First, a cross-sectional study design cannot be used to examine causality. Second, self-reporting of health information may lead to recall bias. Third, the study findings are limited only to women aged 15–49 years. Fourthly, scores of interviewers involved in collecting data on a large scale may contribute to inter-observer variability. Fifth, the effect of some confounding variables, such as time of hypertension diagnosis, stress or anxiety, white-collar hypertension, etc. was not possible to assess. Finally, BMI was the only indicator used to measure overweight and obesity.

Conclusion

The major predictors of hypertension were the increasing age of women, rural inhabitation, pregnancy, obesity, diabetes, less formal education, having access to medical insurance, and indulgence in alcohol, smoking, etc. As overweight and obesity are among the most emphasized risk factors, it is concluded that the risk of hypertension would mitigate if public health policy advocates targeted approaches to reduce obesity among women. Likewise, hypertension awareness should be endorsed especially among geriatric females, rural residents and prudent eating coupled with physical activity should be emphasized.

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