


RESEARCH ARTICLE

The burden of hypertension and unmet need for hypertension care among men aged 15–54 years: a population-based cross-sectional study in India

Ajinkya Kothavale* , Parul Puri  and Suryakant Yadav

International Institute for Population Sciences, Mumbai, India

*Corresponding author. Email: aak.ajinkya@gmail.com

(Received 19 February 2021; revised 19 July 2021; accepted 20 July 2021; first published online 04 October 2021)

Abstract

Hypertension is one of the primary causes of morbidity and premature mortality among the working-age population in India. This study evaluated the burden of hypertension and unmet need for hypertension care among working-age men aged 15–54 years in India using data from the fourth round of the National Family Health Survey (NFHS-4, 2015–16). An individual was recognized as hypertensive if his blood pressure was over 140/90 mmHg or if he was consuming anti-hypertensive medication to lower his blood pressure. The study design was based on the Rule of Halves framework. Hypertensive cases were segmented into five analytical levels: (1) total, (2) screened, (3) diagnosed, (4) treated and (5) controlled cases. The prevalence of hypertension was 16% ($n=16,254$) among the men aged 15–54 years. Of the total hypertensive individuals, 63.2% (10,314) were screened, 21.5% (3428) were diagnosed, 12.6% (1862) were treated and only 6.1% (905) had controlled blood pressure. Of the screened individuals, 66.8% (6886) had never been diagnosed, 45.7% (1566) of those diagnosed had not receive treatment and 51.4% (957) of those treated still had uncontrolled blood pressure. The analyses revealed that 36.5% (5940) of hypertensive individuals were lost at the screening stage. The results demonstrate that there is a significant burden of hypertension and unmet need for hypertension care among men aged 15–54 in India. There is an urgent need to develop suitable strategies and programmes to manage this rising burden of hypertension among men, and reduce losses in the hypertension care continuum.

Keywords: Hypertension care continuum; Unmet need; Rule of Halves

Introduction

One of the biggest obstacles to achieving improved health in India is the accelerating burden of non-communicable diseases (NCDs) such as cardiovascular diseases (CVDs), hypertension and stroke in the working-age population (15–54 years) (de Burgos-Lunar *et al.*, 2013; GBD 2016 Risk Factors Collaborators, 2017). Hypertension is a significant risk factor for CVDs, contributing around 25% of the total NCD burden globally (de Burgos-Lunar *et al.*, 2013; GBD 2016 Risk Factors Collaborators, 2017). It is also a risk factor for cardio-renal diseases like atrial fibrillation and chronic kidney disease (CKD), and non-cardiovascular diseases such as dementia in middle age, cancer, oral health disorders and reduced bone metabolism (Kokubo & Iwashima, 2015). The prevalence of hypertension is rising steadily in India in a range of 4–15% in urban areas and 2–8% in rural areas (Panda *et al.*, 2015; Gupta *et al.*, 2019). The number of individuals with hypertension could increase to 213.5 million by 2025 from 118.2 million in 2000 (de Burgos-Lunar *et al.*, 2013).

The International Conference on Population and Development (ICPD) in 2019 suggested that India would maintain its present age structure, i.e. a higher proportion of individuals in the

working-age group until 2040 (United Nations Population Fund, 2015). The working-age population in India is at higher risk of co-morbidities, including hypertension and a range of NCDs and communicable diseases, compared with other middle-income countries. The working population in India could boost the country's economic development if appropriately utilized in the middle and later phases of the demographic transition. However, to achieve this, the working-age population needs to be healthy (Wei *et al.*, 2019).

The high burden of hypertension at young ages is inflicted by work-related stress, modifiable dietary and lifestyle practices, and other social factors that affect the well-being of individuals in general (O'Donnell *et al.*, 2010; Gamage & Seneviratne, 2016). India may suffer a loss of US\$4.58 trillion before 2030 because of NCDs (Bloom *et al.*, 2014). This is crucial in the Indian context because it is essential that it uses its workforce to its full potential (Motkuri & Naik, 2016). Prenissl *et al.* (2019) pointed out that, despite the rising burden of hypertension in India, around 87% of the total hypertensive population have never received any treatment, and approximately 92% of individuals currently taking anti-hypertensive medications still have high blood pressure levels. Also, as men constitute a significant proportion of India's workforce, effective management and control of hypertension is necessary for increasing economic benefits (Motkuri & Naik, 2016).

Hypertension is the most common CVD, and often remains undetected. In developed countries, a reduction in blood pressure (BP) related mortality is attributable to increased awareness, diagnosis, treatment and control. Even though the stable and high prevalence of hypertension is evident in Western countries, control rates of hypertension have improved more than two-fold over a period of 40 years (Rashid *et al.*, 2003; Wolf-Maier *et al.*, 2004). On the other hand, studies in Asian countries have reported an increase in prevalence of hypertension because of fewer treatments and low control rates (Faizi *et al.*, 2016).

Most countries have paraded the Rule of Halves (RoH) in relation to hypertension because of the asymptomatic nature of the condition. Wilber (1973) was the first to establish the theoretical concept or framework of the RoH in the context of hypertension, where it works as follows: roughly half of patients with hypertension are not diagnosed; half of those diagnosed do not receive proper treatment for hypertension; and half of those who receive treatment do not have their blood pressure levels under control. Hypertension is thought to follow the RoH more closely in less-developed countries, and India, in particular, has a high risk of hypertension disease along with other NCDs. If the RoH is validated in India, one out of eight individuals with hypertension will have controlled blood pressure. Developed countries like Sweden and England have been shown to manifest the RoH framework for hypertension (Wilber, 1973; Wu *et al.*, 2019; Weinehall *et al.*, 2002). However, it is essential to verify the validity of RoH for South Asian countries such as India, where the epidemiological transition has been progressing apace. The RoH is equivalently applicable to explore the continuum of care for hypertension. The specific objectives of this study were: (1) to assess the burden of hypertension and unmet need for care among men aged 15–54 in India using data from the 2015–16 NFHS-4 and using the RoH framework; (2) to estimate the 'gaps' in the analytical levels of hypertension in Indian men by socioeconomic subgroups.

Methods

Study design

The study analysed individual data from the National Family Health Survey (NFHS-4), India, 2015–16. NFHS-4 employed a two-stage stratified sampling design, collecting data in urban and rural areas (International Institute for Population Sciences, 2017). In NFHS-4, clinical and anthropometric evaluation included random blood glucose and standardized blood pressure (BP) measurements. These were reported for men aged 15–54 years at the state level. The analysis

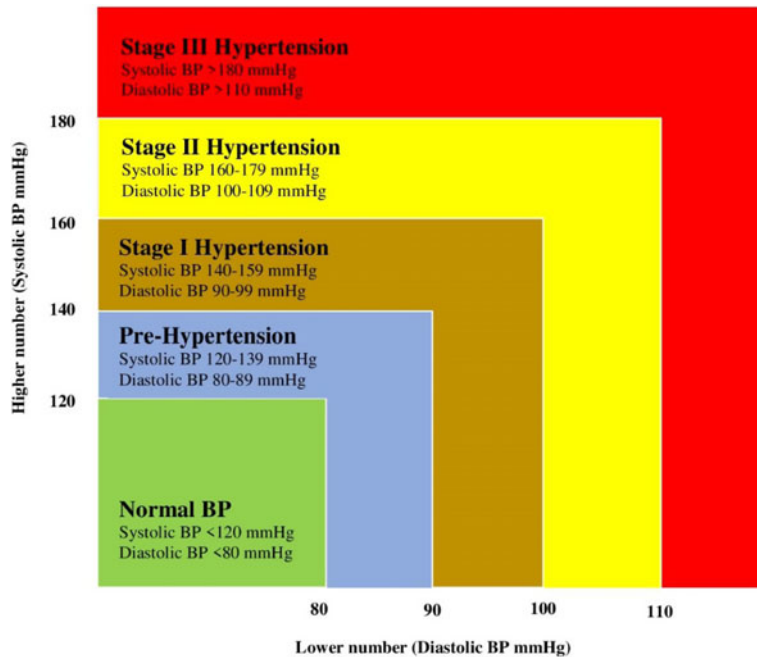


Figure 1. Classification of systolic and diastolic blood pressure levels, American Heart Association.

was restricted to men, with non-missing information on selected covariates and systolic blood pressure (SBP) and diastolic blood pressure (DBP). Individuals were also excluded from the analysis if they had implausible BP values (SBP <70 mmHg or SBP >270 mmHg; DBP <50 mmHg or DBP >150 mmHg). Therefore, a sample of 101,433 men was selected for the final analysis.

Three BP readings were measured for every respondent by a certified and trained investigator according to the guidelines recommended by the American Heart Association (2018). An institutionalized mercury sphygmomanometer (OMRON BP Monitor) was used to measure BP. Depending on the respondent's arm circumference, one of four cuffs, i.e. paediatric, regular adult, large or thigh, was used to measure their BP. The first BP reading was discarded, and the average of the last two readings was used to calculate the respondent's BP level. The result was shared with the respondent immediately after the test was completed on a health card.

Dependent variable

Using a population-level framework, individuals were classified as hypertensive if their SBP was ≥ 140 mmHg or if their DBP was ≥ 90 mmHg, and those currently taking anti-hypertensive medication to lower their BP levels were also considered hypertensive (Asayama *et al.*, 2005). Hypertension was categorized into three stages: Stage I (SBP 140–159 mmHg/DBP 90–99 mmHg), Stage II (SBP 160–179 mmHg/DBP 100–109 mmHg) and Stage III (SBP ≥ 180 mmHg/DBP ≥ 110 mmHg). Along with these, normal and pre-hypertensive individuals were defined as those with SBP <120 mmHg/DBP <80 mmHg and SBP 120–139 mmHg/DBP 80–89 mmHg, respectively (see Figure 1) (American Heart Association, 2018).

Hypertension cases were also classified into four types according to the individual's screening, diagnosis, treatment and control status: (1) 'screened', i.e. those who reported they had ever tested for hypertension before the time of survey interview (the reference period of the NFHS-4); (2) 'diagnosed', i.e. those who reported having a high BP level at the time of the survey interview

Table 1. Classification of hypertension into five mutually exclusive and exhaustive categories

Hypertension category	SBP (mmHg)	DBP (mmHg)	BP check-up status prior to survey
Unscreened	≥140	≥90	Never had BP tested and not reported prior diagnosis
Screened but undiagnosed	≥140	≥90	Had BP tested but not reported prior diagnosis
Diagnosed but untreated	≥140	≥90	Prior reported diagnosis but not currently using any medication
Treated but uncontrolled	≥140	≥90	Prior reported diagnosis and currently using medication
Controlled	<140	<90	Prior reported diagnosis and currently using medication

(self-reported hypertension); (3) ‘treated’, i.e. those who reported they were currently taking prescribed medicine to control their BP; and (4) ‘controlled’, i.e. those whose measured BP at the time of survey interview was <140/90 mmHg but who were continuing to take prescribed medicine to lower their blood pressure.

Furthermore, using four questions asked in the NFHS-4, five mutually exclusive and exhaustive categories of hypertensive individuals were created. Sixteen combinations were generated using permutations and combination of the four questions. Of these, eight are not considered as these were void categories. Of the remaining eight meaningful categories, three were normal categories showing no cases of hypertension at the time of the survey. The remaining five categories of hypertension were: (a) unscreened, (b) screened but undiagnosed, (c) diagnosed but untreated, (d) treated but uncontrolled and (e) controlled cases (Table 1). In addition, ‘unmet need’ was defined as the sum of the first four categories of hypertension, i.e. unscreened, screened but undiagnosed, diagnosed but untreated, treated but uncontrolled. Respondents with controlled blood pressure were not considered to have an unmet need for hypertension care. The RoH will expose gaps between the five categories of hypertension, with each gap representing the lost cases in the continuum of care of hypertension. These gaps will help in identify unmet need for hypertension care.

Independent variables

The independent variables included in the study were based on Anderson’s health care utilization framework (Andersen, 1995), which identifies factors that lead to the use of health services, and can be divided systematically into three groups:

- (1) Predisposing factors: age (15–24, 25–34, 35–44, 45–54 years), marital status (ever married, never married), education (no education, primary, secondary and higher), social class (Scheduled Caste/Tribe [SC/ST], Other Backward Classes [OBC], other), religion (Hindu, Muslim and other [Christian, Sikh, Jain and Buddhist]) and household size (≤4 family members, >4 family members).
- (2) Enabling factors: wealth index (poor, middle and rich), health insurance status (yes, no), place of residence (rural, urban) and region of residence (North, North-East, Central, East, West and South).
- (3) Risk factors: occupation (not working, agricultural worker, casual worker, salaried worker), tobacco consumption (yes, no), alcohol consumption (yes, no), body mass index (BMI kg/m²) (underweight: <18.5; normal: 18.5–24.99; overweight: 25–29.99; obese: ≥30), diet (healthy, unhealthy) and random blood glucose level (<140 mg/dl, ≥140 mg/dl).

Analysis

Sequential logistic random-effect regression models were used to examine the determinants of ‘gaps’ or lost cases in the continuation of hypertension care among the participants. Four models were applied to identify the determinants of ‘unscreened’, ‘screened but undiagnosed’, ‘diagnosed but untreated’ and ‘treated but uncontrolled’ hypertensive cases. Also, descriptive and bivariate analyses were performed to examine the association between the covariates and five hypertension categories, using models of the form:

$$Y_{ij} = O_j + K_j(X_{ikj}) + e_{ij}$$

where Y_{ij} is the outcome variable (unscreened, screened but undiagnosed, diagnosed but untreated and treated but uncontrolled hypertensive cases; 1=Yes, 0=No) i.e. lost cases at each level of the RoH for men i in cluster (community) j ; O_j is the intercept for the individual-level model (average risk of discontinuing at each level of RoH in cluster j); X_{ikj} is the covariate (education, age group, wealth index, etc.); K_j is the coefficients for the individual-level covariates; and e_{ij} is the error terms for the individual-level model.

The intra-cluster correlation (ICC, ρ) was calculated for the dependent variable for a gap in each level of RoH. The latent variable method was used to calculate ρ (Curini *et al.*, 2020), which indicates the proportion of the total variance at the cluster level, calculated as:

$$\rho = \frac{\sigma_1^2}{\sigma_1^2 + \pi^2/3}$$

where σ_1^2 is the variance between clusters and $\pi^2/3$ is the estimated variance between individuals. The proportion of explained variance (σ_e^2) explained by clusters considered in the model, i.e. explained by different blocks of covariates, were then calculated using the formula:

$$\sigma_e^2 = \frac{\sigma_i^2 - \sigma_{ii}^2}{\sigma_i^2}$$

where σ_e^2 is the explained variance, σ_i^2 is the variance in the initial or empty model and σ_{ii}^2 is the second-level variance in the models with various blocks of covariates.

The random-effects logistic regression model is a hierarchical model that assumes that the collected data are drawn from the hierarchy of populations, and their differences relate to that hierarchy. The model is used for controlling unobserved heterogeneity in the sample. Adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated to assess the likelihood of the association of gaps in hypertension continuum care with their selected covariates. All the estimates provided in this study were derived by applying appropriate sampling weights in the NFHS-4 dataset. The analyses were performed on a total of 101,433 hypertensive cases of men using STATA version 15.0. Data visualizations were performed using Excel 2016.

Results

Participants’ background characteristics

Table 2 presents the descriptive statistics of the study sample ($N=101,433$). Approximately one-third (31.5%) of the men belonged to 15–24 year age group. Around 57.3% had completed secondary education and 45.0% belonged to OBCs. The analytic sample were predominately rural residents (63.0%) and of the Hindu religion (83.6%). Thirteen per cent came from the North region, 2.9% from the North-East region, 23.7% from the Central region, 18.3% from the East region, 18.4% from the West region and 23.6% from the South region. Around 59.5% had a household size of four or more. Additionally, 54.0% didn’t consume tobacco, 30.1% consumed alcohol and 19.5% were overweight or obese.

Table 2. Descriptive statistics of study sample, NFHS-4, India, 2015–16

Background characteristic	Weighted % [n]
Predisposing factors	
Age (years)	
15–24	31.5 [32,274]
25–34	27.4 [27,753]
35–44	23.1 [23,396]
45–54	18.0 [18,010]
Education	
No education	13.1 [13,565]
Primary	12.6 [13,146]
Secondary	57.3 [59,106]
Higher	17.0 [15,616]
Social class	
SC/ST	30.2 [38,068]
OBC	45.0 [41,100]
Other	24.7 [22,265]
Religion	
Hindu	83.6 [78,584]
Muslim	11.0 [10,859]
Other	5.4 [11,990]
Household size	
≥4 members	40.5 [38,384]
<4 members	59.5 [63,049]
Marital status	
Never married	34.9 [35917]
Ever married	65.1 [65,516]
Enabling factors	
Place of residence	
Urban	37.0 [31,797]
Rural	63.0 [69,636]
Region of residence	
North	13.0 [18,811]
North-East	2.9 [12,359]
Central	23.7 [29,073]
East	18.3 [15,788]
West	18.5 [11,341]
South	23.6 [14,061]

(Continued)

Table 2. (Continued)

Background characteristic	Weighted % [n]
Wealth index	
Poor	33.3 [33,811]
Middle	33.3 [33,811]
Rich	33.3 [33,811]
Health insurance	
No	76.3 [80,405]
Yes	23.7 [21,028]
Risk factors	
Occupation	
Not working	21.9 [22,387]
Agriculture	27.8 [30,573]
Casual worker	25.9 [25,242]
Salaried	24.5 [23,231]
Tobacco consumption	
No	54.0 [51,174]
Only smoking	15.7 [15,886]
Only chewing	21.5 [22,909]
Both	8.8 [11,464]
Alcohol consumption	
No alcohol	69.8 [68,575]
Almost every day	3.7 [4466]
About once a week	12.2 [13,577]
Less than once a week	14.2 [14,815]
Nutritional status	
Underweight	20.0 [19,854]
Normal weight	60.5 [63,766]
Overweight	16.3 [15,081]
Obese	3.2 [2732]
Diet index	
Healthy	48.6 [52,135]
Unhealthy	51.4 [49,298]
Glucose level	
Normal	91.3 [92,887]
High	8.7 [8546]
Total	100.0 [101,433]

Participants' blood pressure levels

Table 3 shows the prevalences of the different stages of hypertension among the participants by their background characteristics. The prevalences of normal BP and pre-hypertension in the sample were 42.2% and 43.2%, respectively. About 16.0% of the men had hypertension (see Table 4, column B), with 11.0% at Stage I, 2.5% at Stage II and only 1.0% at Stage III ($p < 0.001$) (see Table 3). The prevalence of hypertension was significantly higher ($p < 0.001$) in the old age group (see Table 4, column B).

Table 4 displays the overall prevalence of hypertension among the participants by background characteristics. Those aged 15–24 years had a lower prevalence of hypertension (4.7%) than those in the other age groups: 12.9% for those aged 25–34 years, 22.5% for those aged 35–44 years and 28.9% for those aged 45–54 years. The prevalences of hypertension in ever-married and never-married men were 20.3% and 6.4%, respectively, i.e. 3-fold higher among ever-married than among never-married men. Overall, the prevalence of hypertension was highest in the wealthiest (rich) population (18.9%). The prevalence of hypertension in urban areas (17.5%) was higher than that in rural areas (14.3%). The prevalence of hypertension among salaried men (20.7%) was higher than that in other workers (15.8% in agricultural and 16.5% in casual workers). The prevalence of hypertension increased monotonically with BMI, progressing from 6.1% in underweight men to 38.7% in obese men.

Decomposition analysis of hypertensive individuals

Table 4 also shows the five mutually exclusive and exhaustive categories of hypertensive individuals by background characteristics. More than one-third of the men with hypertension were unscreened (Column D); 40.5% were screened but not diagnosed; 8.6% were diagnosed but not treated; and 6.3% were treated but uncontrolled (Columns F, H and J). Only 6.1% of hypertensive men had controlled blood pressure.

Younger men aged 15–24 years were at a higher risk of being unscreened (56.3%) than older men aged 45–54 years (29.7%). The proportion of unscreened men was higher in rural (41.5%) than in urban areas (30.21%). Men working in agriculture showed a high proportion of unscreened compared with salaried men. The proportion unscreened among poor men (51.4%) was higher than among rich men (24.1%) (Table 4, Column D).

An inverse trend was observed for those who were screened but undiagnosed. While it was evident for all socioeconomic and demographic characteristics, the reverse trend was most striking by wealth index. The percentage of screened but undiagnosed individuals varied from 34.7% in the poor, 40.9% in the middle and 49.2% in the rich (Table 4, Column F). Rich people were more likely to be both treated but uncontrolled as well as controlled compared with non-rich people (Table 4, Columns J and L).

Geographical distribution of hypertensive individuals

Table 5 shows the percentage of hypertensive individuals by screening, diagnosis, treatment and control (RoH) levels and by the states and UTs of India. The percentage of unscreened hypertensive individuals was high in most Indian states and UTs. Odisha (53.0%), Madhya Pradesh (50.7%), Uttar Pradesh (47.2%) and Daman & Diu (47.2%) showed the highest proportions of unscreened men, whereas Chandigarh, Goa, Punjab and Kerala showed the lowest percentages. The 'screened but undiagnosed' category of hypertension varied from 65.3% in Lakshadweep to 20.9% in Daman and Diu; 'diagnosed but untreated' varied between 39.0% in Puducherry and almost zero in Chandigarh, Dadar & Nagar Haveli and Lakshadweep; 'treated but uncontrolled' varied between 26.9% in Chandigarh and 1.6% in Nagaland; and 'controlled' varied from 23.4% in Daman & Diu to 1.0% in Manipur.

Table 3. Prevalence (%) of hypertension status categories by participants' background characteristics, NFHS-4, India, 2015–16

Background characteristic	Normal	Pre-hypertension	Hypertension		
			Stage I	Stage II	Stage III
Predisposing factors					
Age (years)***					
15–24	59.3	36.3	3.9	0.4	0.1
25–34	40.3	47.2	10.0	1.9	0.6
35–44	31.6	47.0	16.0	3.9	1.5
45–54	28.6	44.6	18.6	5.5	2.7
Education***					
No education	39.5	44.4	12.3	2.6	1.2
Primary	39.9	42.9	12.7	3.2	1.4
Secondary	44.6	41.9	10.2	2.3	1.0
Higher	37.7	47.1	11.6	2.7	1.0
Social class***					
SC/ST	42.3	43.2	10.9	2.6	1.0
OBC	43.5	42.3	10.9	2.3	1.1
Other	39.7	45.0	11.5	2.8	1.1
Religion***					
Hindu	42.2	43.3	11.0	2.5	1.0
Muslim	45.0	41.9	9.9	2.3	1.0
Other	36.1	45.4	13.7	3.4	1.4
Household size***					
≥4 members	39.7	44.3	11.8	3.0	1.2
<4 members	43.9	42.5	10.5	2.2	0.9
Marital status***					
Never married	55.6	38.3	5.1	0.8	0.3
Ever married	35.0	45.9	14.2	3.5	1.5
Enabling factors					
Wealth index***					
Poor	47.0	41.9	8.7	1.6	0.8
Middle	41.5	42.6	11.8	2.9	1.2
Rich	36.3	46.3	13.0	3.2	1.2
Region of residence***					
North	36.0	48.2	12.6	2.3	0.9
North-East	29.5	48.7	16.1	3.8	2.0
Central	45.5	42.9	9.0	1.9	0.7
East	44.7	42.8	9.7	2.0	0.9

(Continued)

Table 3. (Continued)

Background characteristic	Normal	Pre-hypertension	Hypertension		
			Stage I	Stage II	Stage III
West	42.6	41.9	11.4	3.2	1.0
South	41.6	41.6	12.3	3.0	1.6
Place of residence***					
Urban	39.9	43.8	12.1	3.0	1.2
Rural	43.5	42.9	10.4	2.2	0.9
Health insurance***					
No	42.7	43.4	10.6	2.4	0.9
Yes	40.5	42.7	12.5	2.9	1.5
Risk factors					
Occupation***					
Not working	56.4	36.4	5.8	1.1	0.4
Agriculture	40.8	44.1	11.7	2.5	1.0
Casual worker	39.7	44.6	11.6	2.9	1.2
Salaried	33.6	46.9	14.4	3.5	1.6
Tobacco consumption***					
No	45.0	42.0	10.0	2.2	0.8
Only smoking	37.4	45.5	12.8	3.0	1.4
Only chewing	39.7	43.8	12.4	2.8	1.3
Both	39.7	45.5	11.0	2.7	1.2
Alcohol consumption***					
No alcohol	44.9	42.5	9.7	2.1	0.8
Almost every day	29.1	43.1	19.2	5.4	3.3
About once a week	34.7	45.7	14.4	3.7	1.5
Less than once a week	38.7	44.6	12.4	3.1	1.3
Nutritional status***					
Underweight	65.5	28.9	4.5	0.8	0.4
Normal weight	40.9	46.0	10.2	2.1	0.8
Overweight	22.9	49.9	19.6	5.4	2.2
Obese	18.6	46.1	24.5	7.6	3.3
Diet index***					
Healthy	43.3	43.1	10.5	2.2	0.9
Unhealthy	41.2	43.3	11.5	2.8	1.2
Glucose level***					
Normal	43.5	43.1	10.3	2.2	1.0
High	28.3	44.9	19.1	5.5	2.1
Total	42.2	43.2	11.0	2.5	1.1

*** $p < 0.01$.

Table 4. Prevalence of hypertension by screening, diagnosis, treatment and control levels by participants' background characteristics, NFHS-4, India, 2015–16

Background characteristic (A)	Hypertension prevalence (%) (B)	Unscreened		Screened but undiagnosed		Diagnosed but untreated		Treated but uncontrolled		Controlled	
		Prevalence (C)	Conditional prevalence (D)	Prevalence (E)	Conditional prevalence (F)	Prevalence (G)	Conditional prevalence (H)	Prevalence (I)	Conditional prevalence (J)	Prevalence (K)	Conditional prevalence (L)
Predisposing factors											
Age (years)											
15–24	4.7	2.7	56.3	1.5	31.7	0.2	3.8	0.0	0.8	0.4	7.4
25–34	13.0	5.5	42.1	5.5	42.7	1.1	8.3	0.4	2.8	0.5	4.1
35–44	22.5	7.8	34.8	10.0	44.5	2.0	8.9	1.5	6.9	1.1	5.0
45–54	28.9	8.6	29.7	11.8	41.0	3.1	10.8	3.0	10.3	2.4	8.2
Education											
No education	16.8	7.6	45.2	6.0	35.5	1.3	8.0	1.0	6.2	0.9	5.1
Primary	17.9	8.0	44.6	6.8	38.0	1.3	7.2	1.0	5.7	0.8	4.5
Secondary	14.2	5.1	36.0	6.1	42.5	1.3	9.1	0.9	6.6	0.8	5.8
Higher	16.6	4.4	26.4	7.8	47.0	1.7	10.4	1.2	7.2	1.5	9.0
Social class											
SC/ST	15.1	6.1	40.6	6.1	40.6	1.4	9.0	0.8	5.3	0.7	4.5
OBC	15.1	5.6	36.7	6.2	40.9	1.3	8.9	1.0	6.9	1.0	6.6
Other	16.4	5.4	32.7	7.3	44.2	1.5	8.9	1.2	7.2	1.2	7.1
Religion											
Hindu	15.4	5.9	38.5	6.2	40.6	1.3	8.5	1.0	6.3	1.0	6.2
Muslim	13.9	4.4	31.8	6.1	43.9	1.4	10.2	1.1	8.1	0.9	6.2
Other	19.4	4.6	23.5	10.2	52.2	2.3	11.6	1.4	7.2	1.1	5.5

(Continued)

Table 4. (Continued)

Background characteristic (A)	Hypertension prevalence (%) (B)	Unscreened		Screened but undiagnosed		Diagnosed but untreated		Treated but uncontrolled		Controlled	
		Prevalence (C)	Conditional prevalence (D)	Prevalence (E)	Conditional prevalence (F)	Prevalence (G)	Conditional prevalence (H)	Prevalence (I)	Conditional prevalence (J)	Prevalence (K)	Conditional prevalence (L)
Household size											
≥4 members	17.1	5.7	33.4	7.4	43.0	1.5	8.7	1.3	7.5	1.3	7.4
<4 members	14.3	5.7	39.6	5.8	40.6	1.3	9.1	0.8	5.7	0.7	5.1
Marital status											
Never married	6.5	3.3	50.5	2.3	36.2	0.4	6.2	0.1	1.0	0.4	6.2
Ever married	20.3	7.0	34.5	8.6	42.6	1.9	9.4	1.5	7.4	1.2	6.1
Enabling factors											
Wealth index											
Poor	11.5	5.9	51.4	4.0	34.7	0.7	6.2	0.4	3.6	0.5	4.1
Middle	16.7	6.1	36.4	6.9	40.9	1.6	9.8	1.2	6.9	1.0	5.9
Rich	18.9	4.6	24.1	9.3	49.2	1.9	9.9	1.6	8.5	1.6	8.3
Region of residence											
North	16.7	4.5	27.2	8.0	48.3	2.1	12.7	1.1	6.4	0.9	5.5
North-East	22.5	7.2	32.2	10.7	47.4	2.4	10.8	1.4	6.0	0.8	3.6
Central	12.2	5.7	46.8	4.6	37.5	0.8	6.9	0.5	3.7	0.6	5.1
East	13.3	5.3	39.9	5.0	37.4	1.2	9.0	1.0	7.8	0.8	5.8
West	16.6	6.6	39.5	7.4	44.8	0.7	4.2	0.8	5.0	1.1	6.5
South	18.0	5.8	31.9	7.3	40.4	2.1	11.4	1.6	8.8	1.3	7.4
Place of residence											
Urban	17.5	5.3	30.2	7.8	44.8	1.7	9.6	1.5	8.3	1.2	7.1

(Continued)

Table 4. (Continued)

Background characteristic	Hypertension prevalence (%)	Unscreened		Screened but undiagnosed		Diagnosed but untreated		Treated but uncontrolled		Controlled	
		Prevalence	Conditional prevalence	Prevalence	Conditional prevalence	Prevalence	Conditional prevalence	Prevalence	Conditional prevalence	Prevalence	Conditional prevalence
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)
Rural	14.3	5.9	41.6	5.6	39.4	1.2	8.4	0.7	5.2	0.8	5.4
Health insurance											
No	14.7	5.7	38.5	6.1	41.2	1.2	8.4	0.9	5.8	0.9	6.0
Yes	17.9	5.8	32.3	7.7	42.8	1.8	10.2	1.5	8.3	1.2	6.4
Risk factors											
Occupation											
Not working	7.9	3.4	42.9	2.6	33.3	0.7	8.4	0.4	5.5	0.8	9.9
Agriculture	15.7	6.9	43.8	5.9	37.6	1.4	8.7	0.8	5.2	0.8	4.8
Casual worker	16.5	6.0	36.2	7.3	44.0	1.3	8.1	1.0	6.1	0.9	5.7
Salaried	20.7	6.1	29.3	9.5	46.0	2.1	10.0	1.7	8.4	1.3	6.3
Tobacco consumption											
No	14.0	4.7	33.2	6.0	43.0	1.3	9.5	0.9	6.7	1.1	7.6
Only smoking	18.0	6.2	34.8	7.3	40.4	1.9	10.8	1.5	8.6	1.0	5.4
Only chewing	17.1	7.3	42.6	7.1	41.3	1.2	6.9	0.9	5.1	0.7	4.2
Both	15.4	7.1	45.9	5.9	38.1	1.1	7.1	0.7	4.7	0.7	4.2
Alcohol consumption											
No alcohol	13.4	5.0	37.2	5.5	41.2	1.1	8.3	0.9	6.3	0.9	6.9
Almost every day	28.8	11.3	39.2	11.1	38.4	2.9	10.1	2.4	8.4	1.1	3.9
About once a week	20.3	7.0	34.5	8.7	42.7	2.1	10.3	1.5	7.5	1.0	5.0

(Continued)

Table 4. (Continued)

Background characteristic	Hypertension prevalence (%)	Unscreened		Screened but undiagnosed		Diagnosed but untreated		Treated but uncontrolled		Controlled	
		Prevalence	Conditional prevalence	Prevalence	Conditional prevalence	Prevalence	Conditional prevalence	Prevalence	Conditional prevalence	Prevalence	Conditional prevalence
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)
Less than once a week	17.6	6.4	36.6	7.7	43.6	1.6	9.2	1.0	5.5	0.9	5.1
Nutritional status											
Underweight	6.1	3.1	51.2	2.0	32.5	0.4	5.8	0.2	2.9	0.5	7.7
Normal	13.7	5.5	40.3	5.8	42.2	1.1	8.1	0.6	4.3	0.7	5.1
Overweight	29.0	8.9	30.7	12.1	41.7	3.2	11.2	2.8	9.8	1.9	6.7
Obese	38.7	8.8	22.7	18.3	47.2	3.3	8.5	4.8	12.3	3.6	9.3
Diet index											
Healthy	14.4	5.7	39.5	6.0	41.5	1.2	8.1	0.8	5.4	0.8	5.5
Unhealthy	16.5	5.7	34.6	6.9	41.8	1.6	9.6	1.2	7.4	1.1	6.6
Glucose level											
Normal	14.2	5.5	38.6	5.9	41.7	1.2	8.6	0.8	5.3	0.8	5.8
High	28.8	8.0	27.7	12.0	41.6	3.0	10.4	3.7	12.7	2.2	7.7
Total	16.0	5.7	36.5	6.5	40.5	1.4	8.6	1.0	6.3	1.4	6.1

'Prevalence' is for the total sample; 'Conditional prevalence' represents the respondent achieving at each step given that he already has hypertension.

Table 5. Prevalence of hypertension screening, diagnosis, treatment and control levels of participants across states and UTs, NFHS-4, India, 2015–16

State	Total hypertension	Unscreened	Screened but undiagnosed	Diagnosed but untreated	Treated but uncontrolled	Controlled
Andaman & Nicobar Islands	30.5	22.8	46.2	10.2	18.8	2.0
Andhra Pradesh	18.7	36.3	41.0	6.9	8.7	7.1
Arunachal Pradesh	22.9	33.1	46.1	10.2	6.5	4.1
Assam	23.9	33.2	47.9	9.8	6.6	2.6
Bihar	11.4	46.3	30.8	7.2	7.0	8.7
Chandigarh	18.0	8.7	54.8	0.0	26.9	9.7
Chhattisgarh	14.2	40.8	48.7	4.2	4.1	2.2
Dadra and Nagar Haveli	14.7	21.3	60.2	0.0	15.2	3.3
Daman and Diu	11.5	47.2	21.0	0.0	8.5	23.4
Goa	16.7	9.0	64.7	4.0	8.0	14.3
Gujarat	14.8	39.0	47.5	3.3	5.4	4.8
Haryana	19.3	16.0	48.5	18.5	6.2	10.8
Himachal Pradesh	24.8	36.1	39.2	13.9	5.2	5.5
Jammu and Kashmir	16.8	30.6	43.1	9.9	9.4	6.9
Jharkhand	13.0	45.3	39.8	8.1	3.4	3.4
Karnataka	18.0	34.5	50.9	3.5	5.9	5.2
Kerala	12.5	14.9	52.2	12.9	5.1	14.9
Lakshadweep	11.5	22.8	65.3	0.0	6.0	5.9
Madhya Pradesh	12.7	50.7	34.0	4.0	4.8	6.5
Maharashtra	18.0	41.0	42.4	4.9	4.6	7.3
Manipur	22.9	18.3	59.1	15.4	6.2	1.0
Meghalaya	14.0	40.0	30.8	5.5	5.4	18.3
Mizoram	18.7	16.5	61.5	15.3	5.1	1.6
Nagaland	25.5	23.5	53.6	18.9	1.6	2.3
Delhi	5.3	28.7	33.2	13.0	12.0	13.0
Odisha	15.0	53.6	23.2	9.4	5.0	8.7
Puducherry	20.0	15.7	25.5	39.0	7.2	12.6
Punjab	23.4	12.5	63.3	15.2	7.2	1.9
Rajasthan	13.4	43.8	40.7	7.1	4.6	3.8
Sikkim	30.5	22.1	45.6	18.6	8.5	5.3
Tamil Nadu	18.8	32.1	32.8	16.8	10.9	7.3
Tripura	17.2	39.2	38.3	12.8	2.5	7.3
Uttar Pradesh	11.2	47.2	35.9	8.8	3.0	5.1
Uttarakhand	19.6	34.3	49.0	7.8	4.8	4.2

(Continued)

Table 5. (Continued)

State	Total hypertension	Unscreened	Screened but undiagnosed	Diagnosed but untreated	Treated but uncontrolled	Controlled
West Bengal	14.5	26.9	48.3	10.6	11.2	3.0
Telangana	20.1	34.6	39.7	10.3	9.6	5.9
Total	16.0	36.5	40.5	8.6	6.3	6.1

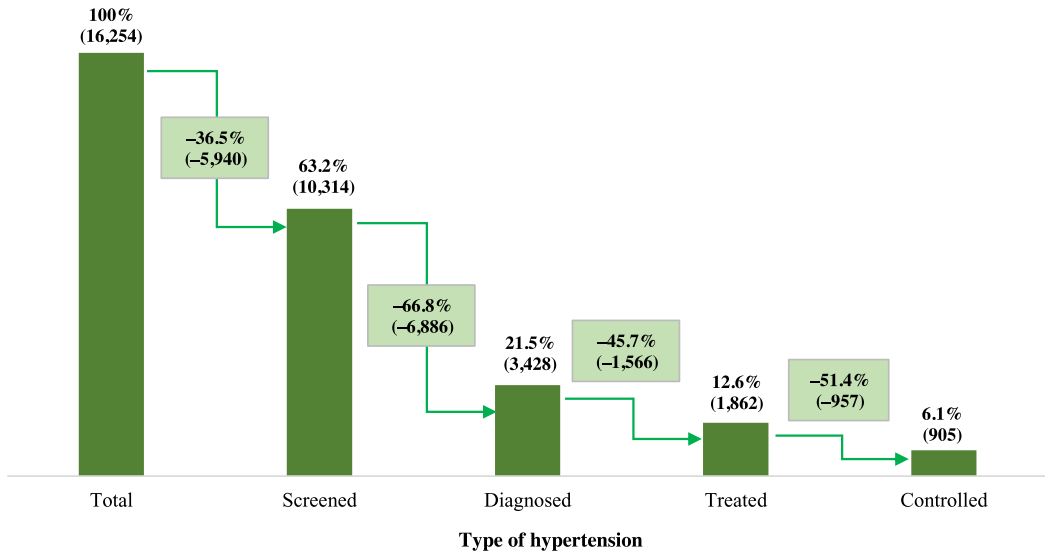


Figure 2. Cascades in hypertension care and percentage loss at each stage, NFHS-4, India, 2015–16.

Unmet need for hypertension care

Figure 2 presents a flowchart of the percentage of men receiving care at each level of RoH. At the national level, of the total 16,254 hypertensive men aged 15–54 years, 63.2% (10,314) were screened, 21.5% (3,428) were diagnosed, 12.6% (1,862) were treated and only 6.1% (905) were having their blood pressure controlled. Almost 63% (10,314) were screened for hypertension – a loss of 36.5% (5,940) at the first level (screening stage). Among men who were screened, 33.2% (3,428) were diagnosed with hypertension, confirming a loss of 66.8% (6,886) at the second level (screened but undiagnosed). Of those diagnosed with hypertension, only 54.3% (1,862) went for effective treatment, giving a loss of 45.7% (1,566) at the third level (diagnosed but untreated cases). Among men currently under hypertensive medication, 48.6% (905) had their BP under control – again, a loss of 51.4% (957) at the fourth level (treated but uncontrolled cases). These outcomes confirm a significant loss at each level of the RoH, showing that hypertensive men in India exhibit the Rule of Halves: approximately one-third at the first level, two-third at the second level and about half at the third and fourth level each. Only 6.1% (905) had their BP under control. Also, the unmet need for hypertension care was 93.9% among the participating men.

Results of regression analysis

Table 6 presents the results of the four sequential random-effect logistic regression models for men with hypertension and not receiving hypertension care. For each model applied for RoH

Table 6. Predictors of unscreened, screened but undiagnosed, diagnosed but untreated and treated but uncontrolled hypertension among men, NFHS-4, India, 2015–16

Background characteristic	Model I		Model II		Model III		Model IV	
	Unscreened	95% CI	Screened but undiagnosed	95% CI	Diagnosed but untreated	95% CI	Treated but uncontrolled	95% CI
	OR		OR		OR		OR	
Predisposing factors								
Age (years) (Ref.: 15–24)								
25–34	1.62***	1.46–1.8	2.2***	1.96–2.48	3.96***	2.95–5.32	3.9***	2.1–7.24
35–44	2.2***	1.96–2.48	3.59***	3.15–4.08	6.99***	5.12–9.55	11.96***	6.41–22.29
45–54	2.53***	2.23–2.86	4.84***	4.24–5.52	10.14***	7.4–13.91	23.64***	12.68–44.09
Education (Ref.: No education)								
Primary	0.98	0.89–1.08	1.08*	0.97–1.2	1.06	0.85–1.32	0.98	0.76–1.27
Secondary	0.82***	0.75–0.89	1.18***	1.08–1.29	1.28**	1.06–1.54	1.04	0.83–1.3
Higher	0.73***	0.65–0.83	1.34***	1.2–1.51	1.51***	1.2–1.89	1.27	0.96–1.67
Social class (Ref.: SC/ST)								
OBC	0.88***	0.82–0.95	0.95	0.89–1.02	0.96	0.83–1.11	1.01	0.85–1.21
Other	0.9***	0.82–0.98	0.99	0.92–1.07	0.92	0.79–1.08	0.98	0.81–1.19
Religion (Ref.: Hindu)								
Muslim	0.81***	0.72–0.91	1.06	0.95–1.17	1.09	0.88–1.34	1.35***	1.07–1.7
Other	0.79***	0.71–0.89	1.06	0.97–1.17	1.21	1.02–1.44	0.98	0.79–1.23
Household size (Ref.: ≥4 members)								
<4 members	1.03***	0.97–1.09	0.83***	0.79–0.88	0.96	0.86–1.07	0.81***	0.7–0.93
Marital status (Ref.: Never married)								
Ever married	0.87	0.79–0.96	1.31***	1.19–1.45	1.26**	1.02–1.55	1.99***	1.34–2.93
Enabling factors								
Wealth index (Ref.: Poor)								
Middle	0.96*	0.89–1.03	1.34***	1.24–1.45	1.42***	1.21–1.67	1.63***	1.32–2.01
Rich	0.75***	0.67–0.84	1.57***	1.42–1.74	1.35***	1.1–1.67	1.79***	1.38–2.33
Region of residence (Ref.: North)								
North-East	1.12*	0.98–1.28	1.28***	1.14–1.44	1.21*	0.97–1.5	1.16	0.88–1.52
Central	1.18***	1.06–1.31	0.65***	0.59–0.72	0.4***	0.33–0.49	0.53***	0.41–0.68
East	1.05	0.93–1.18	0.53***	0.47–0.6	0.58***	0.46–0.72	0.86	0.66–1.13
West	1.22***	1.07–1.38	0.83***	0.74–0.93	0.26***	0.19–0.34	0.74	0.56–0.97
South	1.06	0.93–1.2	0.67***	0.6–0.75	0.63***	0.51–0.78	1.02	0.8–1.3
Place of residence (Ref.: Urban)								
Rural	1.07*	0.98–1.16	0.98*	0.91–1.05	0.87***	0.75–1	0.92	0.78–1.09
Health insurance (Ref.: No)								
Yes	0.96	0.89–1.03	1.03	0.96–1.1	1.06	0.93–1.21	1.05	0.9–1.23

(Continued)

Table 6. (Continued)

Background characteristic	Model I		Model II		Model III		Model IV	
	Unscreened		Screened but undiagnosed		Diagnosed but untreated		Treated but uncontrolled	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Risk factors								
Occupation (Ref.: Not working)								
Agriculture	0.97***	0.88–1.07	1.08***	0.97–1.21	0.75***	0.61–0.92	0.82***	0.62–1.07
Casual worker	0.94***	0.85–1.04	1.27***	1.15–1.42	0.79***	0.64–0.97	0.87***	0.66–1.13
Salaried	0.92***	0.83–1.02	1.34***	1.21–1.49	0.94***	0.78–1.15	0.94***	0.72–1.21
Tobacco consumption (Ref.: No)								
Only smoking	1.05	0.96–1.14	0.84***	0.78–0.91	0.92	0.79–1.07	0.93	0.77–1.12
Only chewing	1.24***	1.15–1.34	1.06*	0.99–1.14	1.04	0.89–1.21	1.05	0.87–1.26
Both	1.05	0.95–1.16	0.86***	0.78–0.95	**0.78	0.64–0.95	0.87	0.68–1.12
Alcohol consumption (Ref.: Never)								
Less than once a week	1.75***	1.56–1.96	1.62***	1.45–1.82	1.91*	1.55–2.35	1.73	1.34–2.23
About once a week	1.33***	1.22–1.45	1.39***	1.29–1.51	1.23**	1.05–1.45	1.25*	1.03–1.51
Almost every day	1.16***	1.07–1.26	1.26***	1.17–1.36	1.2***	1.03–1.41	0.99***	0.8–1.22
BMI (Ref.: Underweight)								
Normal	1.6***	1.47–1.75	1.89***	1.7–2.1	1.9***	1.49–2.43	2.09***	1.46–2.99
Overweight	2.75***	2.47–3.05	3.42***	3.05–3.84	3.86***	2.99–5	5.23***	3.62–7.55
Obese	2.85***	2.42–3.36	4.34***	3.73–5.04	5.18***	3.8–7.06	7.57***	5.04–11.38
Diet index (Ref.: Healthy)								
Unhealthy	1.03	0.96–1.1	1.06	1–1.13	1.05	0.92–1.19	1.03	0.88–1.2
Glucose level (Ref.: Normal)								
High	1.11*	1.01–1.21	1.32***	1.22–1.43	1.4***	1.21–1.62	2.05***	1.75–2.4
ρ	0.15	0.14–0.17	0.14	0.13–0.16	0.27	0.24–0.31	0.2	0.15–0.26

Ref.: reference category; OR: Odds Ratio; CI: Confidence Interval.
 * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

level, the intra-class correlation coefficient within states/UTs (ρ) was used to measure the proportion of variation in the loss of patients within states/UTs. Model I shows the determinants for unscreened cases in hypertensive men. The chance of having unscreened hypertension were 62% (OR=1.62; 95% CI: 1.46–1.80) higher in men aged 25–34 years than those aged 15–24 years. Men with higher education had 0.3 times lower odds of having unscreened hypertension (OR=0.73; 95% CI: 0.65–0.83) than men with only primary education. Muslim men had a 19% (OR=0.81; 95% CI: 0.72–0.81) higher chance of having unscreened hypertension than Hindu men. Men from rural areas had 1.07 (OR=1.07; 95% CI: 0.98–1.16) higher odds of having unscreened hypertension than those from urban areas. The odds of having unscreened hypertension increased 2.9 times (OR=2.85; 95% CI: 2.42–3.36) for obese men compared with underweight men. The ρ of Model I was 0.15 (CI: 0.14–0.17), implying that variation within the state accounted for 15% of the total variation in unscreened hypertension, with individual characteristics causing the remaining 85% of variation.

Model II shows the determinants for screened but undiagnosed cases of hypertensive men. Factors showing significant association in Model I were also significant in Model II – except for respondent's religion. The ρ of Model II was 0.14 (95% CI: 0.13–0.16). All the covariates found to be significant in Model II were significant in Model III, and the ρ for this model was 0.27 (95% CI: 0.24–0.31), i.e. 27%. Model IV explores the effect of correlates on treated but uncontrolled cases of hypertensive men. The covariates show the effect on this level of RoH among hypertensive men, similar to other models. Compared with the previous models, the effects of obesity on treated but uncontrolled hypertensive men were slightly high (OR=7.57; 95% CI: 5.04–11.38). The ρ of Model IV was 0.20 (95% CI: 0.15–0.26), implying that variation within the state accounted for 20% of the total variation in treated but uncontrolled hypertension, with individual characteristics causing the remaining 80% of variation.

Discussion

This study examined the burden of hypertension and unmet need for hypertension care among men of working age (15–54 years) from all 36 states and Union Territories of India. The results showed that around 36.5% had never been screened for hypertension, 40.5% had been screened but had not been diagnosed with hypertension and 8.6% had been diagnosed but had never received any treatment in 2015–16. Only 6.1% had controlled blood pressure. Moreover, 93.9% of the men currently consuming anti-hypertensive medication had an elevated BP level. These findings are in concordance with the existing literature on hypertension proposing the validity of the Rule of Halves in rural India (Faizi *et al.*, 2016).

The escalating rates of hypertension in India have made it a critical public health concern in the country. However, in the case of self-reported hypertension rates, the burden seems low because the vast majority of the population are not aware of their elevated BP status (Prenissl *et al.*, 2019; Puri *et al.*, 2020). However, this is just the tip of the iceberg; none of the categories of hypertension management, i.e. diagnosis, treatment and control, has reached an optimal standard, and there is a need for improvement at every stage in India's hypertension care cascade.

The study revealed that there was low screening coverage in the East region of India in 2015–16 (Odisha, Bihar and Jharkhand), followed by the Central region (Uttar Pradesh and Chhattisgarh). All these states have a low median age, i.e. a higher proportion of young population under the age of 25 years. However, studies have highlighted an increasing prevalence of hypertension among India's working-age groups (Ramakrishnan *et al.*, 2019). A study on hypertension reporting heterogeneity, i.e. the gap between self-reported and clinically diagnosed hypertension, in India has suggested that respondents in the younger age groups are more prone to report that they do not suffer from hypertension. However, their clinical results state otherwise. The primary reason is that they have never been screened for the condition, so they are unaware of their actual health status (Puri *et al.*, 2020). This could be because of the general notion that hypertension is uncommon in younger age groups. Therefore younger men might consider screening to be unnecessary (Benetos *et al.*, 2019).

The coverage of treatment has been found to be lower in the North-East region (the states of Nagaland, Sikkim, Manipur and Mizoram), followed by the North region (the states of Haryana, Punjab and Himanchal Pradesh) (Kasthuri, 2018). Moreover, the North-East region (the states of Manipur, Nagaland, Assam, Mizoram and Arunachal Pradesh), followed by the Central region (the states of Uttarakhand and Chhattisgarh), have the lowest control rates, even after receiving treatment. The probable reason for this is the fragile health care infrastructure in these regions (Saikia & Das, 2012; Prinja *et al.*, 2012), which is lacking one or more of the 5 'A's, i.e. Awareness (of health), Access (to health care), Absence (of human power in health care), Affordability (for the cost of health care), and Accountability (of health care) (Kasthuri, 2018).

This study further found that age, obesity, alcohol consumption and occupation were significantly associated with unscreened, undiagnosed, untreated and uncontrolled hypertension cases among men aged 15–54 years in India. Unscreened cases were highest in the age group 25–34 years, i.e. the comparatively young age group. In contrast, undiagnosed, untreated and uncontrolled cases were highest in those aged 45–54 years. The dominance of unscreened cases among the younger age group could be due to assumption that hypertension is generally associated with the older population. Moreover, uncontrolled hypertension cases could be caused by the biological changes that occur in the arteries with the respondent's age (Herxheimer *et al.*, 1992; Pinto, 2007).

Obesity and alcohol consumption were found to be significant predictors of unscreened, undiagnosed, untreated and uncontrolled cases of hypertension in the study men, suggesting that this population is generally unaware of good health and lifestyle behaviour and tend to remain unaware of existing health conditions due to a lack of diagnosis. Furthermore, previous studies suggest that the regular consumption of alcohol can cause a substantial rise in blood pressure levels, leading them to be uncontrolled and resulting in chronic hypertension (Maheswaran *et al.*, 1991; Husain *et al.*, 2014). In addition, alcohol contains sugar and calories in high concentrations, which can lead to increases in BMI and obesity – significant risk factors for uncontrolled BP levels among men in the younger age groups (Sayon-Orea *et al.*, 2011; Traversy & Chaput, 2015). The study also showed a preponderance of unscreened, untreated and uncontrolled hypertension cases among men aged 15–54 years. The primary reasons for this could be the affordability of medication and hypertension care services in India. Additionally, psychological stress caused by unemployment could lead to uncontrolled high blood pressure levels, even after receiving anti-hypertensive treatment (Shekhar & Shil, 2020).

This study's primary strength was its use of national-level data that included both self-reported and standardized measured SBP and DBP. Another important strength was the use of a continuum of care to depict population-level estimates for the individuals who make it through each stage of the care continuum from screening to hypertension control. However, the study had its limitations. It only considered men of working age (15–54 years), so the findings should not be extrapolated to women or older men. Secondly, it was based on cross-sectional data, so the actual loss of patients in the continuum of care for hypertension could be different.

In conclusion, India is being confronted with several health challenges simultaneously. These are manifold and include high burdens of maternal and child mortality and infectious disease and an accelerating non-communicable disease burden (Arokiasamy & Yadav, 2014; Munshi *et al.*, 2016). Estimates from the present study suggest that hypertension is a significant public health concern among men in the 15–54 year age group, and poor management of hypertension is indisputable at both the national and sub-national level. There are wide gaps in screening, diagnosis, treatment and control of hypertension among different sub-groups in India, and the present study identified specific risk groups for effective hypertension care management by considering several socioeconomic and demographic factors at the individual level. These findings may assist the accountable authorities by providing vital insights at the individual level utilizing nationally represented data. Community-level measures to ensure increased hypertension detection and control should be promoted. Additionally, social marketing strategies are needed to educate the population on the importance of maintaining an optimal body weight and having regular health check-ups at all ages. The involvement of the private sector in the sustainable management of hypertension should be encouraged. If left uncontrolled, hypertension can have severe implications for an individual's work performance, resulting in increased health care costs, absenteeism and loss of productivity. Therefore, it is crucial to study cascades in India's hypertension care to ensure optimal work productivity and economic development. Further research is needed to explore the socioeconomic inequalities and their significant determinants and the association of hypertension with other morbidities such as diabetes in India.

Acknowledgments. The authors are thankful to the DHS programme for offering access to the NFHS-4 datasets.

Funding. This research received no specific grant from any funding agency, commercial entity or not-for-profit organisation.

Conflicts of Interest. The authors have no conflicts of interest to declare.

Ethical Approval. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees.

References

- American Heart Association** (2018) How to Measure Blood Pressure. URL: CCC_Poster_new_URL_10 22 18 - letter (heart.org)
- Andersen RM** (1995) Revisiting the behavioral model and access to medical care: does it matter? *Journal of Health and Social Behavior* **36**(1), 1–10.
- Arokiasamy P and Yadav S** (2014) Changing age patterns of morbidity vis-à-vis mortality in India. *Journal of Biosocial Science* **46**(4), 462–479.
- Asayama K, Ohkubo T, Kikuya M, Metoki H, Obara T, Hoshi H et al.** (2005) Use of 2003 European Society of Hypertension-European Society of Cardiology guidelines for predicting stroke using self-measured blood pressure at home: the Ohasama Study. *European Heart Journal* **26**(19), 2026–2031.
- Benetos A, Petrovic M and Strandberg T** (2019) Hypertension management in older and frail older patients. *Circulation Research* **124**(7), 1045–1060.
- Bloom DE, Cafiero-Fonseca ET, Candeias V, Adashi E, Bloom L, Gurfein L et al.** (2014) Economics of Non-Communicable Diseases in India: The Costs and Returns on Investment of Interventions to Promote Healthy Living and Prevent, Treat, and Manage NCDs. World Economic Forum, Harvard School of Public Health.
- Curini L, Franzese R and Steenbergen M** (2020) Multilevel analysis. Curini L and Franzese R (eds) *The SAGE Handbook of Research Methods in Political Science and International Relations*. Sage Publications, pp, 679–700, doi: [10.4135/9781526486387.n39](https://doi.org/10.4135/9781526486387.n39).
- de Burgos-Lunar C, del Cura-González I, Salinero-Fort MA, Gómez-Campelo P, Pérez de Isla L and Jiménez-García R** (2013) Delayed diagnosis of hypertension in diabetic patients monitored in primary care. *Revista Española de Cardiología (English Edition)* **66**(9), 700–706.
- Faizi N, Ahmad A, Khalique N, Shah M, Khan M and Maroof M** (2016) Existence of rule of halves in hypertension: an exploratory analysis in an Indian village. *Materia Socio Medica* **28**(2), 95.
- Game AU and Seneviratne RDA** (2016) Perceived job stress and presence of hypertension among administrative officers in Sri Lanka. *Asia-Pacific Journal of Public Health* **28**(6), 41S–52S.
- GBD 2016 Risk Factors Collaborators** (2017) Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet* **390**(10100), 1345.
- Gupta R, Gaur K and Ram CV** (2019) Emerging trends in hypertension epidemiology in India. *Journal of Human Hypertension* **33**(8), 575–587.
- Herxheimer A, Dahlöf B, Lindholm LH, Hansson L, Scherstén B, Ekbom T et al.** (1992) Managing hypertension in the elderly. *The Lancet* **339**(8787), 252.
- Husain K, Ansari RA and Ferder L** (2014) Alcohol-induced hypertension: mechanism and prevention. *World Journal of Cardiology* **6**(5), 245.
- International Institute for Population Sciences** (2017) National Family Health Survey (NFHS-4) 2015–16 India. IIPS and ICF, pp. 1–192, doi:kwm120 [pii]10.1093/aje/kwm120.
- Kasthuri A** (2018) Challenges to healthcare in India – the five A's. *Indian Journal of Community Medicine* **43**(3), 141–143.
- Kokubo Y and Iwashima Y** (2015) Higher blood pressure as a risk factor for diseases other than stroke and ischemic heart disease. *Hypertension* **66**(2), 254–259.
- Maheswaran R, Gill JS, Davies P and Beevers DG** (1991) High blood pressure due to alcohol: a rapidly reversible effect. *Hypertension* **17**(6), 787–792.
- Motkuri V and Naik SV** (2016) Growth and structure of workforce in India. *The Indian Economic Journal* **64**(1–4), 57–74.
- Munshi V, Yamey G and Verguet S** (2016) Trends in state-level child mortality, maternal mortality, and fertility rates in India. *Health Affairs* **35**(10), 1759–1763.
- O'Donnell MJ, Denis X, Liu L, Zhang H, Chin SL, Rao-Melacini P et al.** (2010) Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. *The Lancet* **376**(9735), 112–123.
- Panda BB, Pati MR and Sahu PK** (2015) Survey of prescription pattern of anti-hypertensive drugs in hypertensive and diabetic hypertensive patients. *Asian Journal of Pharmaceutical and Clinical Research* **8**(1), 250–252.
- Pinto E** (2007) Blood pressure and ageing. *Postgraduate Medical Journal* **83**(976), 109–114.

- Preussl J, Manne-Goehler J, Jaacks LM, Prabhakaran D, Awasthi A, Bishops AC et al.** (2019) Hypertension screening, awareness, treatment, and control in India: a nationally representative cross-sectional study among individuals aged 15 to 49 years. *PLoS Medicine* **16**(5), 1–18.
- Prinja S, Kanavos P and Rajesh K** (2012) Health care inequities in north India: role of public sector in universalising health care. *Indian Journal of Medical Research* **136**(3), 421–431.
- Puri P, Singh SK and Srivastava S** (2020) Reporting heterogeneity in the measurement of hypertension and diabetes in India. *Journal of Public Health (Germany)* **28**(1), 23–30.
- Ramakrishnan S, Zachariah G, Gupta K, Shivkumar Rao J, Mohanan PP, Venugopal K et al.** (2019) Prevalence of hypertension among Indian adults: results from the great India blood pressure survey. *Indian Heart Journal* **71**(4), 309–313.
- Rashid P, Leonardi-Bee J and Bath P** (2003) Blood pressure reduction and secondary prevention of stroke and other vascular events: a systematic review. *Stroke* **34**(11), 2741–2748.
- Saikia D and Das K** (2012) Rural health infrastructures in the north-east India. *The NEHU Journal* **12**(2), 77–100.
- Sayon-Orea C, Martinez-Gonzalez MA and Bes-Rastrollo M** (2011) Alcohol consumption and body weight: a systematic review. *Nutrition Reviews* **69**(8), 419–431.
- Shekhar C and Shil A** (2020) Linkages between occupation and elevated blood pressure among men in India: a cross-sectional study. *International Journal of Public Health* **65**(6), 835–846.
- Traversy G and Chaput JP** (2015) Alcohol consumption and obesity: an update. *Current Obesity Reports* **4**(1), 122–130.
- United Nations Population Fund** (2015) India Country Office at a Glance. URL: 1-A&YProfile_Size-GrowthRateand Distribution.pdf (unfpa.org)
- Wei Y, Wang Z, Wang H, Li Y and Jiang Z** (2019). Predicting population age structures of China, India, and Vietnam by 2030 based on compositional data. *PLoS One* **14**(4), e0212772.
- Weinehall L, Öhgren B, Persson M, Stegmayr B, Boman K, Hallmans G and Lindholm LH** (2002) High remaining risk in poorly treated hypertension: the “rule of halves” still exists. *Journal of Hypertension* **20**(10), 2081–2088.
- Wilber JA** (1973) The problem of undetected and untreated hypertension in the community. *Bulletin of the New York Academy of Medicine: Journal of Urban Health* **49**(6), 510–520.
- Wolf-Maier K, Cooper RS, Kramer H, Banegas JR, Giampaoli S, Joffres MR et al.** (2004) Hypertension treatment and control in five European Countries, Canada, and the United States. *Hypertension* **43**(1), 10–17.
- Wu AS, Dodhia H, Whitney D and Ashworth M** (2019) Is the rule of halves still relevant today? A cross-sectional analysis of hypertension detection, treatment and control in an urban community. *Journal of Hypertension* **37**(12), 2470–2480.

Cite this article: Kothavale A, Puri P, and Yadav S (2022). The burden of hypertension and unmet need for hypertension care among men aged 15–54 years: a population-based cross-sectional study in India. *Journal of Biosocial Science* **54**, 1078–1099. <https://doi.org/10.1017/S0021932021000481>