Original article

Alcohol and tobacco influencing prevalence of hypertension among 15–54 years old Indian men: An application of discriminant analysis using National Family Health Survey (NFHS), 2015–16

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ABSTRACT

Background: Hypertension has been described as an “iceberg disease” as those who suffer are usually unaware and hence usually seek healthcare services at a very late stage. It is estimated that more than two million Indians are suffering from hypertensive heart diseases that contributed to above 0.13 million deaths in 2016.

Objectives: The present study aims to know the prevalence of Hypertension in India and its variation by socio-economic backgrounds, and to find out risk factors discriminating hypertension with special emphasis on tobacco and alcohol consumption among men aged 15–54 years in India.

Methods: In this study, NFHS (2015–16) data were analyzed by applying binary logistic regression and discriminant analysis in the attempt to find significant predictors and discriminants of interest.

Results: The prevalence of hypertension was 16.5% in the study population. The results suggested that the consumption of alcohol and tobacco are significant discriminant characteristics associated with hypertension irrespective of the socioeconomic background characteristics of the respondents. Hypertension is a chronic disease and is itself a causative factor for several other diseases like renal impairment, other cardiovascular diseases, and stroke.

Conclusions: The findings are expected to have direct implications on public health interventions and policy formulation to reduce diseases caused by tobacco and alcohol, particularly hypertension among men in the potential economically productive age group in India and similar settings.

What is already known?

- More than 2 million Indians are suffering from hypertensive heart disease that contributed to above 0.13 million deaths in 2016.
- Substance use is an important predictor of hypertension irrespective of socioeconomic background characteristics.
- Alcohol and tobacco consumption, both smoking as well as smokeless, are linked to elevated blood pressure and other cardiovascular diseases in both men and women

What does this study add?

- This is the first time in the history of NFHS in India that such a critical association on a large-scale population-based nationally representative survey has been made.
- The finding has direct implications on framing policies for reducing diseases caused by tobacco and alcohol.
- The lowest share of normotensive people belonged to the age group 40–49
- Consumption of alcohol and tobacco alone, or together, was found to be a very crucial determinant of elevation in BP

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1. Introduction

Hypertension is defined as a chronic elevation in blood pressure (BP): systolic ≥ 130 mmHg or diastolic ≥ 80 mm Hg.^{1,2} BP in the range of 130–139 mm Hg systolic or 80–89 mm Hg diastolic is termed as hypertension (previously referred to as Pre-hypertension), while stage 2 hypertension refers to BP 140/90 mm Hg or higher.³ Being the commonest cardiovascular disorder, hypertension is a crucial public health problem as it is associated with stroke, coronary heart diseases, and other vascular complications.¹ Hypertension is present in 69% of the cases with a first myocardial infarction (MI), 77% of the patients with a first stroke, 74% of the cases of chronic heart failure, and 60% of the patients with peripheral artery diseases.² It is interesting to note that in the majority (80–95%) of the cases the etiology of hypertension is unknown, such cases are termed as patients of primary or “essential” hypertension, and cases where BP is raised due to some underlying pathology/drugs, fall into the category of secondary hypertension.³ Secondary hypertension can occur due to a variety of reasons like renal parenchymal diseases, renal artery stenosis (termed as renovascular hypertension), drugs (Oral Contraceptive Pills (OCs), cocaine, steroids, etc.), pheochromocytoma, coarctation of aorta, aldosterone secreting tumors, etc.^{4–6} These causes should be ruled out before initiating therapy for raised BP.

Hypertension has been aptly described as an “iceberg disease” as its sufferers are rarely aware of it, and hence, usually seek healthcare services very late.⁷ Perhaps, this inertia in seeking healthcare is one of the reasons behind changing the previous classification of pre-hypertension to stage 1 disease. According to a recently published study, the trend of hypertension in India differs from that in developed countries where the burden is mainly in the socioeconomically weaker groups, while in India, there is no particular pattern.⁸ However, the burden of deaths due to hypertensive disorders is concentrated among the lower socioeconomic strata of the society.⁹ A study done in Thailand revealed that heavy alcohol consumption is associated with a higher risk of hypertension and other Non-Communicable Diseases (NCDs).¹⁰ Furthermore, genetic defects associated with alcohol metabolizing genes further contribute to the development of hypertension.¹¹ Although some studies have suggested that there might be a protective effect of hormones in females against the hypertensive effect of alcohol, but, a recent meta-analysis suggests that there is no such protective effect and both the genders are equally susceptible to the hypertensive effects of alcohol.^{12,13}

Several studies have stated that tobacco consumption, both smoking as well as smokeless, is linked to elevated blood pressure and other cardiovascular diseases in both men and women.^{14–16} Tobacco has multiple reasons for causing raised blood pressure, these include endothelial dysfunction, raised cardiac output, and peripheral vascular resistance. Furthermore, as tobacco blunts the BP-lowering effect of beta-blockers, the treatment of hypertension in tobacco users also becomes tricky.^{15–17} Many risk factors are associated with hypertension. These include age, body mass index, gender, diet, physical activity, socioeconomic status, emotional stress, and drugs.^{9,18,19} Age is an important contributor as found in many studies; one study has revealed that hypertension is significantly higher in the age group ‘35 years and above’ as compared to the age group ‘0–35 years’.^{18,20} Furthermore, higher age makes management of hypertension more difficult and increasing associated with the development of complications in the patients.¹⁹ There is a significant difference amongst different education classes as well, with more educated people being less prone to develop hypertension.¹⁸

Based on the above background of the study, this study analyses the prevalence of hypertension by socio-economic backgrounds and attempts to find risk factors of hypertension in India. The authors believe that this will provide clues for further strengthening the health care policies for curbing substance abuse and hypertension in India. It will be the first study, which will be based on a nationally representative large-

scale sample survey in India.

2. Methods

2.1. Data source

This study uses data from the fourth round of the National Family Health Survey (NFHS)-4, the Indian version of the Demographic and Health Survey (DHS), conducted in the year 2015–16. NFHS-4 is the first nationwide community-based survey in India to provide estimates of blood pressure and blood glucose levels in the general population. BP was measured for eligible women aged 15–49 and (in the state module subsample of households only) eligible men aged 15–54, using an Omron BP Monitor to determine the prevalence of hypertension. BP measurements for each respondent were taken three times with an interval of 5 min between two consecutive readings.

2.2. Sampling techniques and study population

The NFHS-4 sample is a stratified two-stage sample. The 2011 census served as the sampling frame for the selection of primary sampling units (PSUs). PSUs were villages in rural areas and Census Enumeration Blocks (CEBs) in urban areas. PSUs with fewer than 40 households were linked to the nearest PSU. For this study analysis considered 1,12,122 males aged 15–54 from 1778 clusters (PSUs) in 640 districts of India.⁸

2.3. Outcome measurements

The outcome variable for this study was hypertension. An individual is classified as having hypertension if the systolic blood pressure level is greater than or equal to 140 mmHg, or diastolic blood pressure is greater than or equal to 90 mmHg, or s/he is currently taking antihypertensive medication(s) to lower her/his blood pressure. In the NFHS-4, blood pressure (both diastolic and systolic) of respondents was measured three times following a 5-min gap for the second and third reading. This study has considered the average of the last two readings as suggested in the literature that it help in avoiding upward bias due to anxiety or nervousness while taking the very first reading.

2.4. Defining predictor variables

Based on the theoretical and observed importance applied in the literature and available in the NFHS data-set, significant socioeconomic and risk factors considered in this study are age, education, marital status, occupation, religion, caste/tribe, economic status (wealth index, i.e., wealth quintiles), place of residence, tobacco alcohol, dietary habits and body mass index (BMI).^{9,18,21,22}

The NFHS-4 canvassed following questions on tobacco and alcohol consumption to the respondents. There were respectively (a) Do you currently smoke or use tobacco in any other form? (b) Do you drink alcohol? The response of each question were sought in dichotomous form as “Yes” and “No”. In this paper, a respondent is considered as consumer of tobacco if he answered to the question (a) in “Yes”. He is considered as consumer of alcohol if answered to the question (b) in “Yes”. The survey asked tobacco consumed in any form (like raw or various local means) as well as through smoking. However, no passive or second hand smoking is considered in the definition. Alcohol is also available in various form including locally made liquor and branded ones. No minimum limit on the quantity of alcohol was considered in the definition. These are limitations of data in the large-scale survey.

2.5. Analytical approach

To meet the objective, this study used univariate logistic regression to identify the associated significant risk factors and then used the Fisher’s discriminant analysis to establish a simple and useful prediction

Table 1
Background characteristics of the sampled study Population.

Background Characteristics	Weighted Sample ^a	Weighted proportion
Individuals characteristics		
Age (in years)		
15–24	35,363	31.5
25–40	48,559	43.3
41–49	28,200	25.2
Education		
Non-literate	14,592	13.0
Below Primary	7371	6.6
Below Middle	6720	5.9
Below Secondary	51,240	45.7
Secondary and above	32,200	28.7
Marital Status		
Never married	39,762	35.5
Currently married	70,782	63.1
Others	1578	1.4
Occupation		
Not working	24,818	22.1
Agricultural work	30,202	26.9
Skilled/Unskilled work	28,910	25.8
Professional work	28,191	25.1
Household characteristics		
Religion		
Hindu	91,390	81.5
Non-Hindu	20,732	18.5
Social group		
Scheduled Tribe	9870	9.2
Scheduled Caste	22,138	20.6
Other Backward Class	48,848	45.4
Others	26,673	24.8
Wealth quintile		
Poorest	16,437	14.7
Poorer	20,902	18.6
Middle	23,689	21.1
Richer	24,979	22.3
Richest	26,115	23.3
Community characteristics		
Place of residence		
Rural	42,955	38.3
Urban	69,167	61.7
Region		
North	13,187	11.8
Central	24,931	22.2
East	21,046	18.8
Northeast	3692	3.3
West	20,491	18.3
South	26,602	23.7
Union Territories	2174	01.9
Risk behaviour		
Smoking		
No	61,087	54.5
Yes	51,035	45.5
Alcohol		
No	79,029	70.5
Yes	33,093	29.5
Either Tobacco or Alcohol		
No	51,451	45.9
Yes	60,671	54.1
Both Tobacco and Alcohol		
No	88,665	79.1
Yes	23,457	20.9
Diet		
Vegetarian	32,095	28.6
Non-vegetarian	80,027	71.4
Diabetic		
No	1,09,726	97.9
Yes	2396	02.1
Told by a doctor that he has hypertension or high blood pressure		
No	1,04,828	97.4
Yes	2757	2.6
BMI		
Low	21,347	19.8

Table 1 (continued)

Background Characteristics	Weighted Sample ^a	Weighted proportion
Medium	65,145	60.0
High	17,600	16.4
Obese	3552	03.3
Total	1,12,122	100

Sources: Based on author's computation from NFHS-4 (2015–16).

^a The total may not be equal due to some missing cases.

model based on the significant predictors. Univariate analysis could not control the confounding effect of other variables or avoid the collinearity among some variables. Thus, in the Fisher discriminant analysis, we used a stepwise method to determine the final prediction, which could control the confounding effect and overcome the collinearity between variables. Fisher's discriminant analysis was done to find a linear combination for categorical groups, as the discriminant scores (Z) were calculated to maximize the between-group variance and minimize the within-group variation.

3. Results

3.1. Background characteristics of the respondents

Table 1 shows the background characteristics of our study participants. It can be seen that the study population had a higher proportion of young individuals (age group 15–40 years constituted more than 2/3rd of the participants). Of the surveyed population, around 13% were illiterate individuals, the highest proportion was of the individuals who had been educated below the middle secondary school (45.7%) followed by the secondary and above (28.7%). If we consider the marital status, married individuals contributed to the greatest share of participants (63.1%). Amongst the different occupational groups, the proportion of participants was nearly equal, the lowest proportion amongst them was the not working category participants. The highest proportion of study subjects were from the southern region followed by the central region of the country. Around 55% of subjects reported as current smokers and around 71% reported as current consumers of alcohol in the survey while 21% of all subjects reported consuming both tobacco and alcohol regularly. Most of the participants were non-vegetarians (71.4%). Almost 98% surveyed individuals in this study were non-diabetics.

3.2. Prevalence of hypertension by sociodemographic characteristics and behavioral risk factors

Table 2 depicts the prevalence of hypertension according to various sociodemographic characteristics and behavioral risk factors. The upper limit for normotensive individuals was 120 mmHg systolic and 80 mmHg diastolic blood pressure. Mildly high BP has a cut off value of 140 and 90 mmHg for systolic and diastolic BP respectively. It can be seen that the higher the age of the subject, the greater is the likelihood of being mildly hypertensive. Also, it can be observed that irrespective of the sociodemographic variables, individuals who use either tobacco or alcohol or both had a greater percentage of hypertensives than their counterparts. Nonetheless, the effects of other contributing factors seem to add up to the percentage of hypertensive individuals in the respective group. For example, in younger (15–24 yrs) addicts (of alcohol/tobacco/both) the percentage of hypertensives is lower than their older counterparts (25–40 yrs and 41–49 yrs). Furthermore, mildly high BP was more prevalent in non-vegetarians than vegetarian subjects. Participants who were diabetic had a higher proportion of mildly high BP than non-diabetics.

Table 2

Prevalence of hypertension by sociodemographic characteristics and behavioral risk factors.

Individuals characteristics	Tobacco	Alcohol	Both Tobacco and Alcohol	Prevalence of Hypertension	
	%	%	%	%	95% CI
Age (in years)					
15–24	27.3	16.1	10.5	5.6	[05.2–05.9]
25–40	52.3	35.9	25.6	17.2	[16.6–17.7]
41–49	56.7	35.3	25.9	30.4	[29.5–31.3]
Education					
Non-literate	68.4	40.0	33.4	18.1	[17.2–19.0]
Below Primary	67.4	36.1	29.8	20.7	[19.3–22.3]
Below Middle	62.2	36.7	29.1	17.9	[16.5–19.3]
Below Secondary	44.1	27.9	19.7	15.5	[14.9–16.0]
Secondary and above	28.9	24.3	13.4	17.5	[16.8–18.2]
Marital Status					
Never married	27.9	18.7	11.9	7.5	[07.1–08.0]
Currently married	54.9	35.3	25.7	21.9	[21.4–22.4]
Others	70	39.9	35.0	21.6	[18.6–25.0]
Occupation					
Not working	22.3	14.5	9.1	9.1	[08.6–09.6]
Agricultural work	56.8	32.2	24.7	17.2	[16.6–17.8]
Skilled/Unskilled work	58.4	37.9	28.5	17.9	[17.2–18.7]
Professional work	40.6	31.2	19.5	22.3	[21.4–23.3]
Household characteristics					
Religion					
Hindu	46.1	31.9	22.9	16.9	[16.5–17.3]
Non-Hindu	43.0	19.1	12.3	16.7	[15.9–17.6]
Social group					
Scheduled Tribe	57.7	41.9	33.4	16.6	[15.7–17.5]
Scheduled Caste	50.0	36.9	27.9	16.6	[15.8–17.4]
Other Backward Class	43.5	28.9	19.5	16.4	[15.9–17.0]
Others	40.9	21.8	14.4	18.2	[17.4–19.1]
Wealth quintile					
Poorest	64.2	35.8	31.5	12.2	[11.6–12.8]
Poorer	55.9	30.2	24.5	13.2	[12.6–13.9]
Middle	46.6	30.3	21.3	16.6	[15.9–17.4]
Richer	39.7	28.4	17.7	19.7	[18.9–20.6]
Richest	30.0	25.3	14.1	20.4	[19.5–21.4]
Community characteristics					
Place of residence					
Urban	39.7	29.1	19.1	18.9	[18.1–19.7]
Rural	49.2	29.8	22.1	15.7	[15.3–16.1]
Region					
North	38.7	22.6	13.9	19.2	[18.4–20.0]
Central	55.8	27.9	23.6	13.6	[13.1–14.1]
East	55.5	31.7	26.9	14.6	[13.9–15.5]
Northeast	65.8	40.7	33.9	23.2	[22.1–24.4]
West	43.7	17.0	12.1	18.1	[16.8–19.4]
South	31.2	41.0	22.3	19.4	[18.5–20.3]
Union Territories	30.3	27.6	18.5	9.7	[07.7–12.2]
Risk factors					
Tobacco					
No	–	15.8	–	15.4	[14.9–15.9]
Yes	–	46.0	–	18.6	[18.1–19.1]
Alcohol					
No	34.9	–	–	14.9	[14.4–15.3]
Yes	70.9	–	–	21.6	[20.9–22.4]
Either Tobacco or Alcohol					
No	–	–	–	14.1	[13.5–14.6]
Yes	–	–	–	19.2	[18.7–19.7]
Both Tobacco and Alcohol					
No	–	–	–	15.7	[15.3–16.1]
Yes	–	–	–	21.3	[20.5–22.1]
Diet					
Vegetarian	40.6	15.3	10.4	15.7	[15.1–16.3]
Non-vegetarian	47.5	35.2	25.1	17.4	[16.9–17.8]

Table 2 (continued)

Individuals characteristics	Tobacco	Alcohol	Both Tobacco and Alcohol	Prevalence of Hypertension	
	%	%	%	%	95% CI
Diabetic					
No	45.5	29.3	20.8	16.4	[16.0–16.8]
Yes	46.9	39.2	26.3	38.9	[35.4–42.4]
BMI					
Low	44.7	23.4	18.7	07.2	[06.7–07.7]
Medium	48.3	31.1	22.6	15.0	[14.5–15.5]
High	40.3	32.8	19.6	30.8	[37.1–42.9]
Obese	36.7	28.7	16.1	40.0	[16.5–17.2]
India	45.5	29.5	20.9	16.5	[16.5–17.3]

Sources: Based on author's computation from NFHS-4 (2015–16).

3.3. Prevalence of hypertension according to substance use and socioeconomic characteristics

In Table 3, it can be seen that irrespective of the age group, individuals who use both alcohol and tobacco have a greater prevalence of hypertension compared to those who neither smoke nor drink alcohol. If we take educational status under consideration, smoking and alcohol, alone or combined, increase the risk of being hypertensive among the various educational groups. However, one paradoxical finding was a relatively higher prevalence of hypertension amongst the currently married non-smokers as compared to smokers. Furthermore, our study reveals that irrespective of wealth quintile, place or region of residence and dietary preferences, alcohol, and smoking lead to greater chances of being hypertensive. It is to be noted that the proportion of hypertensive participants amongst diabetic alcoholic/smokers was higher than non-diabetic alcoholics/smokers, as diabetes itself may lead to cardiovascular morbidity. Similarly, obese individuals tend to have higher chances of getting hypertension irrespective of addiction status as obesity is a major contributor to raised blood pressure besides other cardiovascular abnormalities.

3.4. Tests of equality of group means

Table 4 provides strong statistical evidence of significant differences between means of smoker and non-smoker groups for all independent variables with producing a very high value of F's for age, body mass index, marital status, occupation, diabetes, wealth index, use of alcohol, and tobacco. The associations for all the groups within a background characteristic except religion were significantly different.

3.5. Summary of canonical discriminant functions

Canonical correlation can tell what proportion of the total variation is due to variation in a discriminant function if we squared it (Table 5). It means around 10% variation in men carrying hypertension could be explained alone by substance use considered in this study.

3.6. The standardized canonical discriminant function coefficients

The interpretation of the discriminant coefficients (or weights) is similar to multiple regression. Table 6 provides an index of the importance of each predictor like the standardized regression coefficients (Beta) dose in multiple regression. The sign indicates the direction of the relationship. Age and BMI were the strongest predictors while marital status and caste (note –ve sign) were next in importance as predictors. Place of residence, wealth quintile, education, and occupation were not as strong predictors as age and BMI. Alcohol alone and both alcohol and smoking together have their independent effects on the person being hypertensive.

Table 3
Prevalence of hypertension according to substance use and sociodemographic characteristics.

Background Characteristics	Smoking Hypertension %	Never Smoking Hypertension %	Alcohol Hypertension %	No Alcohol Hypertension %	Both Smoking and Alcohol Hypertension %	Neither of them Hypertension %
Individuals characteristics						
Age (in years)						
15–24	6.2	5.3	7.1	5.3	7.2	5.4
25–40	17.1	17.3	19.6	15.8	19.2	16.4
41–49	28.5	32.9	33.5	28.7	32.0	29.9
Education						
Non-literate	18.8	16.4	22.4	15.2	22.1	16.1
Below Primary	19.9	22.5	25.3	18.1	23.2	19.7
Below Middle	17.7	18.1	20.3	16.5	19.3	17.3
Below Secondary	17.7	13.6	21.3	13.2	20.6	14.2
Secondary and above	20.3	16.3	20.9	16.4	21.9	16.8
Marital Status						
Never married	9.2	6.9	10.3	6.9	11.2	7.0
Currently married	21.2	22.9	24.8	20.4	23.7	21.3
Others	21.6	21.6	28	17.4	27.3	18.6
Occupation						
Not working	14.3	7.5	15.0	8.1	16.0	8.4
Agricultural work	17.4	17	21.2	15.3	20.7	16.1
Skilled/Unskilled work	18.2	17.4	21.7	15.6	21.2	16.6
Professional work	23.1	21.8	24.8	21.2	24.6	21.8
Religion						
Hindu	18.8	15.3	21.4	14.8	21.1	15.6
Non-Hindu	17.8	15.9	23.7	15	22.7	15.9
Social group						
ST	18.9	13.4	20.7	13.6	21.1	14.3
SC	18.1	15.1	21.5	13.7	20.5	15.1
OBC	18.3	15	20.8	14.6	20.8	15.4
Others	20	17	24.6	16.4	24.2	17.2
Wealth quintile						
Poorest	14.4	8.1	16.2	9.9	16.6	10.1
Poorer	15.3	10.6	17.6	11.4	17.9	11.7
Middle	19.3	14.2	22.4	14.1	23.4	14.8
Richer	22.5	17.9	25.6	17.4	25.2	18.6
Richest	23.6	19	25.5	18.7	25.2	19.6
Place of residence						
Urban	21.4	17.2	23.4	17.0	23.4	17.8
Rural	17.3	14.2	20.6	13.6	20.2	14.4
Region						
North	20.7	18.2	27.8	16.7	26.6	18.0
Central	14.9	11.9	17.1	12.2	17.1	12.5
East	17.1	11.6	18.9	12.7	19.2	13.0
Northeast	24.4	20.9	27.8	20	27.8	20.8
West	20.6	16.1	25.8	16.4	25.3	17.0
South	22.5	17.9	22.8	17.0	23.4	18.2
Union Territories	13.1	8.0	13.2	8.2	12.7	8.9
Diet						
Vegetarian	17.5	14.4	21.3	14.7	20.9	15.1
Non-vegetarian	19.0	15.8	21.7	15.0	21.4	16.0
Diabetic						
No	18.1	14.9	21.1	14.4	20.8	15.2
Yes	41.7	36.4	42.0	36.8	38.6	38.9
BMI						
Low	10.1	4.8	13.0	5.4	13.6	5.7
Medium	16.9	13.2	18.7	13.4	19.2	13.7
High	33.2	29.2	35.0	28.8	35.3	29.7
Obese	41.2	39.3	46.9	37.2	42.8	39.5
India	18.6	15.4	21.6	14.9	21.3	15.7

Sources: Based on author's computation from NFHS-4 (2015–16).

3.7. Classification of results

The classification of results in Table 7 reveals that 83.1% of respondents were classified correctly into 'suffering from hypertension' or 'not suffering from hypertension' groups. It is also called a hit ratio. The ratio beyond 75% suggests that a variable chosen in discriminant function has a strong power in segregating persons suffering from hypertension, and otherwise. The histogram is given in Fig. 1, drawn from discriminant scores, which depicts the shape of the normal distribution, it again supports whether the variable chosen in the analysis has strong predicting power to a person being hypertensive or not.

4. Discussion

The results of the study suggest that substance use is an important predictor of a person being hypertensive, irrespective of what socio-economic background characteristic s/he possesses. The first time in the history of NFHS in India, this study brings out such a critical association using a large-scale population-based nationally representative survey data. The findings have direct implications for the government's efforts in framing and rolling out policies on preventing diseases caused by tobacco and alcohol, particularly hypertension among men. Our study analyses the effect of different variables on Hypertension. It was

Table 4
Tests of equality of group means.

Background Characteristics	Tests of Equality of Group Means		
	Wilks' Lambda	F- test ^a	Significance
Age	.932	7468.81	.000
Education	1.000	43.82	.000
Marital Status	.968	3348.89	.000
Occupation	.987	1340.68	.000
Religion	1.000	0.39	.531
Caste	1.000	17.35	.000
Wealth quintile	.993	723.01	.000
Place of residence	.998	171.04	.000
States	1.000	11.89	.001
Smoking	.998	188.66	.000
Alcohol	.993	708.34	.000
Both Tobacco and Alcohol	.996	382.81	.000
Diet	1.000	50.41	.000
Diabetic	.993	722.96	.000
BMI	.952	5105.47	.000

Sources: Based on author's computation from NFHS-4 (2015–16).

^a Model was tested at degrees of freedom (df1) = 1 and df2 = 101736.

Table 5
Result of discriminant function of men who are suffering with hypertension.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical correlation
1	.108 ^a	100.0	100.0	.312

First function 1 canonical discriminant functions were used in the analysis.
Sources: Based on author's computation from NFHS-4 (2015–16).

Table 6
Standardized canonical discriminant function coefficients.

Background Characteristics	Standardized Canonical Discriminant Function Coefficients	
	Function	
Age	.721	
Education	.029	
Marital Status	-.049	
Occupation	.033	
Religion	.011	
Caste	-.059	
Wealth quintile	.117	
Place of residence	.022	
States	-.023	
Smoking	-.044	
Alcohol	.098	
Both Tobacco and Alcohol	.051	
Diet	.028	
Diabetic	.129	
BMI	.488	

Sources: Based on author's computation from NFHS-4 (2015–16).

observed the lowest share of normotensive people belonged to the age group 40–49. While education did not seem to act as a determinant of high BP, marital status sure was. The least likelihood of hypertension was seen among the never-married individuals after controlling other backgrounds. Several reasons can be attributed to that, responsibilities associated with married life bring along stress which might be one of the pertinent reasons. Professional work was seen to be associated with the greatest chances of raised BP, here again; the role of stress associated with work might be another important reason. Also, as compared to manual labor, professional workers are relatively less active physically contributing to cardiovascular morbidities, like hypertension.^{23,24} In the case of rural-urban comparison, it should be noted that apart from factors like food habits, stress levels and sedentary lifestyles, pollution in urban areas is now coming up as an important determinant of raised BP.^{15,25,26} It is interesting to note that substance use, consumption of

Table 7
Classification results.

		Prevalence of hypertension	Predicted Group Membership		Total
			0	1	
Original	Count	0	83202	1346	84548
		1	15874	1316	17190
	%	Ungrouped cases	1518	49	1567
		0	98.4	1.6	100.0
Cross-validated ^a	Count	1	92.3	7.7	100.0
		Ungrouped cases	96.9	3.1	100.0
	%	0	83194	1354	84548
		1	15878	1311	17190
		0	98.4	1.6	100.0
		1	92.4	7.6	100.0

Sources: Based on author's computation from NFHS-4 (2015–16).

^a 83.1% of cross-validated grouped cases correctly classified.

alcohol and tobacco alone, or together, was found to be a very crucial determinant of elevation in BP. The prevalence of hypertension was higher amongst tobacco users as compared to the general population. These findings are in agreement with previous studies where tobacco was found to be a contributing factor for hypertension due to various reasons ranging from oxidative stress, catecholamine release, and endothelial dysfunction.^{14,15} Furthermore, it can be seen that a higher percentage of tobacco users were hypertensive as compared to either solely alcohol users or both. This might be because of the cardio-protective effect of light to moderate alcohol consumption as revealed by many studies.^{27,28} However, people with addiction to substances like tobacco and alcohol, either alone or in combination, have a higher proportion of mildly high BP than the rest of the subjects.²⁹ It should be noted that both smoking and use of smokeless tobacco have been found to contribute to the rise in BP, the latter being more critical in a country like India. India is the second-largest consumer of tobacco, one in every three Indians is a tobacco user, contributing to around 18% of the global share of tobacco users.^{30,31} This huge burden of tobacco use poses a threat to the possible emergence of hypertension amongst the younger individuals in the country.^{15,31} It calls for stricter laws against the sale and purchase of tobacco, especially to adolescents. Our study further finds that alcohol consumption is also an important determinant of hypertension among Indian men aged 15–54. This finding is supported by previous studies that stated the ill effects of alcohol on blood pressure.^{13,32} The reasons can be various, the build-up of xenobiotics due to liver dysfunction and the toxic effects of alcohol metabolites (like aldehyde), cardiovascular dysfunction, and dyslipidemia.¹ Furthermore, the current use of both alcohol and tobacco was also suggestive of elevated risk for hypertension. Based on these findings, this study suggests the expansion of intervention programs for reducing consumption of tobacco and alcohol in India and calls for regular screening of alcohol and tobacco users for hypertension. These regulatory measures are earnestly required keeping in view that more and more studies are revealing that alcohol, even in minor quantities, has a profound negative impact on the body.²⁹

5. Conclusion

In conclusion, many factors affect the occurrence of hypertension, many of which are non-modifiable, such as age and gender. However, amongst the modifiable risk factors, alcohol and tobacco use are found as crucial determinants of hypertension in Indian men. Hypertension is a chronic disease and is itself a causative factor for several other diseases like renal impairment, other cardiovascular diseases, and stroke. Checking on abuse of these substances can potentially reduce the disease and health expenditure burden on treatment and care of diseases associated with hypertension in a country like India. Therefore, to improve

Fig. 1. Histograms showing the distribution of discriminant scores for hypertension.

the general well-being and thus the productivity of the country as a whole, policies to check the abuse of these two substances are much needed and updated in India.

Ethics statement

The present study used the data from secondary sources which is freely available to individuals. Therefore, no ethical approval is required separately for the present study.

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Ethical approval

Not required.

Author contributions

JY, CS and SA conceived the idea for the study and developed the analysis plan. JY contributed to the data analysis. SA, CS GJ and JY wrote the initial draft and all authors were involved in commenting on subsequent revisions.

Declaration of competing interest

None declared.

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