Evaluating the Pre-Hypertension and Hypertension with Associated Risk Factors in India: Evidence From LASI 2017–2018 Data

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Abstract

India's cardiovascular conditions and healthcare systems are significantly impacted by hypertension. This study aims to provide estimates of the prevalence of hypertension, and pre-hypertension, in India. Furthermore, it identifies lifestyle modifications to reduce hypertension in age groups of 45–59 and 60+. This study uses data from the Longitudinal Ageing Study in India, 2017–2018, which includes information on 31,197 adults (45–59) and 28,567 older adults (60+). Descriptive, multivariate, and multinomial regression analyses have been performed to ascertain the prevalence and correlation of socioeconomic characteristics and related risk factors. The finding of this study suggests that individuals in the 60+ age group have a higher prevalence of hypertension. In contrast, a higher prevalence of pre-hypertension can be seen in the 45–59 age group. Gender, place of residence, living arrangement MPCE quintile, family history of hypertension, body mass index, self-rated health, and alcohol consumption are significantly associated with pre-hypertension and hypertension. There is a need for public awareness and control since people with age 45–59 are less aware of hypertension; otherwise, unintentionally, they can develop more risk with aging. Methods of modifying one's lifestyle and dietary changes have a significant impact on the prevention of hypertension; that is why there is a great need for people to be aware of all these.

Keywords

Body mass index (BMI); hypertension (HTN); pre-hypertension (pre-HTN)

Introduction

High blood pressure (BP) is the foremost risk factor for the burden of diseases and the leading cause of hypertension (HTN), heart attack, and stroke. High blood pressure refers to those with systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg (World Health Organization, 2020). The situation in India is more alarming for hypertension as there is sufficient clinical and epidemiological evidence (Anchala et al., 2014; Gupta et al., 2003).

Hypertension is the fourth-highest leading cause of morbidity and mortality worldwide. Compared to communicable diseases, non-communicable diseases (NCDs) are increasing in India as the country moves through an epidemic transition phase (Murray et al., 2016; Roychoudhury et al., 2021). The prevalence of hypertension varied and doubled from 1990 to 2019 (Mohanty et al., 2021; Zhou et al., 2021). The Indian Government has set up Indian Hypertension Control Initiative (IHCI) to improve treatment services as Government is keen to have a 25% relative fall in the prevalence of hypertension (high blood pressure) by 2025 (World Health Organization, 2020).

The prevalence rate of hypertension was 11.3% in younger individuals (15–59 years), according to National Family Health Survey (NFHS-4) 2015–2016. For the first time, this survey determined the prevalence of hypertension among young and middle-aged groups in India using a representative sampling across the country (Gupta et al., 2019). Systematic reviews of various local and regional hypertension epidemiological studies in India had reported that awareness of BP who reside in rural and urban India was 25.1% and 41.9%, respectively. The study also revealed that the percentage of treated hypertension in rural and urban areas was 24.9% and 37.6%, respectively (Anchala et al., 2014). These figures were low comparatively in other nations like the United States, where awareness, treatment, and control of hypertension are 81%, 74%, and 53%, respectively (Shah et al., 2020). With dietary and lifestyle modifications, pre-hypertension can be prevented from progressing to hypertension, which could significantly affect the prevalence of cardiovascular disease in the Indian subcontinent (Mendis et al., 2007; Singh et al., 2011; Singh et al., 2000).

There are no prospective studies among Indians comparable to the Framingham study or other research; as a result, it is not well-defined what level of blood pressure triggers an increase in the risk of cardiovascular events (Gupta, 2004). Due to the present recommended guidelines of the World Health Organization and numerous Indian Consensus Groups, we will accept the criteria of systolic ≥ 140 mmHg and/or diastolic ≥ 90 mmHg as the cut-off level for the diagnosis of hypertension.

According to the 2011 census, 8.6% of India's population was above 60 years old, which rose to 10.1% in 2021. The projection will reach 19.5% by 2050 (International Institute for Population Sciences et al., 2020; United Nations, 2019). India's longevity is increasing, and the population of this age is at higher risk of pre-hypertension and hypertension (Mohanty et al., 2021). Some studies reported the estimated hypertension and hypertension care cascade, but none of them used nationally representative data to produce estimates of pre-hypertension and its association with the correlates (Bhatia et al., 2021; Chauhan et al., 2021; Kothavale et al., 2022; Lee et al., 2022; Mohanty et al., 2021). In previous studies, pre-hypertension has been studied. However, some of them are restricted to specific regions in India, one study focused only on rural India and another on the urban middle class, and some of them focused on

youths and school children (Gupta et al., 2013; Parthaje et al., 2016; Patel et al., 2019; Premkumar et al., 2016; Rai et al., 2020; Roychoudhury et al., 2021; Singh et al., 2011; Tripathy et al., 2017).

In order to examine the health impacts, this study investigates the prevalence of pre-hypertension and hypertension in adults (45–59 years) and older adults (60 years and older). It also identifies their relationship with determinants and correlates with sociodemographic, lifestyle, and risk factors. It also aims to provide the prevalence of hypertension at different levels: awareness, treatment, and control. For the definition of overweight and obesity among Asian people, the International Obesity Task Force has suggested a lower BMI cut-off (Lim et al., 2017; World Health Organization, 2000). Based on the new Asian population fatness assessment criteria, another explanatory's objective is to analyze the relationship between overweight/obesity and high blood pressure.

Data and methods

Study design

The data from the Longitudinal Ageing Study in India (LASI), 2017–2018 (International Institute for Population Sciences et al., 2020), was employed for the present study. The LASI was India's first and, globally, the largest in Health and Retirement studies on aging. The LASI adopted a multistage stratified area probability cluster sampling design with a significant objective to estimate the prevalence of chronic diseases among adults and the older adult population across the socioeconomic spectrum in India and its states and union territories. Detailed information on the sampling frame is available in the LASI Wave-1 report. The LASI Wave 1 included all Indian adults and older men and women aged 45 and above with a sample of 72,250 (30,569 men and 41,681 women) and their spouses (irrespective of age) across all states and union territories (UTs) (except Sikkim) in India.

The present study was carried out for those aged 45 years and above. Furthermore, this study used a complete case analysis. Two datasets were merged to perform this study, the "individual dataset," which included a sample of 72,250, and the "Biomarker dataset," with a sample of 65,900. The sample size was reduced to 65,900. Participants younger than aged 45 years were excluded from the analysis (n = 6,687), as well as those who did not have at least one valid systolic BP (SBP) or diastolic BP (DBP) (n = 5,962). After this exclusion, the sample size was 59,613, which was included in this analysis.

Measures

Burden estimates and patterns were provided for HTN and pre-HTN measurements with self-reported hypertension. An average of the last two systolic and diastolic BP measures were taken in a sitting position, and they were currently on medication. The hypertension care cascade was defined at the awareness level (diagnosed and undiagnosed), control level (uncontrolled and controlled), and treatment level (untreated, undertreated, adequately treated, and controlled but not on treatment) in this study.

Normotension was measured with SBP < 120 mmHg and DBP < 80 mmHg and was never diagnosed with hypertension.

Pre-hypertension (Pre-HTN) refers to SBP of 120–139 mmHg and/or DBP of 80–89 mmHg.

Hypertension was taken as those ever diagnosed (self-reported) with HTN by a health worker/undiagnosed with HTN before but whose measured SBP was ≥ 140 mmHg or DBP ≥ 90 mmHg at the time of the survey or both.

Explanatory description

In the study, socioeconomic and demographic factors such as age (categorized as 45–59 and 60+), marital status (coded as currently married, widowed, and divorced/separated/deserted/others), residence, gender, living arrangements, monthly per capita expenditure (MPCE) quintile, and ever attained school were included as independent variables for the association.

Modifiable risk factors for hypertension were available in the LASI dataset. These included ever smoking or using smokeless tobacco (yes/no), ever consuming any alcoholic beverages (yes/no), and ever being diagnosed with diabetes (yes/no). The BMI defines a person's obesity and is calculated with the help of height and weight, as weight is divided by height^2. The range of BMI was defined as if BMI < 18.5 kg/m^2, i.e., underweight, if 18.5–22.9 kg/m^2, i.e., average weight, if 23–24.9 kg/m^2, i.e., overweight, and if ≥ 30 kg/m^2, i.e., obese, family history of hypertension (mother and father), physical activity includes engaging in vigorous activities, moderate energetic activities, and involvement in activities like yoga, meditation, asana, pranayama, etc. All these variables were considered explanatory variables.

Statistical analysis

This study measured the prevalence of HTN on three levels as dependent variables normotension, pre-HTN, and HTN according to age group (45–59 and 60+). Descriptive statistics of the sample study by the selected variables and their association were given via multivariate analyses to demonstrate the preliminary findings. Multinomial logistics regression was used to examine the variation between the outcome and explanatory variables at a 5% significance level.

The relative risk ratio (RRR) is the probability of choosing one outcome category over the baseline category as a multinomial logistic regression. The multinomial logistic regression equation is

$$RRR = \frac{P(y = 1 \,|\, (x + 1)) \, P/(y = \text{base category} \,|\, (x + 1))}{P(y = 1 \,|\, x)/P \, (y = \text{base category})}$$

Where RRR is the relative risk ratio, and P is the probability of occurrence. When RRR > 1 increases the risk of predictor variables among the exposed group, and when RRR < 1 reduces the risk of predictor variables among the exposed group and RRR = 1, the link between the response variable and the exposed group is unlikely to exist.

Results

Sociodemographic profile of the study population

Table 1 represents the descriptive analysis of the study sample. Approximately 52% belonged to the adult age group, of which 53.5% were female, and 46.5% were male. About three-fourths (74.4%) of the population were currently married, and 57.4% lived with spouses and children. The sample was primarily rural (64.7%) and Hindu religion (73.4%). According to the wealth group, the sample was approximately equally distributed for all grades, and 55.7% sample belongs to BMI < 23. Approximately 41% reported that their health was good. As well, 85% of individuals hardly did yoga, meditation, or asana, and most were hardly or never involved in vigorous activity.

The age-specific prevalence of hypertension, pre-hypertension, and normotension are shown in Figure 1. The prevalence of HTN was higher among older people (60+; 54%) than adults (45–59; 40%). The prevalence of pre-HTN was high in adults (30%).

Figure 1: Age-Specific Prevalence of Normotension, Pre-HTN, and HTN Among Older Adults in India
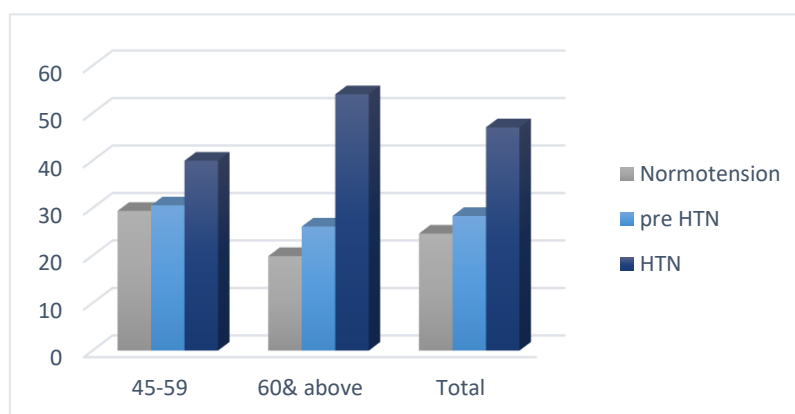
Hypertension and its Care Cascade

HTN and its care cascade in Indians aged 45 years and above are shown in Figure 2 using a flow chart. Around 48% of people had HTN, and 25.5% had pre-HTN. A high prevalence of HTN was seen in the age 60+ (55%). Out of total hypertensive persons, 58.2% were diagnosed by a health professional, and 41.8% were unaware of their HTN. Among those diagnosed with HTN, 54.4% had controlled HTN (SBP < 140 mmHg & DBP < 90 mmHg). Furthermore, among those who had controlled HTN, 70.5% of individuals were on anti-hypertensive medication and had their BP in control. Again, among uncontrolled HTN (45.6%), 74.4% were under treatment for HTN. Age-specific hypertension care cascade is shown in flow charts Figure 3 and Figure 4.

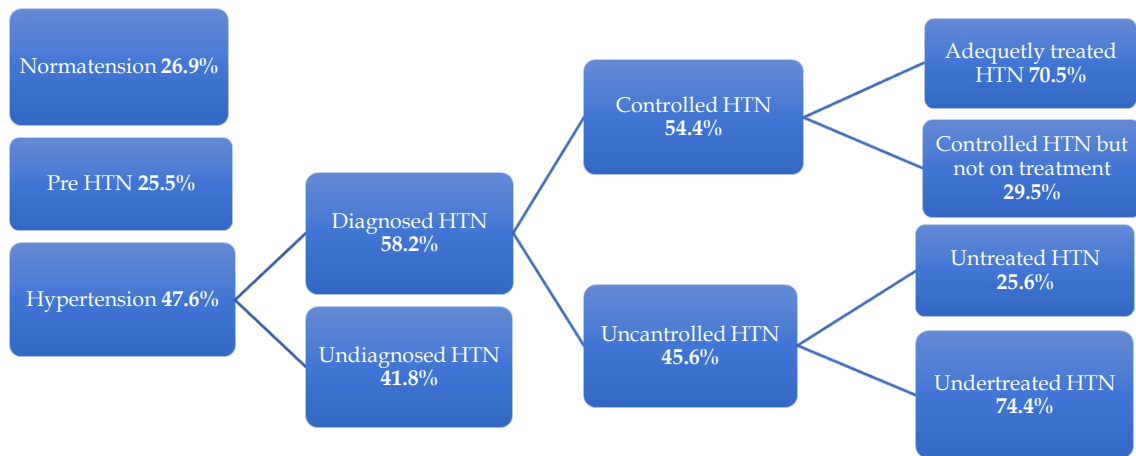**Figure 2:** The Hypertension Care Cascade Among Older Adults (45+)

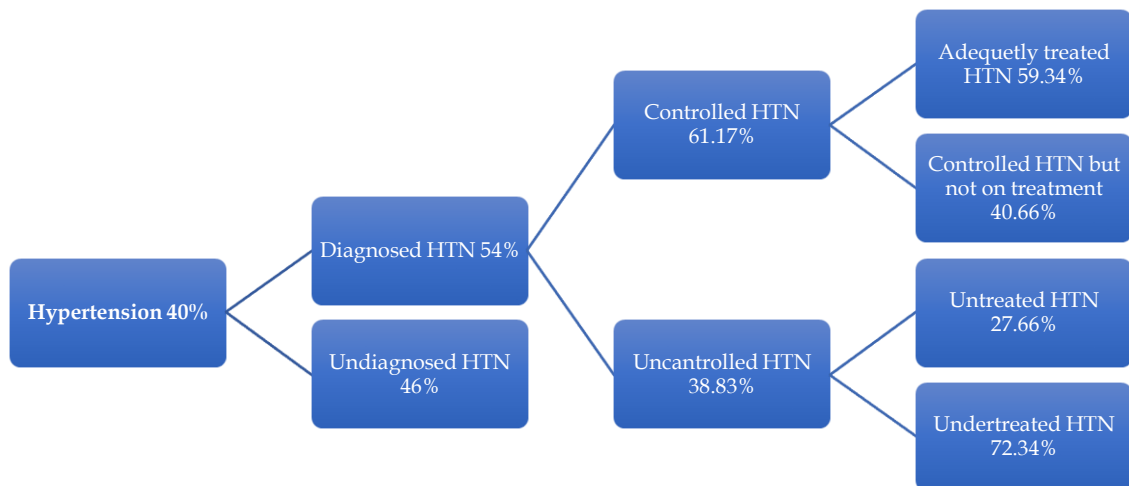**Figure 3:** The Hypertension Care Cascade Among the 45–59 Age Group

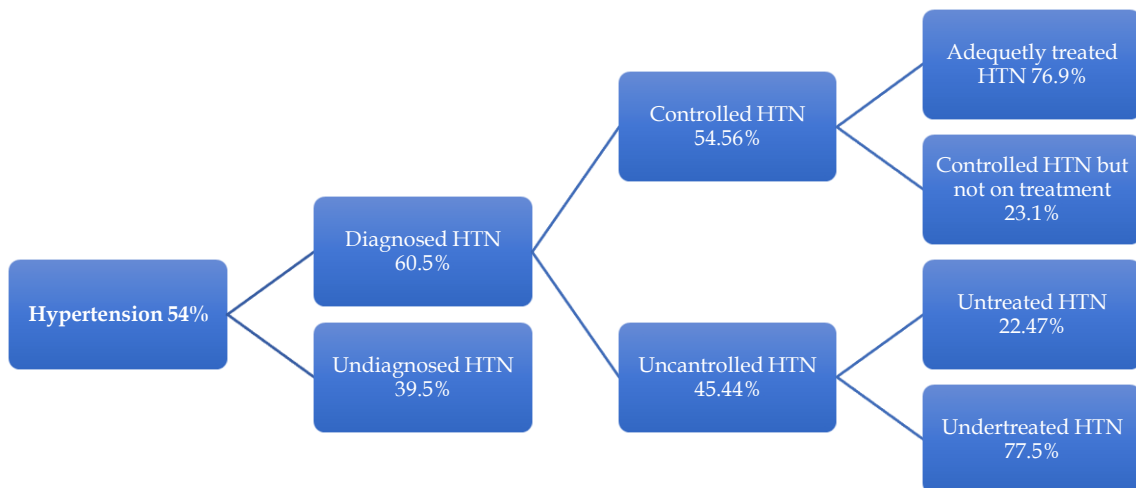**Figure 4:** The Hypertension Care Cascade Among the 60+ Age Group

Table 1: Summary Statistics of the Study Sample

Variable	45–59		60+		Total	
	Weighted percentage	Frequency	Weighted percentage	Frequency	Weighted percentage	Frequency
Gender						
Male	46.2	14,470	46.4	13,317	46.3	39,008
Female	53.8	16,659	53.6	15,167	53.7	20,605
Residence						
Rural	68.2	20,050	71.5	18,958	69.5	30,376
Urban	31.8	11,079	28.5	9,526	30.5	
Marital status						
Currently married	85.4	26,367	62	18,165	73.7	44,532
Widowed	11.1	3,569	35.8	9,588	23.5	13,157
Others[a]	3.5	1,193	2.2	731	2.8	1,924
Living arrangements						
Living alone	1.7	643	5.7	1,478	3.7	2,121
Living with spouse and/or others	12.6	3,564	19.8	5,555	16.2	9,119
Living with spouse and children	71.5	22,213	41.6	12,401	56.5	34,164
Living with children and others	10.9	3,715	27.6	7,581	19.3	11,296
Living with others only	3.3	994	5.2	1,469	4.3	2,463
Religion						
Hindu	82.4	22,883	82.7	20,845	82.5	43,728
Muslim	11.2	3,696	10.9	3,389	11.0	7,085
Others[c]	6.4	4,550	6.4	4,250	6.5	8,800
Caste						
Scheduled caste	20.4	5,383	19.4	4,653	19.9	10,036
Scheduled tribe	9.4	5,764	8.2	4,696	8.8	10,460
Other backward class	46.8	11,646	46.9	10,844	46.8	22,490
None of them	23.4	7,195	25.5	7,360	24.5	14,555
Ever Attend school						
No	45.0	12,813	56.6	13,236	50.8	28,061
Yes	55.0	18,315	43.4	15,248	49.2	31,551
MPCE Quintile						
Poorest	20.6	5,960	21.6	5,831	21.1	11,791
Poorer	20.8	6,145	21.7	5,877	21.2	12,022
Middle completed	20.0	6,182	20.8	5,858	20.5	12,040
Richer	19.8	6,403	19.5	5,611	19.6	12,014
Richest	18.8	6,439	16.4	5,307	17.6	11,746
Genetics						
Hypertension Father						
No	89.7	27,833	93.95	26,319	91.8	54,152
Yes	10.3	3,219	6.05	2,037	8.2	5,256
Hypertension Mother						
No	86.7	26,940	93.6	26,339	90.2	53,279
Yes	13.3	4,112	6.4	2,017	9.8	6,129

Variable	45–59 Weighted percentage	Frequency	60+ Weighted percentage	Frequency	Total Weighted percentage	Frequency
BMI						
Underweight	16.1	4,432	26.7	6,581	21.4	10,950
Normal weight	36.7	11,104	38.2	10,775	37.4	21,879
Overweight/obese	47.2	15,460	35.1	10,715	41.2	26,175
Self-reported health						
Good	44.4	14,930	30.8	9,545	37.6	24,475
Moderate	43.2	12,540	45.0	12,344	44.2	24,884
Poor	12.4	3,648	24.2	6,582	18.2	10,230
Ever smoked or used smokeless tobacco						
No	65.1	65	59.4	17,238	62.2	37,535
Yes	34.9	35	40.6	11,209	37.8	21,999
Ever consumed any alcoholic beverages						
No	84.3	81	85.3	23,528	84.8	48,807
Yes	15.7	19	14.7	4,926	15.2	10,746
Diagnose with Diabetes						
No	90.4	90	85.7	24,079	88.0	51,951
Yes	9.6	10	14.3	4,404	12.0	7,659
Physical activities **Engage in vigorous activities.**						
Every day	32.2	29.88	18.5	5,111	25.3	14,403
More than once a week	8.2	8.44	5.3	1,589	6.7	4,215
Once a week	4.6	4.18	2.9	890	3.7	2,189
One to three times a month	6.2	5.67	5.1	1,252	5.7	3,014
Hardly ever or never	48.8	51.83	68.2	19,602	58.5	35,719
Engage in moderate energetic activities.						
Every day	65.1	62.77	49.1	13,682	57.1	33,200
More than once a week	6.0	6.46	5.9	1,958	5.9	3,967
Once a week	3.5	3.58	3.7	1,154	3.6	2,268
One to three times a month	3.2	2.83	3.8	894	3.51	1,775
Hardly ever or never	22.2	24.36	37.5	10,764	29.9	18,338
Involvement in activities like yoga, meditation, asana, etc.						
Every day	9.0	9.97	9.6	3,156	9.3	6,256
More than once a week	1.8	1.94	1.8	458	1.8	1,060
Once a week	1.3	1.47	1.2	359	1.2	816
One to three times a month	1.6	1.53	1.4	390	1.5	867
Hardly ever or never	86.3	85.09	86.0	24,067	86.2	50,519

Note: [a] Others: Divorced, Separated, Deserted, Live- In, never married; [c] Others: Christian, Buddhist, Sikh, Jain, Parsi, Others

Hypertension, pre-hypertension, normotension, and their covariates

Normotension, pre-HTN, and HTN in the subject with their covariates are illustrated in Table 2. As people aged, their prevalence of normotension decreased, and their rate of HTN increased in both genders. The prevalence rate of HTN was high in urban areas for both 45–59 and 60+ age groups, 49.2%, and 65.5%, respectively.

As well, HTN was found more in people aged 60+ living with someone else and children, followed by those living alone; the reverse pattern was seen for the age group 45–59. The higher prevalence of HTN was found at 42.8% and 58.9% for the age group 45–59 and 60+, respectively, for people who were not SC, ST, or OBC. Individuals aged 60+ with the highest incomes and those who ever attended school had a high prevalence of HTN at 60.7% and 59.2%, respectively, followed by those in the 45–59 age group at 46.2% and 42.3%. The prevalence of pre-HTN was more in the poorest, both in the 45–59 and 60+ age groups. A high prevalence of HTN was found in those who reported poor health and those diagnosed with diabetes, with 47.9% and 58.7%, 66.1%, and 79.4%, respectively, for the 45–59 age group and 60+ age group. Also, those with a family history of HTN had a higher frequency of HTN. The HTN was found to be more prominent amongst people in the 60+ age group who did almost no energetic or intense exercise. A significantly greater prevalence of HTN was seen in overweight/obese in both age groups, 45–59 and 60+, respectively.

To depict the association of normotension, pre-HTN, and HTN with sociodemographic, lifestyle, and risk factors, multinomial logistic regression is used, and the result is illustrated in Table 3. The analysis considered pre-HTN and HTN for the relative risk ratio (RRR) concerning normotension as the reference category.

Table 2: Prevalence (percent) of Normotension, Pre-HTN, and HTN According to Risk Factors, Sociodemographic Characteristics, and Lifestyle

(Demographic Variable)	40–59			60+			Total		
	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN
Gender									
Male	29.9	31.6	38.5	19.7	26.3	54.0	24.8	28.9	46.3
Female	29.0	29.7	41.3	20.1	26.0	53.9	24.5	27.9	47.6
Residence									
Rural	32.9	31.4	35.7	22.9	27.8	49.4	27.7	29.5	42.7
Urban	22.0	28.8	49.2	12.4	22.1	65.5	17.5	25.6	56.9
Marital status									
Currently married	29.9	23.3	37.3	21.9	27.4	50.7	26.5	29.3	44.2
Widowed	23.3	31.0	45.7	16.4	24.0	59.6	18.0	25.6	56.3
Others[a]	37.3	28.1	34.6	21.6	24.8	53.6	31.3	26.8	41.9
Living arrangements									
Living alone	23.1	30.7	46.3	13.9	28.7	57.5	16.0	29.1	54.9
Living with spouse and/or others	32.1	28.7	39.2	20.7	27.9	51.4	25.1	28.2	46.7
Living with spouse and children	29.6	30.9	39.5	22.5	27.2	50.3	27.0	29.5	43.5
Living with children and others	23.7	32.3	44.0	16.	23.3	60.3	18.5	25.8	55.7
Living with others only	38.1	24.7	37.2	20.7	23.6	55.7	27.4	24.0	48.6
Religion									
Hindu	30.0	31.0	39.1	20.6	26.6	52.8	25.3	28.8	46.0
Muslim	25.2	28.6	46.2	17.9	24.3	57.8	21.5	26.5	52.0
Christian	36.6	30.6	32.8	15.0	23.9	61.1	26.2	27.4	46.4
Others[c]	23.1	27.8	49.2	14.1	22.2	63.7	18.4	24.9	56.7
Caste									

(Demographic Variable)	40–59			60+			Total		
	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN
Scheduled caste	32.4	30.1	37.6	22.9	27.8	49.4	27.7	29.00	43.30
Scheduled tribe	29.3	36.9	33.8	22.2	30.6	47.3	26.0	34.00	40.10
Other backward class	30.0	29.6	40.5	20.2	25.9	53.9	25.1	27.70	47.20
None of them	26.2	30.9	42.8	16.8	24.3	58.9	21.3	27.50	51.30
Ever Attend school									
No	31.8	31.0	37.3	22.6	27.4	50.0	26.7	29.00	44.40
Yes	27.5	30.2	42.3	16.3	24.5	59.2	22.6	27.70	49.70
MPCE Quintile									
Poorest	31.0	34.5	34.5	21.6	28.4	50.1	26.2	31.40	42.50
Poorer	30.4	31.7	37.9	22.2	27.1	50.8	26.2	29.30	44.50
Middle completed	29.3	30.0	40.7	19.5	27.0	53.5	24.3	28.50	47.20
Richer	29.3	29.4	41.4	18.2	25.1	56.7	23.8	27.30	49.00
Richest	26.9	26.9	46.2	17.2	22.1	60.7	22.3	24.70	53.00
Genetics									
Hypertension Father									
No	29.8	31.4	38.8	20.3	26.5	53.2	24.9	28.9	46.2
Yes	26.6	24.2	49.2	14.2	19.2	66.6	22.	22.4	55.7
Hypertension Mother									
No	30.8	31.2	38.0	20.6	26.7	52.7	25.5	28.9	45.6
Yes	20.5	27.0	52.5	9.2	17.5	73.3	16.9	23.9	59.2
BMI									
Underweight	48.7	27.8	23.5	32.9	28.8	38.2	38.9	28.5	32.6
Normal weight	35.6	32.8	31.6	20.2	28.4	51.3	27.8	30.6	41.7
Overweight/obese	18.2	30.0	51.8	9.6	21.9	68.5	14.6	26.5	58.9
Self-rated health									
Good	29.3	34.6	36.2	20.6	30.6	48.8	25.7	32.9	41.4
Moderate	30.2	28.1	41.7	19.6	25.5	54.9	24.8	26.7	48.5
Poor	27.0	25.1	47.9	19.6	21.8	58.7	22.1	48.5	55.0

(Demographic Variable)	40–59			60+			Total		
	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN
Diagnosed with Diabetes									
No	31.1	31.6	37.2	22.0	28.3	49.7	26.7	30.0	43.3
Yes	13.4	20.5	66.1	7.3	13.3	79.4	9.7	16.2	74.1
Ever smoked or used smokeless tobacco									
No	28.5	29.7	41.8	17.5	24.7	57.8	23.2	27.3	49.4
Yes	31.2	32.2	36.6	23.5	28.1	48.4	27.0	30.0	43.0
Ever consumed any alcoholic beverages									
No	29.9	30.4	39.8	19.8	25.8	54.4	24.8	28.1	47.2
Yes	27.2	31.7	41.1	20.4	28.0	51.6	23.9	29.9	46.2
Physical activities									
Engage in vigorous activities.									
Every day	31.2	32.1	36.8	23.4	28.0	48.6	28.3	30.6	41.1
More than once a week	33.1	31.4	35.5	26.7	27.6	45.7	30.6	29.9	39.5
Once a week	38.4	30.6	31.0	28.4	27.1	44.5	34.5	29.3	36.5
1–3 times a month	34.1	27.3	38.7	24.3	29.2	46.5	29.6	28.2	36.2
Hardly ever or never	26.3	29.9	43.9	17.8	25.2	57.0	21.3	27.2	42.2
Engage in moderate energetic activities.									
Every day	30.8	30.0	39.1	30.8	30.0	39.1	26.3	28.7	45.0
More than once a week	27.4	30.5	42.2	27.4	30.5	42.2	24.9	28.0	47.1
Once a week	28.6	35.3	36.1	28.6	35.3	36.1	23.8	29.3	47.0
1–3 times a month	25.6	32.9	41.5	25.6	32.9	41.5	24.1	28.8	47.1
Hardly ever or never	26.6	31.1	42.3	26.6	31.1	42.3	21.6	27.6	50.8

(Demographic Variable)	40–59			60+			Total		
	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN	Normo-Tension	Pre-HTN	HTN
Involvement in activities like yoga, meditation, asana, etc.									
Every day	22.3	26.9	50.9	16.2	23.5	60.3	19.1	25.1	55.8
More than once a week	28.3	26.3	45.4	18.4	25.4	56.3	23.3	25.8	50.9
Once a week	29.5	26.9	43.5	23.0	23.3	53.7	26.5	25.3	48.3
1–3 times a month	27.4	27.7	44.8	20.0	21.4	58.6	23.9	24.7	51.4
Hardly ever or never	30.2	31.2	38.6	20.3	26.6	53.1	25.3	28.8	45.9

Note: HTN: Hypertension; PRE-HTN: Pre-hypertension; [a] Others: Divorced, Separated, Deserted, Live-in, never married; [c] Others: Christian, Buddhist, Sikh, Jain, Parsi, Others

Pre-hypertension, HTN, and their covariates (regression result)

The results demonstrated that males in the 45–59 age group had a 33% higher risk of pre-HTN and 22% higher risk of HTN than females, whereas males in the 60+ aged had a 12% high risk of pre-HTN, but the females were more likely to have HTN (RRR = 1.13, 95% CI [1.03, 1.23]). The RRR of pre-HTN (RRR = 1.08, 95% CI [1.00, 1.16]) and (RRR = 1.11, 95% CI [1.00, 1.21]), and HTN (RRR = 1.23, 95% CI [1.15, 1.32]) and (RRR = 1.21, 95% CI [1.11, 1.32]) was slightly high for both 45–59 and 60+ age groups who resided in urban areas compared to their counterparts. Individuals who lived alone were more likely to have pre-HTN and HTN for the 45–59 and 60+ age groups, respectively. In the 45–59 and 60+ age groups with a family history of HTN (father or mother had HTN), the RRR for HTN was significantly high. Those with high BMI were 2.71 times more likely to have pre-HTN for the 45–59 age group and 2.28 times for the 60+ age group, respectively, and approximately four times more likely to have HTN for both age groups. Individuals who reported poor health were more likely to have HTN; 1.39 times for the 45–59 age group and 1.34 times 60+ age group. Diabetes was associated with a 30% increased chance of developing pre-HTN in both age groups, whereas the risk of developing HTN was approximately 60–65% higher in the age groups 45–59 and 60+, respectively. Those who practiced yoga daily were more likely to show HTN than those who did hardly ever/never do it; this might be because they began the practice after knowing they had HTN as a pre-or hypertensive person is generally advised to adopt yoga regularly.

Table 3: RRR and 95% Confidence Intervals for Socioeconomic Condition, Lifestyle, and Risk Factor Association of Pre-HTN and HTN Compared to Normotension.

	45–59		60+	
	Pre-HTN	**Hypertension**	**Pre-HTN**	**Hypertension**
(Demographic Variable)	**RRR (95% CI)**	**RRR (95% CI)**	**RRR (95% CI)**	**RRR (95% CI)**
Gender				
Male[a]	1	1	1	1
Female	0.67*** [0.61, 0.72]	0.78*** [0.71, 0.84]	0.88* [0.80, 0.97]	1.13** [1.03, 1.23]
Residence				
Rural[a]	1	1	1	1
Urban	1.08* [1.00, 1.16]	1.23*** [1.15, 1.32]	1.11* [1.00, 1.21]	1.21*** [1.11, 1.32]
Marital status				
Currently married[a]	1	1	1	1
Widowed	1.14 [0.88, 1.48]	1.36* [1.06, 1.74]	0.76 [0.47, 1.23]	0.97 [0.62, 1.54]
Others[b]	1.15 [0.86, 1.52]	0.97 [0.73, 1.29]	0.74 [0.43, 1.27]	0.75 [0.46, 1.25]
Living arrangements				
Living alone[a]	1	1	1	1
Living with spouse and/or others	0.66* [0.47, 0.92]	0.67* [0.49, 0.92]	0.57* [0.34, 0.96]	0.57* [0.35, 0.91]
Living with spouse and children	0.61** [0.44, 0.84]	0.0.57*** [0.42, 0.78]	0.53* [0.32, 0.89]	0.52** [0.32, 0.84]
Living with children and others	0.69** [0.53, 0.90]	0.67** [0.52, 0.87]	0.84 [0.69, 1.03]	0.84* [0.71, 1.01]

(Demographic Variable)	45–59		60+	
	Pre-HTN	Hypertension	Pre-HTN	Hypertension
	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
Living with others only	0.60** [0.45, 0.82]	0.69* [0.52, 0.93]	0.92 [0.72, 1.19]	0.96 [0.76, 1.20]
Religion				
Hindu[a]	1	1	1	1
Muslim	1.07 [0.97, 1.20]	1.21*** [1.09, 1.34]	1.03 [0.90, 1.18]	1.26*** [1.12, 1.42]
Others[c]	0.98 [0.88, 1.08]	1.07 [0.97, 1.19]	1.10 [0.97, 1.26]	1.27*** [1.13, 1.43]
Caste				
Scheduled caste[a]	1	1	1	1
Scheduled tribe	1.26*** [1.13, 1.40]	1.27*** [1.14, 1.41]	1.86* [1.03, 1.34]	1.20** [1.05, 1.35]
Other backward class	0.99 [0.90, 1.08]	0.93 [0.85, 1.01]	1.00 [0.90, 1.12]	0.94 [0.86, 1.170]
None of them	1.02 [0.91, 1.12]	1.01 [0.92, 1.12]	1.16* [1.02, 1.31]	1.15* [1.02, 1.28]
Ever Attend school				
Yes[a]	1	1	1	1
No	1.00 [0.93, 1.07]	1.05 [0.98, 1.13]	0.98 [0.90, 1.07]	0.84*** [0.78, 0.91]
MPCE Quintile				
Poorer[a]	1	1	1	1
Poorest	0.90* [0.82, 0.99]	0.99 [0.90, 1.08]	0.91 [0.81, 1.02]	0.92 [0.84, 1.03]
Middle completed	0.84** [0.77, 0.93]	0.99 [0.89, 1.08]	0.88* [0.79, 0.99]	0.99 [0.89, 1.10]
Richer	0.89* [0.81, 0.98]	1.05 [0.95, 1.16]	0.89 [0.78, 1.00]	1.03 [0.92, 1.15]
Richest	0.83** [0.75, 0.92]	1.00 [0.90, 1.11]	0.79*** [0.69, 0.89]	0.93 [0.82, 1.04]
Genetics				
Hypertension Father				
No[a]	1	1	1	1
Yes	1.05 [0.93, 1.17]	1.34*** [1.20, 1.49]	0.97 [0.81, 1.18]	1.45*** [1.23, 1.70]
Hypertension Mother				
No[a]	1	1	1	1
Yes	1.00 [0.90, 1.12]	1.41*** [1.28, 1.55]	1.22* [1.00, 1.48]	1.71*** [1.44, 2.03]
BMI				
Underweight[a]	1	1	1	1
Normal weight	1.52*** [1.39, 1.66]	1.65*** [1.50, 1.80]	1.59*** [1.46, 1.74]	1.98*** [1.83, 2.15]
Overweight/obese	2.71*** [2.47, 2.98]	4.22*** [3.84, 4.64]	2.28*** [2.05, 2.55]	4.26*** [3.85, 4.71]
Self-rated health				
Good[a]	1	1	1	1
Moderate	0.87 *** [0.81, 0.93]	1.14*** [1.06, 1.21]	0.92 [0.85, 1.00]	1.12** [1.03, 1.21]
Poor	0.82*** [0.74, 0.92]	1.39*** [1.26, 1.54]	0.88* [0.79, 0.98]	1.34*** [1.21, 1.47]
Diagnosed with Diabetes				
Yes[a]	1	1	1	1
No	0.77*** [0.67, 0.88]	0.36*** [0.31, 0.40]	0.76** [0.66, 0.89]	0.38*** [0.32, 0.42]
Ever smoked or used smokeless tobacco				
Yes[a]	1	1	1	1
No	1.12** [1.03, 1.20]	1.16*** [1.07, 1.25]	1.11* [1.01, 1.20]	1.09* [1.01, 1.18]
Ever consumed any alcoholic beverages				
Yes[a]	1	1	1	1

| | 45–59 | | 60+ | |
| | Pre-HTN | Hypertension | Pre-HTN | Hypertension |
(Demographic Variable)	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
No	0.88** [0.80, 0.97]	0.64*** [0.59, 0.71]	0.84** [0.75, 0.93]	0.78*** [0.70, 0.86]
Physical activities				
Engage in vigorous activities.				
Every day[a]	1	1	1	1
More than once a week	0.92* [0.82, 1.04]	0.91 [0.81, 1.03]	0.99 [0.83, 1.17]	0.96 [0.82, 0.919]
Once a week	0.90 [0.77, 1.05]	0.84* [0.71, 0.97]	0.83 [0.67, 1.03]	0.85 [0.69, 1.04]
1–3 times a month	0.81** [0.70, 0.93]	0.91 [0.79, 1.04]	0.84 [0.70, 1.01]	0.89 [0.75, 1.06]
Hardly ever or never	0.98 [0.90, 1.06]	1.08* [1.003, 1.17]	1.01 [0.91, 1.12]	1.11* [1.01, 1.23]
Engage in moderate energetic activities				
Every day[a]	1	1	1	1
More than once a week	1.06 [0.93, 1.21]	1.06 [0.94, 1.21]	0.94 [0.80, 1.09]	1.00 [0.87, 1.15]
Once a week	0.07 [0.90, 1.26]	1.02 [0.87, 1.21]	1.13 [0.93, 1.38]	1.08 [0.90, 1.30]
1–3 times a month	1.20 [0.99, 1.45]	1.26* [1.05, 1.53]	0.97 [0.79, 1.20]	0.96 [0.79, 1.16]
Hardly ever or never	1.03 [0.95, 1.13]	1.08* [1.00, 1.17]	0.93 [0.84, 1.02]	1.04 [0.95, 1.13]
Involvement in activities like yoga, meditation, asana, etc.				
Every day[a]	1	1	1	1
More than once a week	0.83 [0.65, 1.06]	0.82 [0.64, 1.04]	1.16 [0.83, 1.61]	0.88 [0.65, 1.20]
Once a week	0.76* [0.58, 0.97]	0.75 [0.57, 0.97]	0.72 [0.51, 1.02]	0.67* [0.49, 91]
1–3 times a month	0.83 [0.63, 1.09]	0.86 [0.66, 1.11]	0.89 [0.63, 1.24]	0.79 [0.58, 1.07]
Hardly ever or never	0.92 [0.83, 1.03]	0.82*** [0.74, 0.91]	1.02 [0.89, 1.17]	0.85** [0.75, 0.96]

*Note: Pre-HTN: Pre-hypertension; RRR: Relative risk ratio; *** p < .001, ** p < .01, *p < .05; [a] Reference category; [b] Others: Divorced, Separated, Deserted, Live-In, never married; [c] Others: Christian, Buddhist, Sikh, Jain, Parsi, Others*

Discussion

This population-based study among a nationally representative sample of adults and older adults in India depicts an extensively high prevalence of HTN, with 47% of individuals having HTN. Our study is a more comprehensive analysis of the 45–59 and the 60+ age group individuals of India.

This study found that the prevalence of normotension declines for males and females with aging. In contrast, HTN increases with age, and the prevalence of HTN is significantly higher in females. This study perceived a similar trend of a high prevalence of HTN in females than in males in another systematic analysis of the prevalence of HTN (Gupta et al., 2004; McDonald et al., 2009; Wilmańska et al., 2002). Urban residents and individuals who lived alone were more prevalent for HTN. One of the vital societal causes of HTN is the urbanization of rural populations. Some other systematic reviews also found the same result in their studies (Anchala et al., 2014; Gupta, 2004; Hawkley et al., 2010). Normotension and its determinants, such as residence, living arrangement, physical activity, and BMI, are also essential modules for the present study; all these factors are essential for ideal cardiovascular health. This study illustrates that normotension is a maker of good health.

Previously, no detailed studies of normotension in India had been conducted. A higher wealth index showed a significantly high prevalence of HTN compared to the lowest wealth index. Excess weight gain is also a significant cause of HTN, and the increase in weight is frequently associated with a decrease in normotension. A lower prevalence rate is correlated with normotension and pre-HTN, and a higher BMI means a higher risk of HTN (Landi et al., 2018; Rai et al., 2020; Sobngwi et al., 2002). The present study also illustrates significant results. One of the primary reasons for HTN is associated with a family history of HTN and another risk factor for heart disease and stroke. The results of this study show significant results; the prevalence of HTN is significantly higher in those with a family history of HTN for both age groups (Ranasinghe et al., 2015). Previous studies from different countries have shown similarly increased risks (Corvol et al., 1992; Stamler et al., 1979; Williams et al., 1993). This study also found that people had much higher odds of HTN if diagnosed with diabetes; a person with one condition is at an increased risk of developing another. With diabetes mellitus, people have a high risk of cardiovascular disease, and HTN is a significant risk of CVD (cardiovascular disease); the same has been found in some studies (Cryer et al., 2016; Sobngwi et al., 2002). Diabetes and HTN are frequently associated and may have similar causes. Some include high-calorie consumption, a sedentary lifestyle, obesity, etc. (Sowers et al., 1988).

Furthermore, according to this study, smoking was less likely to be the risk of HTN in both age groups regarding the behavioral risk factor; this should be interpreted with caution since it does not suggest that smoking is a hypertensive-protective factor. Some epidemiological studies suggest smokers have lower blood pressure than non-smokers (Omvik, 1996). According to the etiology of HTN, smoking is linked to increased 24-hour energy expenditure, which reduces weight growth and may instigate low blood pressure (Hofstetter et al., 1986; Rai et al., 2020). Overall, this result is complex and should be treated with caution. Alcohol drinkers are often more likely to go from pre-hypertensive to hypertensive condition, according to the findings. This finding was similar to prior research (Ghosh et al., 2016; Rai et al., 2020).

Several limitations of the current study must be taken into account. It uses simple definitions for measuring hypertension care cascade from earlier studies. The chances of under-reporting cannot be ruled out as BP could not be measured for almost 9% of LASI participants. The analytical sample is restricted to the age group 45+; there is a large absolute number of younger adults with HTN in the country (Mohanty et al., 2021). Respondents were asked if they were diagnosed with HTN by a health professional; this could result in recall bias. Some respondents might not be able to recall this, so the indicator may lead us to suffer from selection bias. Also, we have not assessed dietary and salt intake in this study due to the unavailability of information about this in LASI. Therefore, we could not determine the association between these factors and the prevalence of HTN. The main strength of this study is the use of recently released nationally representative data, LASI, which provides a robust estimate of the study variable. Also, this study focused on adults and older adults separately. Another strength is that we have included a comprehensive range of factors, including more traditional demographic, behavioral, and lifestyle factors.

Conclusion

This study shows that adults and older adults in India experience an enlargement in the prevalence of HTN. This extensive nationally representative data show a low prevalence of normotension and pre-HTN compared to a high prevalence of HTN. To summarize this study, a comprehensive interpretation of HTN and pre-HTN and their association with socioeconomic inequalities, lifestyle, and behavioral risk factors can be modified to improve the burden of HTN. This study reinforces the need for policy measures to improve hazardous working conditions on all levels of HTN in the poor. When it comes to interventions, the emphasis should be on the primary prevention of HTN, whereas regular physical activity and weight control also should be promoted.

Acknowledgments

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