

Prevalence and risk factors associated with tobacco smoking among adults in India: a nationally representative household survey

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A – Study Design, B – Data Collection, C – Statistical Analysis, D – Data Interpretation, E – Manuscript Preparation, F – Literature Search, G – Funds Collection

Summary Background. Tobacco smoking is a global epidemic among adults and increases the risk of different diseases, and premature deaths.**Objectives.** This study attempts to investigate and estimate the prevalence and risk factors of tobacco smoking among adults in India.**Material and methods.** This study utilized cross-sectional data from the nationally representative 2017 Global Adult Tobacco Survey. Chi-square analysis was used to show the association between tobacco smoking and risk factors. Binary logistic regression was used to determine the risk factors of tobacco smoking based on *p*-values and odds ratio along with confidence interval.**Results.** The overall prevalence of tobacco smoking was 12.84% (Male: 25.01%, Female: 2.63%). The highest prevalence of tobacco smoking was in Meghalaya (35.04%) and the lowest in Goa (3.07%). Genderwise, the highest prevalence of tobacco smoking was 57.27% in Meghalaya for males and 7.27% in Manipur for females. This study found that 16 out of 19 covariates were significantly (*p* < 0.001) associated with tobacco smoking. Age, region, gender, education, religion, marital status, wealth index, number of living persons, and presence of smoking persons were found to be highly significant (*p* < 0.001) risk factors. Adults from 46–60 years, north east region, no education, daily wage/casual labourers and self-employed, non-Hindu, married. Poorest, presence of smoking persons, and no knowledge about smoking cause strokes had significantly higher risk of tobacco smoking.**Conclusions.** Tobacco smoking remains one of the major causes of diseases, deaths and economic losses. This recent realistic evidence will help policy makers to make policy for reducing tobacco smoking in India, as well as different states.**Key words:** disease, logistic models, prevalence, risk factors, tobacco smoking.Ahammed B, Maniruzzaman Md., Kundu S, Al Mahmud J, Ferdausi F. Prevalence and risk factors associated with tobacco smoking among adults in India: a nationally representative household survey. *Fam Med Prim Care Rev* 2019; 21(4): 307–317, doi: <https://doi.org/10.5114/fmPCR.2019.86505>.

Background

Tobacco smoking is the common practice of smoking in India. Tobacco smoking is one of the major public health threats in the world [1], and tobacco is a highly addictive material [2]. Globally, tobacco smoking remains one of the most important causes of diseases and deaths [3–5]. Two third of the tobacco smokers in the world live in low and middle income countries [6]. India has one of the top tobacco users in the world, and one of the fewer countries in the world where the prevalence of tobacco smoking is high [7]. In 1998–1999, the national family health survey second round found that the prevalence of tobacco use in India was approximately 37% among adults of aged 15 years and above [8]. The problem of tobacco use is significantly concomitant with a high mortality problem. The number of tobacco users is increasing all over the world, and the global prevalence of tobacco smoking among adults is 22% [9]. Tobacco smoking is one of the leading causes of various preventable diseases and premature deaths. In India a large number of premature deaths occur through tobacco smoking, and the majority of smoking related deaths occur in the prime working age group of under 60 years [10]. According to the World Health Organization (WHO), approximately six million deaths occur every single year

due to tobacco smoking, and in 2030 these deaths will be more than eight million per year [11]. A global adult tobacco survey was conducted among three billion individuals from 16 countries, and the survey showed that approximately 48.6% of males and 11.3% of females were tobacco users [12]. A recent study found that worldwide about 400 million adult deaths will occur through tobacco smoking between the year 2010 and 2050, and most of the deaths will occur in the age group 30–69 years [13].

Another burden of tobacco smoking is the economic costs. Tobacco smoking costs can be categorized into direct, and indirect costs, and around 15% of the aggregate health care expenditure in high income countries can be credited to smoking [14]. The expenditure on purchasing tobacco contributes to household poverty [2]. In addition, the treatment costs of tobacco smoking related diseases were higher among tobacco smoking families. All the problems of tobacco smoking are public health and socioeconomic problems. The design and implementation of appropriate policies for controlling tobacco smoking is very important for the improvement of public health disease [2]. So understanding the factors that influence the tobacco smoking status of adults is important to policymakers as well as researchers. India is one of the countries in Asia that shares the burden of tobacco smoking epidemics. The Indian government has taken different steps to reduce the prevalence of tobacco



smoking. An effective tobacco smoking policy mainly depends on the assessment of the prevalence of tobacco smoking. This is an important step in reducing tobacco use in the country. There are several national level studies that have been conducted to collect information on tobacco use to evaluate the prevalence of tobacco use. Among the national level studies, the National Family Health Survey (NFHS), the National Household Survey of Drug and Alcohol Abuse in India (NHSDAA), and the Global Adult Tobacco Survey (GATS) are notable [7]. All these studies accumulated data on tobacco use as a component of health knowledge, attitudes and perceptions based surveys. Most of the previous research work on tobacco smoking was based on localized studies with sociodemographic predictors of tobacco related behaviour.

Objectives

This study is an effort to examine the prevalence and regional variations of tobacco smoking among adults in India using large, nationally representative, and more recent Global Adult Tobacco Survey (GATS) data. Therefore, this study also identifies the different associated factors and impacts of tobacco smoking among adults in India.

Material and methods

Data sources

The study was based on a nationally representative sample of adults (≥ 15 years of age) living in India, and the data extracted from the 2017 Global Adult Tobacco Survey (GATS-2017) India. The Global Adult Tobacco Survey (GATS), a component of the Global Tobacco Surveillance System (GTSS), is a global standard for systematically monitoring adult tobacco use and tracking key tobacco control indicators. After excluding all unnecessary and missing information of adult respondents, 73,757 adults were finally used in this study.

Sample design

The multistage stratified cluster sample design was used in GATS-2017 India data. The sample size was 84,047 selected

households with 74,037 completed individual interviews. The questionnaire of GATS India included fundamental questions about background characteristics, tobacco smoking, smokeless tobacco, cessation, secondhand smoke, economics, media, and knowledge, attitudes and perceptions. All the questions were reviewed and improved. Finally, questions were approved by a questionnaire expert review committee. GATS is designed to produce national and sub-national estimates among adults across countries. The target population includes all men and women who are 15 years of age or older. All members of the target population were sampled from the household that was their usual place of residence. Data were collected using electronic handheld devices. The survey covered fields like tobacco use (smoking and smokeless tobacco), exposure to second hand smoke, cessation, economics of tobacco, exposure to media messages on tobacco use, and knowledge, attitudes and perceptions towards tobacco use. The survey was designed to provide estimates of tobacco prevalence at national and state levels. Data on tobacco use were collected from eligible respondents aged 15 years and above.

Outcome variable

In this study the outcome variable is tobacco smoking status. The tobacco smoking status of respondents was determined by answers (“daily”, “less than daily”, and “not at all”) to the question “Do you currently smoke tobacco?” Respondents who answered “not at all” were categorized as “non-smokers”, whilst those who answered “daily” or “less than daily” were considered “current smokers”.

Independent variables

The national level and state level variations in tobacco smoking were measured for the 6 national region and 32 states of India. The variation in tobacco smoking was also assessed for 14 age groups. The outcome variables were studied against all selected potential risk variables, and these variables were divided into different groups, namely: sampling variables, household variables, and background characteristics of the respondents, media exposure variable, and knowledge, attitudes & perceptions of tobacco smoking. Short descriptions of different independent variables along with their categories are given in Table 1.

Table 1. Short description of different variables with their categories

Variable	Description of variable	Categories of variable for analysis
Age (year)	Age of the respondents in group	15–30 years, 31–45 years, 46–60 years, and 61+ years
Residence	Residence status of respondent	Urban, and rural
Region	National region of the respondents	North, Central, East, North East, West, and South
Gender	Records the gender of the selected person	Male or female
Education	What is the highest level of education the respondent has completed?	No education, up to primary, up to secondary, and more than secondary
Occupation	Which of the following best describes your main work status over the past 12 months?	Govt/non-govt employee, daily wage/casual labourer, self-employed, homemaker, student, and others (retired, unemployed, don't know, refused)
Religion	What is your religion?	Hindu, and others (Muslim, Christian, Buddhism, Jain, Sikh, etc.)
Marital status	What is your marital status?	Not married, currently married, and formally married (separated, divorced, widowed, etc.)
Wealth index	This variable is computed using household facilities and products such as electricity, flush toilet, telephone, mobile phone, television, radio, refrigerator, car, moped, scooter or motorcycle, washing machine, computer or laptop, air conditioner, and electric fan	Richest, rich, middle, poor, and poorest
No of living persons	In total how many persons live in the household?	1–3, 4–6, and 7+

Table 1. Short description of different variables with their categories

Variable	Description of variable	Categories of variable for analysis
Presence of smoking person	This variable is computed from the smoking history of different persons in a household	Yes or no
Use of smokeless tobacco	Does the respondent currently use smokeless tobacco, including betel quid with tobacco, sada or surti, khaini or tobacco lime mixture, gutkha?	Yes or no
Mass media exposure	In the last 30 days have you noticed information about the dangers of smoking tobacco, or that encourages quitting in newspapers or in magazines?	Yes or no
Print media exposure	In the last 30 days, have you noticed information about the dangers of smoking tobacco, or that encourages quitting on television or radio?	Yes or no
Smoking causes serious illness	Do you know or believe that smoking tobacco causes serious illness?	Yes, no, or do not know
Smoking causes stroke	Do you know or believe that smoking tobacco causes strokes?	Yes, no, or do not know
Smoking causes heart attack	Do you know or believe that smoking tobacco causes heart attacks?	Yes, no, or do not know
Smoking causes lung cancer	Do you know or believe that smoking tobacco causes lung cancer?	Yes, no, or do not know
Smoking causes TB	Do you know or believe that smoking tobacco causes TB?	Yes, no, or do not know

Statistical analysis

The dataset was analyzed using different statistical tools and statistical techniques. In the base characteristics table for continuous variables they are expressed as mean (\pm standard deviation), and categorical variables are expressed as frequency (percentages) (Table 3). Frequency scores were also used to compute the prevalence of tobacco smoking status. These descriptive statistics were used to demonstrate the baseline characteristics of the selected potential risk factors. Different graphical (bar diagram, line diagram, etc.) representations were used to display the prevalence of tobacco smoking. This study also examined the observed and expected value by state and gender to show the differences in the prevalence of captures. To do this analysis, firstly this study ran a binary logistic regression model, except three geographic variables, namely: state, region, and place of residence. Then it computed the predicted probabilities from the binary logistic regression. The predicted probabilities are divided into two groups: if the probability value is less than 0.50, considered as not tobacco smoking (0), otherwise tobacco smoking (1). By using this result this study obtained the average frequency of tobacco smoking status by statewise and compared it to observed prevalence (Table 2). This is a simple way to quantify what accounts for the massive difference in the different states. Analysis of the determinants of tobacco smoking was done on unweighted data as it gives associations of smoking with different considered independent variables. Bivariate analyses were performed to obtain the prevalence of tobacco smoking for various categories of the selected variables. Pearson chi-square (χ^2) analysis was used to show the association between tobacco smoking and the selected potential risk factors [15]. Moreover, binary logistic regression was used to determine the high risk factors of tobacco smoking based on odds ratio (OR) and *p*-value [16, 17]. Statistical significance was defined with *p* < 0.05 (significant) and *p* < 0.01 (highly significant). SPSS version 23.0 and Ri86 3.5.2 were used for analysis.

Ethical approval

The world worked together to design and implement GATS, by the Centers for Disease Control and Prevention (CDCP), CDC

Foundation, the Johns Hopkins Bloomberg School of Public Health (JHSPH), Research Triangle Institute International (RTI International), the World Health Organization (WHO), and many countries. The GATS-2017 India survey was approved by the Ministry of Health and Family Welfare, Government of India.

Results

The data were introduced and analyzed based on descriptive statistics and the logistic regression model. The purposes of the study were to measure the prevalence, and identify the risk factors, of tobacco smoking among adults aged 15 years and older in India. Overall, 12.84% of adults were found to smoke tobacco. The general perception of the prevalence of tobacco smoking is presented by state in Figure 1. The prevalence of tobacco smoking was higher in Meghalaya (35.04%) and lower in Goa (3.07%) compared to other states of India.

The prevalence of tobacco smoking is also presented in Figure 2 based on gender in India by state. Among males, the highest proportion of tobacco smoking was 57.27% in Meghalaya, and the lowest proportion was 6.75% in Maharashtra. But in females the results were different: the highest amount of tobacco smoking was 17.14% in Mizoram, and the lowest amount was 0.07% in Puducherry.

The 32 states of India were divided into 6 national regions as north, central, east, north east, west, and south. Figure 3 presents the prevalence of tobacco smoking among adults, male and female, in India by national region. Among male and female adults the prevalence of tobacco smoking was maximum in the north east region (Male: 38.48% and Female: 6.73%) and minimum in the west region (Males: 10.91% and Females: 0.82%).

The prevalence of tobacco smoking according to males and females by 14 age group gives us the real picture of the hazardous age group of tobacco smoking presented in Figure 4. The highest risk age group for male adults of tobacco smoking was 55–59 years (34.48%), and the lowest risk age group was 15–19 years (6.08%). Among females, the highest risk age group of tobacco smoking was 75–79 years (6.65%), and the lowest risk age group was 15–19 years (0.43%).

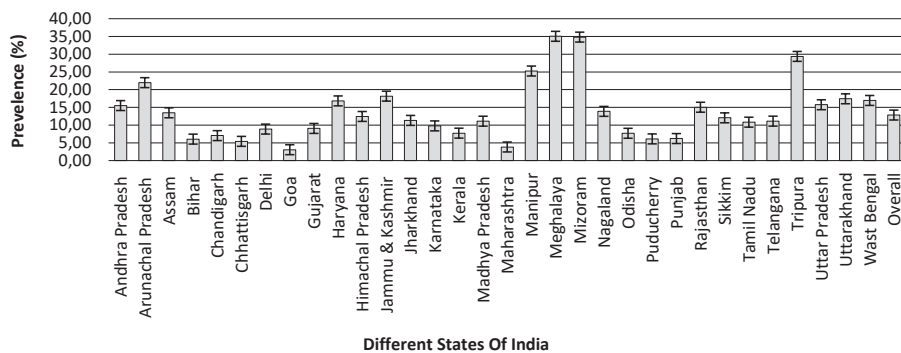


Figure 1. Prevalence of tobacco smoking among adults in India by state

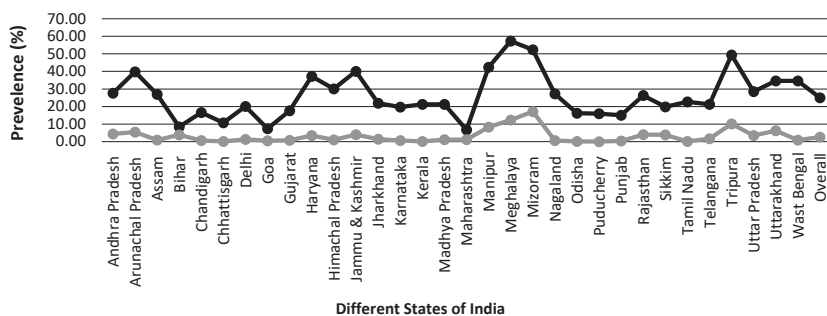


Figure 2. Prevalence of tobacco smoking among adults, male and female, in India by state

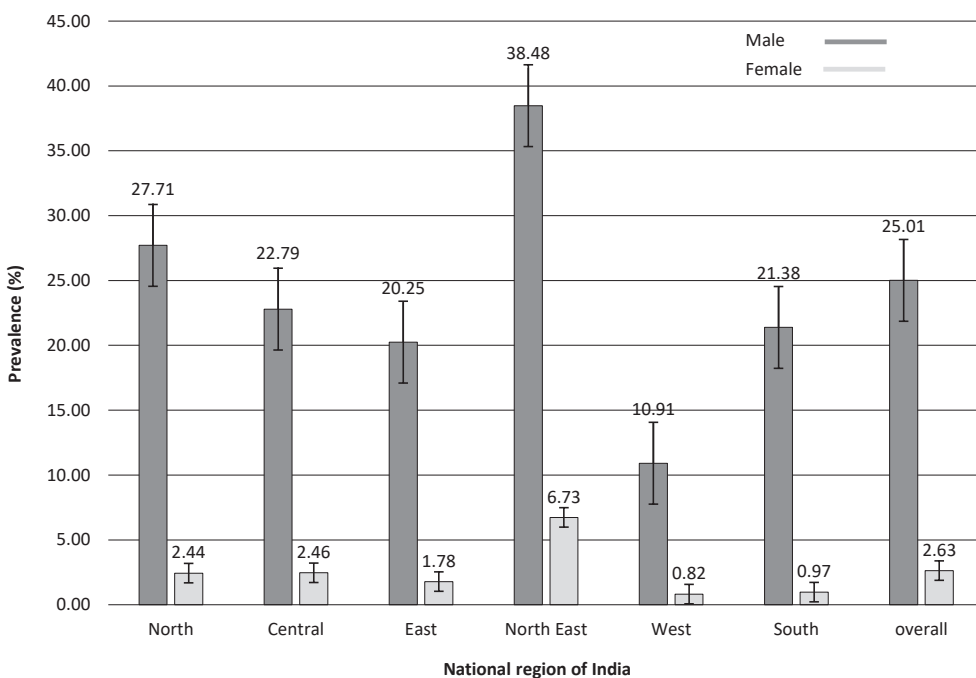


Figure 3. Prevalence of tobacco smoking among adults, male and female, in India by national region

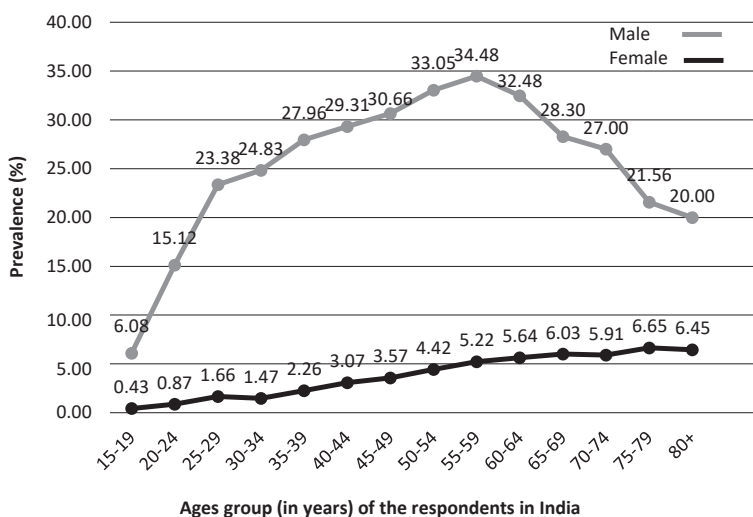


Figure 4. Prevalence of tobacco smoking according to gender and age groups in India

Table 2 presents the observed and expected prevalence of tobacco smoking by state. There was marked state-level variation in the observed prevalence of tobacco smoking, with rates ranging from 3.07% in Goa to 35.04% in Meghalaya. The observed prevalence of tobacco smoking was greater than 20% in Arunachal Pradesh, Manipur, Meghalaya, Mizoram, and Tripura, and between 10% and 20% in Andhra Pradesh, Assam, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Madhya Pradesh, Nagaland, Rajasthan, Sikkim, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand, and West Bengal.

The estimated prevalence of tobacco smoking for males was between 30% and 56% in Andhra Pradesh, Arunachal Pradesh, Haryana, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Rajasthan, Tripura, Uttar Pradesh, Uttarakhand and West Bengal. But for females tobacco smoking was more than 10% only in Mizoram (15.59%) state.

Among 73,757 adults only 9,471 smoked tobacco. The overall mean age (\pm standard deviation) of the respondents was 39.46 (\pm 15.43) years. The mean (\pm standard deviation) number

of family members to every respondent was 4.78 (\pm 2.28). Table 3 provides the overall summary statistics of the different characteristics of respondents. About 70.49% of respondents were under 45 years old, and the majority of respondents were female (54.38%). Around two thirds of the respondents were from rural areas, and the highest 23.17% lived in the North region in India. The majority of the study population had at least up to secondary education (30.34%), and 34.89% of respondents were homemakers. About 72.95% of respondents were Hindu, and 76.99% were currently married. 41.26% of respondents were in the poor wealth category, 57.26% of respondents' family members were in the 4–6 category. About 82.64% of respondents' families had no smoking person, and 79.62% of respondents did not use any smokeless tobacco. 62.20% of respondents has access to mass media but only 37.18% had access to print media. The highest portion of the respondents had knowledge about tobacco smoking causing serious illness (92.15%), strokes (67.69%), heart attacks (78.53%), lung cancer (93.68%) and TB (93.04%).

Table 2. Observed versus expected prevalence of tobacco smoking among adults in India

State	Male			Female			Total		
	<i>n</i>	observed (%)	expected (%)	<i>n</i>	observed (%)	expected (%)	<i>n</i>	observed (%)	expected (%)
Andhra Pradesh	260	27.60	30.25	45	4.39	3.32	305	15.51	16.23
Arunachal Pradesh	262	39.82	40.73	39	5.48	4.21	301	21.97	21.75
Assam	371	26.96	29.29	13	0.88	0.68	384	13.47	14.49
Bihar	126	8.38	11.31	62	3.87	3.68	188	6.05	7.38
Chandigarh	156	16.58	17.85	9	0.64	0.21	165	7.04	7.30
Chhattisgarh	111	10.72	12.95	2	0.19	0.19	113	5.42	6.53
Delhi	188	20.04	22.17	17	1.24	0.73	205	8.87	9.44
Goa	56	7.43	8.62	6	0.47	0.16	62	3.07	3.31
Gujarat	235	17.59	25.07	11	0.80	1.38	246	9.06	13.04
Haryana	368	37.25	39.27	53	3.50	2.44	421	16.83	16.99
Himachal Pradesh	301	30.07	31.67	15	0.97	0.65	316	12.44	12.87
Jammu & Kashmir	390	40.08	43.68	60	3.99	3.46	450	18.17	19.26
Jharkhand	204	21.89	24.25	14	1.41	1.21	218	11.33	12.37
Karnataka	254	19.66	22.45	9	0.64	0.86	263	9.78	11.23
Kerala	166	21.25	22.41	2	0.14	0.14	168	7.73	8.15
Madhya Pradesh	308	21.23	27.64	17	1.15	0.61	325	11.11	14.02
Maharashtra	102	6.75	10.05	18	1.11	0.43	120	3.83	5.08
Manipur	341	42.41	42.29	67	8.25	7.27	408	25.25	24.69
Meghalaya	453	57.27	55.37	96	12.37	4.12	549	35.04	29.99
Mizoram	408	52.44	49.87	133	17.14	15.59	541	34.81	32.75
Nagaland	216	27.27	25.76	5	0.62	0.37	221	13.87	12.99
Odisha	142	16.17	20.05	1	0.10	0.31	143	7.70	9.63
Puducherry	150	15.89	18.11	1	0.07	0	151	6.12	6.93
Punjab	150	15.02	17.02	6	0.40	0.4	156	6.21	7.01
Rajasthan	393	26.29	30.57	62	4.05	2.55	455	15.04	16.40
Sikkim	142	19.80	23.85	27	3.94	3.21	169	12.05	13.77
Tamil Nadu	311	22.70	24.60	3	0.20	0.2	314	10.83	11.73
Telangana	187	21.20	25.17	16	1.70	1.91	203	11.12	13.15
Tripura	377	49.41	51.64	80	10.09	7.44	457	29.37	29.11
Uttar Pradesh	479	28.46	30.60	62	3.54	2.45	541	15.75	16.24
Uttarakhand	328	34.56	33.19	91	6.25	5.22	419	17.42	16.26
West Bengal	480	34.56	37.94	14	0.92	1.05	494	16.95	18.63

Table 3. Summary statistics and bivariate analysis of different variables							
	Total		Tobacco smoking status				p
	n	%	no		yes		
			n	%	n	%	
Age group							
15–30 years	25 572	34.67	23 595	92.27	1977	7.73	< 0.001
31–45 years	26 422	35.82	22 735	86.05	3687	13.95	
46–60 years	14 054	19.05	11 545	82.15	2509	17.85	
61+ years	7709	10.45	6411	83.16	1298	16.84	
Residence							
Urban	26 414	35.81	23 901	90.49	2513	9.51	< 0.001
Rural	47 343	64.19	40 385	85.30	6958	14.70	
Region							
North	17 088	23.17	14 956	87.52	2132	12.48	< 0.001
Central	11 470	15.55	10 036	87.50	1434	12.50	
East	9801	13.29	8758	89.36	1043	10.64	
North East	13 509	18.32	10 479	77.57	3030	22.43	
West	7870	10.67	7442	94.56	428	5.44	
South	14 019	19.01	12 615	89.99	1404	10.01	
Gender							
Male	33 647	45.62	25 232	74.99	8415	25.01	< 0.001
Female	40 110	54.38	39 054	97.37	1056	2.63	
Educational							
No education	18 423	24.98	15 674	85.08	2749	14.92	< 0.001
Up to primary	16 308	22.11	13 409	82.22	2899	17.78	
Up to secondary	22 377	30.34	19 703	88.05	2674	11.95	
More than secondary	16 649	22.57	15 500	93.10	1149	6.90	
Occupation							
Govt./Non-Govt. Employee	9576	12.98	8230	85.94	1346	14.06	< 0.001
Daily Wage/Casual Labourer	13 699	18.57	10 485	76.54	3214	23.46	
Self-Employed	13 912	18.86	10 769	77.41	3143	22.59	
Homemaker	25 734	34.89	24 977	97.06	757	2.94	
Student	6113	8.29	5940	97.17	173	2.83	
Others	4723	6.40	3885	82.26	838	17.74	
Religion							
Hindu	53 804	72.95	47 591	88.45	6213	11.55	< 0.001
Others	19 953	27.05	16 695	83.67	3258	16.33	
Marital status							
Not married	11 906	16.14	11 028	92.63	878	7.37	< 0.001
Currently married	56 782	76.99	48 670	85.71	8112	14.29	
Formerly married	5069	6.87	4588	90.51	481	9.49	
Wealth index							
Richest	3099	4.20	2935	94.71	164	5.29	< 0.001
Rich	12 100	16.41	11 164	92.26	936	7.74	
Middle	18 281	24.79	16 285	89.08	1996	10.92	
Poor	30 434	41.26	25 868	85.00	4566	15.00	
Poorest	9843	13.35	8034	81.62	1809	18.38	
No of living persons							
1–3	19 739	26.76	17 104	86.65	2635	13.35	0.001
4–6	42 236	57.26	36 975	87.54	5261	12.46	
7/7+	11 782	15.97	10 207	86.63	1575	13.37	
Presence of a smoking person							
No	60 954	82.64	59 989	98.42	965	1.58	< 0.001
Yes	12 803	17.36	4297	33.56	8506	66.44	
Use of smokeless tobacco							
Yes	15 032	20.38	12 250	81.49	2782	18.51	< 0.001
No	58 725	79.62	52 036	88.61	6689	11.39	
Mass media exposure							
Yes	45 876	62.20	40 044	87.29	5832	12.71	0.182
No	27 881	37.80	24 242	86.95	3639	13.05	
Print media exposure							
Yes	27 422	37.18	23 969	87.41	3453	12.59	0.120
No	46 335	62.82	40 317	87.01	6018	12.99	

	Total		Tobacco smoking status				p
	n	%	no		yes		
			n	%	n	%	
Smoking causes serious illness							
Yes	67 970	92.15	59 352	87.32	8618	12.68	< 0.001
No	4501	6.10	3825	84.98	676	15.02	
Do not know	1286	1.74	1109	86.24	177	13.76	
Smoking causes strokes							
Yes	49 924	67.69	43 714	87.56	6210	12.44	< 0.001
No	13 449	18.23	11 486	85.40	1963	14.60	
Do not know	10 384	14.08	9086	87.50	1298	12.50	
Smoking causes heart attacks							
Yes	57 922	78.53	50 716	87.56	7206	12.44	< 0.001
No	9128	12.38	7727	84.65	1401	15.35	
Do not know	6707	9.09	5843	87.12	864	12.88	
Smoking causes lung cancer							
Yes	69 098	93.68	60 389	87.40	8709	12.60	< 0.001
No	2626	3.56	2178	82.94	448	17.06	
Do not know	2033	2.76	1719	84.55	314	15.45	
Smoking causes TB							
Yes	68 624	93.04	59 856	87.22	8768	12.78	0.098
No	3015	4.09	2590	85.90	425	14.10	
Do not know	2118	2.87	1840	86.87	278	13.13	
Total	73 757	100.00	64 286	87.16	9471	12.84	

Table 3 also represents a bivariate analysis of selected covariates by tobacco smoking status. The prevalence of tobacco smoking was higher among respondents aged 46–60 years. The smoking rate of tobacco smoking was higher in rural areas. The majority of the respondents were in the north east (22.43%). This study reveals that male respondents had a higher tobacco smoking prevalence, and the smoking rate were also higher among those who had up to primary education. The utmost prevalence of tobacco smoking was 23.46%, and 22.59% among respondents who were daily wage/causal labourers, and self-employed, respectively. The smoking rate of tobacco smoking was higher in married (14.29%) and other (16.33%) religious respondents. The tobacco smoking rate was higher in the poorest families, and 66.44% of the respondents smoking tobacco informed that their family members were also used to smoking. The tobacco smoking rate was also highest for the respondents who use smokeless tobacco. It is observed that all variables considered in this study, excepting only three variables, namely: mass media, print media, and knowledge about tobacco smok-

ing causing TB, were highly significantly ($p < 0.001$) associated with tobacco smoking (see the last column of Table 3).

Table 4 presents the odds ratio of different risk factors of tobacco smoking. This study found that the respondents' age had a positive effect on tobacco smoking, and it is statistically significant at 1% level of significance. Tobacco smoking was 1.965 (OR = 1.965, CI: 1.766–2.166; $p < 0.001$), 2.497 (OR = 2.497, CI: 2.223–2.805; $p < 0.001$) and 2.019 (OR = 2.019, CI: 1.746–2.334; $p < 0.001$) times higher in the respondents in age group 31–45 years, 46–60 years and 60+ years, respectively, compared to the age group 15–20 years. The region of the respondents had a significant negative effect, except the north east region, on tobacco smoking. The central, east, west and south regions were 0.677 (OR = 0.677, CI: 0.599–0.766; $p < 0.001$), 0.590 (OR = 0.590, CI: 0.517–0.674; $p < 0.001$), 0.345 (OR = 0.345, CI: 0.293–0.406; $p < 0.001$) and 0.639 (OR = 0.639, CI: 0.567–0.721; $p < 0.001$) times less likely to smoke tobacco than the north region, respectively. But the north east region was 1.451 times (OR = 1.451, CI: 1.295–1.625; $p < 0.001$) more likely to smoke tobacco than the north region.

Characteristics	Coefficient	p	OR	95% C.I. for OR	
				lower	upper
Age group					
15–30 years (Ref)			1.000		
31–45 years	0.671	< 0.001	1.956	1.766	2.166
46–60 years	0.915	< 0.001	2.497	2.223	2.805
61+ years	0.702	< 0.001	2.019	1.746	2.334
Residence					
Urban (Ref)			1.000		
Rural	-0.026	0.561	0.975	0.893	1.063
Region					
North (Ref)			1.000		
Central	-0.390	< 0.001	0.677	0.599	0.766
East	-0.528	< 0.001	0.590	0.517	0.674
North East	0.372	< 0.001	1.451	1.295	1.625
West	-1.065	< 0.001	0.345	0.293	0.406
South	-0.448	< 0.001	0.639	0.567	0.721

Table 4. Odds ratio and 95% confidence interval for the risk of tobacco smoking among adults in India					
Characteristics	Coefficient	p	OR	95% C.I. for OR	
				lower	upper
Gender					
Male (Ref)			1.000		
Female	-1.434	< 0.001	0.238	0.209	0.273
Education					
No education (Ref)			1.000		
Up to primary	-0.239	< 0.001	0.787	0.711	0.872
Up to secondary	-0.568	< 0.001	0.567	0.510	0.630
More than secondary	-0.786	< 0.001	0.456	0.401	0.517
Occupation					
Govt./Non-Govt. Employee (Ref)			1.000		
Daily Wage/Casual Labourer	0.307	< 0.001	1.360	1.203	1.537
Self-Employed	0.172	0.003	1.188	1.059	1.333
Homemaker	-0.084	0.345	0.919	0.772	1.095
Student	-1.074	< 0.001	0.342	0.277	0.420
Others	0.025	0.765	1.025	0.872	1.205
Religion					
Hindu (Ref)			1.000		
Others	0.173	< 0.001	1.189	1.089	1.297
Marital status					
Not married (Ref)			1.000		
Currently married	0.934	< 0.001	2.544	2.249	2.877
Formerly married	0.939	< 0.001	2.557	2.082	3.139
Wealth index					
Richest (Ref)			1.000		
Rich	0.226	0.019	1.254	1.038	1.514
Middle	0.373	< 0.001	1.452	1.213	1.738
Poor	0.433	< 0.001	1.542	1.289	1.845
Poorest	0.629	< 0.001	1.876	1.532	2.296
No of living persons					
1-3 (Ref)			1.000		
4-6	-0.368	< 0.001	0.692	0.634	0.755
7/7+	-0.859	< 0.001	0.423	0.379	0.473
Presence of smoking person					
Yes (Ref)			1.000		
No	-4.628	< 0.001	0.010	0.009	0.011
Use of smokeless tobacco					
Yes (Ref)			1.000		
No	0.085	0.040	1.088	1.004	1.180
Mass media exposure					
Yes (Ref)			1.000		
No	0.059	0.175	1.060	0.974	1.154
Print media exposure					
Yes (Ref)			1.000		
No	-0.006	0.891	0.994	0.914	1.081
Smoking causes serious illness					
Yes (Ref)			1.000		
No	0.001	0.996	1.000	0.862	1.160
Do not know	-0.210	0.143	0.811	0.613	1.073
Smoking causes strokes					
Yes (Ref)			1.000		
No	0.135	0.017	1.145	1.025	1.279
Do not know	0.123	0.076	1.131	0.987	1.295
Smoking causes heart attacks					
Yes (Ref)			1.000		
No	0.065	0.331	1.067	0.936	1.218
Do not know	-0.169	0.049	0.844	0.713	0.999
Smoking causes lung cancer					
Yes (Ref)			1.000		
No	0.241	0.038	1.273	1.014	1.599
Do not know	0.276	0.037	1.318	1.017	1.707
Smoking causes TB					
Yes (Ref)			1.000		
No	-0.082	0.448	0.922	0.746	1.138
Do not know	-0.198	0.125	0.820	0.636	1.057

OR – odds ratio.

From the results, it is clear that the gender of respondents has a negative effect on tobacco smoking. The possibility of tobacco smoking for females was a 0.238 (OR = 0.238, CI: 0.209–0.273; $p < 0.001$) times lower risk compared to males. It is observed that there is an inverse relationship between education status and tobacco smoking. That means increasing education status from primary to higher; the amount of tobacco smoking is decreased, because an educated person is more conscious of their health. The possibility of tobacco smoking of up to primary, up to secondary, and more than secondary educated respondents was 0.787 (OR = 0.787, CI: 0.711–0.872; $p < 0.001$), 0.567 (OR = 0.567, CI: 0.510–0.630; $p < 0.001$), and 0.456 (OR = 0.456, CI: 0.401–0.517; $p < 0.001$) times less likely compared to uneducated respondents, respectively. These results of occupation showed that daily wage/casual labourer and self-employed had a significant positive impact, and student had a significant negative impact on tobacco smoking. The possibility of tobacco smoking for a daily wage/casual labourer and self-employed was 1.360 (OR = 1.360, CI: 1.203–1.537; $p < 0.001$) and 1.188 (OR = 1.188, CI: 1.059–1.333; $p = 0.003$) times higher compared to a government/non-government employee. On the other hand, the respondents who were students had 0.342 (OR = 0.342, CI: 0.277–0.420; $p < 0.001$) times lower tobacco smoking than government/non-government employees. The likelihood of tobacco smoking in others families had 1.189 (OR = 1.189, CI: 1.089–1.297; $p < 0.001$) times higher compared to a Hindu family. The marital status of respondents had a positive significant effect on tobacco smoking. The chance of tobacco smoking for currently married and formerly married was 2.544 (OR = 2.544, CI: 2.249–2.877; $p < 0.001$) and 2.557 (OR = 2.557, CI: 2.082–3.139; $p < 0.001$) times more likely compared to unmarried respondents. Wealth index had a significant positive effect on tobacco smoking. The chance of tobacco smoking for rich, middle, poor and poorest families was 1.254 (OR = 1.254, CI: 1.038–1.514; $p = 0.019$), 1.452 (OR = 1.452, CI: 1.213–1.738; $p < 0.001$), 1.542 (OR = 1.542, CI: 1.289–1.845; $p < 0.001$) and 1.876 (OR = 1.876, CI: 1.532–2.296; $p < 0.001$) times, respectively, more likely compared to the richest families. These results of the number of living person indicate that it has a significant negative impact on tobacco smoking. The likelihood of tobacco smoking for 4–6 and 7+ number of living person was 0.692 (OR = 0.692, CI: 0.634–0.755; $p < 0.001$), and 0.423 (OR = 0.423, CI: 0.379–0.473; $p < 0.001$) times lower than 1–3 number of living persons. Families having a smoking person had a significant negative effect on tobacco smoking. The chance of tobacco smoking for absence of smoking person was 0.010 times (OR = 0.010, CI: 0.009–0.011; $p < 0.001$) less likely compared to the presence of a smoking person. Use of smokeless tobacco also has a significant positive effect on tobacco smoking. That means tobacco smoking was 1.088 (OR = 1.088, CI: 1.004–1.118; $p = 0.040$) times higher than the respondents who used smokeless tobacco. Respondents having no knowledge that smoking causes strokes had a significant positive effect on tobacco smoking. The chance of tobacco smoking for respondents having no knowledge that smoking causes strokes were 1.145 times (OR = 1.145, CI: 1.025–1.279; $p = 0.017$) higher than those having knowledge that smoking causes strokes. Knowledge of smoking's association with lung cancer has a significant positive effect on tobacco smoking. The likelihood of tobacco smoking for no knowledge of smoking's association with lung cancer was 1.273 times (OR = 1.273, CI: 1.014–1.599; $p = 0.038$) higher than that having knowledge of smoking's association with lung cancer.

Discussion

In this study, nationwide large scale GATS-2017 India data were used, and it provide a sufficient study on tobacco smoking behaviour among adults. To analyze the prevalence and risk factors of tobacco smoking, different statistical techniques and models were developed and carried out. Therefore, there

is no scope for comparing the developed statistical techniques and models in the present study, but it is important to compare this study with other studies. This study found that the national prevalence of tobacco smoking was 12.84% in India, with 25.01% for males and 2.63% for females. This finding is much higher than national studies from Ethiopia [2] and Ghana [18], but lower than national studies from Madagascar [19] and Nepal [20]. The social acceptance of tobacco consumption is also high in Nepal [20]. This study revealed variations in tobacco smoking all over India's regional states, and similar results were found in Ethiopia [2]. The highest prevalence was found in the north east region, and this result is not supported by the previous surveys' results in India [7]. Tobacco smoking in India is higher among males than females. In this study the female tobacco smoking rate is 2.63% in India, whereas this rate is higher than Pakistan (1.8%) [6]. In India tobacco smoking is higher among up to primary educated, married, poorest and casual labourer. This result is supported by Singh and Ladusingh [7]. The odds of tobacco smoking was found to be more likely among the middle and older age groups. Specifically, those who were in the age group 46–60 years were more likely to smoke tobacco compared to those in the 15 to 30 years age group, and this is consistent with a previous study of India [7]. This finding is also more similar to a study from Nepal [20], a town surveys in south-central Ethiopia [21], Ghana [18], Brazil [22] and Madagascar [19]. One important fact is that older adults have had a longer time experience to smoke tobacco, and have developed the bad habit of tobacco smoking [23]. A person who started tobacco smoking in early life has been found to have less chance of giving up tobacco smoking in future life [24]. This study showed that older adults (65+ years) were more likely to ignore tobacco smoking, and these findings are supported by Van Loon et al. [25].

Tobacco smoking in India varies significantly by national region. The risk of tobacco smoking among adults is more likely in the north east region compared to the north region. This finding is consistent with a previous study on GTAS-India 2009 data [7, 8]. Males are more likely to smoke tobacco as compared to females. Several studies in Africa have shown that tobacco smoking is more prevalent in males [23, 26–28]. Females who are in the habit of tobacco smoking face humiliation and discrimination by their own community in India. Females are also more socially restricted than their male counterparts [23]. This is supported by Reda et al. [23]. Education was one of the most important factors of tobacco smoking among adults in India. Adults with no education were at higher risk, and more than higher educated adults were at a lower risk of tobacco smoking in India. This finding is supported by the previous study in 2009 using GTAS-India data [7], and survey analysis in the Butajira town of Ethiopia [21]. This study found that occupation type was associated with tobacco smoking. Daily wage/casual labourer were associated with higher odds of tobacco smoking as compared to adult government/non-government employees. Lakew and Haile found that professional working adults were associated with lower odds of tobacco smoking in Ethiopia [2]. The possible justification could be that ethics demanded for professional workers might prevent them from tobacco use [2]. A study in Nepal found that adults in labour-intensive occupations had increased odds of using tobacco smoking as compared to government/non-government (professional) jobs [20]. In Madagascar, occupation type was also significantly associated with tobacco smoking [19]. The odds of tobacco smoking among currently married and formerly married adults were around 54% and 56% higher as compared to unmarried adults. This result is supported by Lakew and Haile [2]. Being among the poorest was significantly associated with a higher risk of tobacco smoking among adults in India [2]. The odds of tobacco smoking increased when the respondent wealth index was decreasing from the richest to the poorest. This finding is supported by Singh and Ladusingh [7] and Nketiah-Amponsah et al. [29]. The number of living persons in a family is a significant associated

factor of tobacco smoking, and the odds of tobacco smoking were decreased if the number of living persons was increased. Knowledge about the health hazards of tobacco smoking is important for finding the important determinants. The health risks of tobacco smoking are sometimes not understood by tobacco smokers [30]. Most of the adults knew that strokes and lung cancer are the most common diseases induced by smoking. There are several others non-communicable diseases which are caused by tobacco smoking. The risk of tobacco smoking was higher among adults who were not aware that tobacco smoking causes lung cancer and strokes in India. Singh and Ladusingh do not support this finding, and they obtained the reverse results [7]. The GATS-India 2017 report shows that knowledge about the health hazards of tobacco smoking is moderately high in India, and similar results were found in GATS-India 2009 reports. So there is a need to raise awareness about the effects of tobacco smoking.

As this study utilized a nationally representative sample from India, the results can be generalized to the target population (≥ 15 -year-old population in India). Moreover, due to the utilization of standard and valid tools for data collection by GATS, the probability of the existence of measurement error is less in this study in comparison to other single cross-sectional studies conducted in India.

Limitations and recommendations of the study

However, this study has some potential limitations. Although a standardized procedure and questionnaire were utilized in this study, the limitations of this study cannot be ignored. The cross-sectional design of the study could not enable us to establish correlations between variables. Also, the questionnaire was controlled by interviewers, so there was a risk of interviewer bias. Though multistage random sampling was used for the selection of respondents, it could be subject to some selection bias if the interviewer did not follow sampling instructions properly. The survey was limited to household population in 32 states, and findings cannot be generalized to segments that were excluded, as discussed in the methods section. The prevalence and risk factors of smoking were measured at one point in time. Therefore, it is not possible to determine the direction of causal relationships between smoking and some factors, like income.

These findings support the need for strengthening the tobacco control programme in India. In detail, this study recommends the following:

- There was a significant decrease in tobacco smoking among adults compared to a previous study in India, and the tobacco control programme needs to focus on its strategies and continue these strategies. In India there exist rules that ban tobacco smoking in public places. To reduce tobacco smoking among adults the advertisement about the bad impact of tobacco products in electronic media is essential. Under such situations, only putting health warnings on cigarette packaging is not enough to control the tobacco smoking epidemic in the country.
- The tobacco smoking rate was higher among males than females at the current time. So to reduce the

number of male smokers there needs to more awareness about the harmful effects of tobacco smoking. Female tobacco smoking is at a low level, and continued efforts are needed to keep it at low levels.

- The poorer and uneducated are at high risk of tobacco smoking. So tobacco control campaigns should demonstrate a motivation to quit. An increase in price and taxation on tobacco products can decrease its consumption. Capitalizing in education would have additional benefits for tobacco control because higher education makes a person more conscious about health.
- Formerly married people, and families having a smoking person are also at high risk of tobacco smoking. A formerly married person feels lonely and affected by depression, so they need more awareness and entertainment. Most people start smoking in their teen years. They might start because their parents or other family members smoke. If the family member is educated and conscious about their health and future, then it will help to reduce tobacco smoking.
- Systematic surveys on the prevalence and risk factors of tobacco smoking in the general population should be carried out at regular time intervals. Otherwise, the progress of the tobacco smoking control programme will be unable to control the smoking epidemic.

Conclusions

This study used nationally representative data to discover the prevalence and factors that affect tobacco smoking intensity among adults in India. The overall prevalence of tobacco smoking seems relatively high in India. There are some regional states, specifically Arunachal Pradesh, Manipur, Meghalaya, Mizoram, and Tripura, that need special attention because of their higher prevalence (more than 20%) of tobacco smoking. All factors had a statistically significant association with tobacco smoking except the mass media exposure, print media exposure, and knowledge that tobacco smoking causes TB variables. Age, national region, gender, education, occupation, religion, marital status, wealth index, number of living persons, presence of smoking persons, use of smokeless tobacco, and knowledge that smoking causes strokes and lung cancer had a statistically significant impact on tobacco smoking. As a result, these factors should be considered when pointing out specific public health interventions to reduce tobacco smoking in India. High prevalence regions of tobacco smoking need extraordinary intervention. This can often be endorsed among people with less knowledge and awareness of the bad impact of tobacco smoking.

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