



Social determinants of dual tobacco use in India: An analysis based on the two rounds of global adult tobacco survey

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ABSTRACT

This study examines the socioeconomic determinants of dual use of smoked and smokeless tobacco (SLT) in India between 2009–10 and 2016–17. Data from two rounds of the nationally representative cross-sectional Global Adult Tobacco Survey (GATS) conducted in 2009–10 and 2016–17 was used. Complete sample size from both rounds of survey covering 143,333 individuals (GATS I: 69,296 and GATS II: 74,037) from 153,239 households (GATS I: 76,069 and GATS II: 77,170) included in the study. Dual use was assessed based on current smoked and SLT users in both rounds. Bivariate analysis was applied to assess differences in dual tobacco use by socioeconomic status (SES) and across regions, whereas, pooled sampled analysis was conducted to examine the determinants of dual use applying multinomial logistic regression model. Findings reveal that dual use has declined in India from nearly 5% in 2009–10 to 3.4% in 2016–17. Considerable regional and SES differences in dual use are evident. Multivariate results indicate, while age is positively associated with dual use, education and household wealth was negatively associated. Dual use of tobacco was found to be considerably higher among men as compared to women (RRR: 15.66, 95%CI 14.20–17.27). Awareness about the adverse health consequences of tobacco was also negatively associated with dual tobacco use (RRR: 0.56, 95%CI 0.50–0.64). Future awareness and enforcement efforts should focus on all forms of tobacco, especially targeting vulnerable SE groups.

1. Introduction

Globally, 8 million people die prematurely from lifelong tobacco use every year (WHO, 2019). Out of more than one billion smokers and more than 350 million smokeless tobacco users in the world, nearly 11 percent smokers (104 million) and almost 60 percent smokeless (200 million) tobacco users live in India (John et al., 2018; Reitsma et al., 2017; Sinha et al., 2017). The social and economic consequences of premature deaths due to tobacco use are enormous (Beaglehole et al., 2015; Britton, 2017; Reddy and Gupta, 2004; Sinha et al., 2018, 2016), particularly in low-and-middle income countries like India, which expects to harness its demographic dividends (James, 2011). The adverse impact of dual tobacco use on health includes poor biomarkers

(Benowitz et al., 2012), elevated risk of pancreatic and oesophageal cancer and cardiovascular disease (Cogliano et al., 2004; Secretan et al., 2009). Moreover, dual tobacco users were found to be more vulnerable to increase in nicotine exposure (Bombard et al., 2008), nicotine dependence (Cavazos-Rehg et al., 2014) and higher relapse rate for 30 day cessation session as compared with single form of tobacco users (Messer et al., 2015).

India has a range of both smoked and SLT products and previous evidences have shown that consumption of both forms of tobacco has been highly prevalent (Mehrotra et al., 2017; Tata Institute of Social Sciences and Ministry of Health and Family Welfare Government of India, 2017). Moreover, the patterns of usage are unequally distributed across different socioeconomic groups – sex, education, and wealth, like

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in case of other risk factors associated with chronic diseases (Bhan et al., 2012; Rani et al., 2003; Subramanian et al., 2004). Literature search showed very few studies that have analyzed dual burden of tobacco use in India. For instance, a study based on WHO South-East Asia region namely Bangladesh, Indonesia, India, Maldives, Nepal, and Timor Leste using Demographic and Health Surveys found highest consumption of dual tobacco among men in Nepal (17.9% in 2009–10), followed by India (13.4% in 2005–06) and Bangladesh (9.6% in 2012) (Sinha et al., 2016). The other studies utilized the first round of Global Adult Tobacco Survey (GATS 2009–10) and showed considerable disparity in dual tobacco use across regions and socioeconomic groups (Gupta et al., 2017; Singh and Ladusingh, 2014).

In this study, we aim to examine the determinants of dual tobacco consumption in India while incorporating various socioeconomic, demographic and awareness related dimensions during two rounds of Global Adult Tobacco Survey conducted in 2009–10 and 2016–17.

2. Methods

2.1. Data

This study utilizes data from two rounds of the Global Adult Tobacco Survey (GATS) conducted in 2009–10 and 2016–17 (<https://mohfw.gov.in/newshighlights/global-adult-tobacco-survey-2-gats-2-india-2016-17-report>). Both rounds of survey are nationally representative, covering all states and three Union Territories (UTs) – Chandigarh, Delhi and Puducherry. The sampling for GATS was done independently in each of the states/UTs based on 2001 and 2011 census population, respectively. The inclusion criteria were all Indian residents aged 15 years and above, living in their usual residence prior to the survey date. A three- and two-stage sampling process in urban and rural areas respectively was adopted to draw a representative sample. A detailed sampling design could be found in the GATS reports available on (<https://mohfw.gov.in/newshighlights/global-adult-tobacco-survey-2-gats-2-india-2016-17-report>). The overall response rate calculated as the product of the response rates at the household and person-level was 91.8% and 92.9% in GATS-1 and GATS-2, respectively. This study utilized complete sample size from both rounds of survey covering 143,333 individuals (GATS I: 69,296 and GATS II: 74,037) from 153,239 households (GATS I: 76,069 and GATS II: 77,170).

2.2. Dependent and independent variables

Both rounds of GATS asked two identical questions on current use of smoked and SLT to all the selected respondents without providing any reference time period. The specific questions are:

- “Do you currently smoke tobacco? (daily, less than daily, not at all, don't know, refused)”
- “Do you currently use smokeless tobacco? (daily, less than daily, not at all, don't know, refused)”

Using this information a new ‘dual use’ variable was constructed consisting of three categories – dual use (individuals using both smoked and SLT daily and less than daily), single use (individuals using either smoked or SLT daily or less than daily) and non-tobacco user (individuals neither using smoked nor SLT).

Study includes range of demographic, socioeconomic and awareness variables including age of the respondents (grouped as 15–21, 22–35, 36–64 and 65 +) and sex (male/female). Socioeconomic status was measured in terms of individual's education (no formal education, less than primary, primary completed, less than secondary, secondary completed, higher secondary completed, college/university completed and post-graduate completed), occupation (government employee, non-government employee, self-employed, student, homemaker, retired, unemployed, able to work and unemployed, unable to work) and household wealth (poorest, poorer, middle, rich and richest). A household wealth index based on 10 households assets namely availability of electricity, refrigerator, washing machine, radio, television, moped/scooter/motorcycle, car, flush toilet, fixed telephone and cell phone was constructed using Principle Component Analysis (PCA) (Rutstein and Staveteig, 2014). Individuals were ranked on the basis of their household scores and divided into different quintiles, each representing 20 percent of the score, between 1 (poorest) and 5 (wealthiest) (Rutstein and Staveteig, 2014). However, to check the internal consistency, that is, how closely all selected household and consumer durable assets considered for the construction of the wealth index are related, Cronbach α test (Cronbach and Shavelson, 2004) was applied in both rounds of GATS. The test shows a value for both rounds of GATS above 0.7 (for GATS 1: 0.782; and GATS 2: 0.811), indicating reliability in the estimates. A knowledge variable that assesses adverse effects of tobacco on health was constructed based on the five variables: smoking causes serious illness, smoking causes stroke, smoking causes heart attack, smoking causes lung cancer and smokeless tobacco causes serious illness. Three categories ‘no, to all five components’ no, to at least one component’ and yes, to all five components’ were created. Place of residence (urban/rural) and states were also taken into consideration.

2.3. Analytical strategy

Study estimated the prevalence of dual use of tobacco for both rounds of GATS. To examine the bivariate association between the dual use of tobacco and selected independent variables in both survey rounds, χ^2 test was performed. Overall state-wise trends along with urban–rural difference in the prevalence of dual use have been studied. The survey methodology and tools of data collection were largely identical in both the rounds of GATS. Hence, we pooled both rounds of sample. We introduced new *time dummy* (2009–10 & 2016–17) as an independent variable to examine the association between the dual use of tobacco and socioeconomic status while adjusting the survey periods in the regression models.

Multinomial logistic regression is used to examine the adjusted associations between tobacco use and selected independent variables. To illustrate, in the multinomial logit model we assume that the log odds of each response follow either a linear or a non-binary model (Scott Long, 1997)

$$n_{ij} = \log \frac{\pi_{ij}}{\pi_{iJ}} = \alpha_j + x_i \beta_j,$$

where α_j is a constant and β_j is a vector of regression coefficient, for $j = 1, 2, \dots, J - 1$. Note that we have written the constant explicitly, so we assume that the model matrix X does not include a column of ones. This model is analogous to a logistic regression model, except that the probability distribution of the response is multinomial, in this case ‘non

Table 1
Sample description of the study population, Global Adult Tobacco Survey (GATS), India 2009–2017.

Background characteristics	GATS I (2009–10)		GATS II (2016–17)	
	n	%	n	%
Demographic				
Age				
15–21	8888	20.7	8756	18.8
22–35	26,989	36.7	26,693	34.5
36–64	28,729	35.8	32,576	38.3
65+	4690	6.8	6012	8.4
Sex				
Female	35,529	48.3	40,265	48.9
Male	33,767	51.7	33,772	51.1
Socio-economic				
Education				
No formal education	18,805	30.9	18,473	26.4
Less than primary	7992	12.2	7510	9.2
Primary completed	8311	11.8	8858	11.3
Less than secondary	11,236	17.0	12,109	16.9
Secondary completed	8949	11.6	10,331	14.1
Higher secondary completed	6195	7.9	7959	11.2
College/University completed	5529	6.1	6096	7.8
Post-graduate degree completed	2139	2.2	2642	3.1
Don't know/refused	140	0.3	59	0.1
Occupation				
Student	5819	11.2	6134	11.9
Government employee	4002	3.2	3355	2.7
Non-government employee	11,926	21.0	20,008	29.5
Self-employed	19,629	28.5	13,955	19.4
Homemaker	23,858	30.5	25,833	30.1
Retired	1207	1.4	1679	2.1
Unemployed, able to work	1501	2.1	1572	1.9
Unemployed, unable to work	1224	1.9	1471	2.3
Don't know/refused	130	0.1	30	0.0
Wealth quintile				
Poorest	14,115	20.4	15,019	20.3
Poorer	16,127	20.3	20,272	21.3
Middle	11,602	19.7	10,013	19.5
Richer	13,852	20.0	13,934	19.0
Richest	13,600	19.6	14,799	19.9
Awareness of adverse effects of tobacco				
No, to all five	3992	6.5	1461	2.0
No, to at least one	32,568	49.9	27,799	39.3
Yes, to all five	32,736	43.6	44,777	58.7
Contextual				
Place of residence				
Urban	27,471	29.2	26,488	34.5
Rural	41,825	70.8	47,549	65.5
Total	69,296	100	74,037	100

All 'n' are unweighted.

tobacco user, 'smokeless only' 'smoke only' and 'dual user (both smokeless and smoke)', instead of binomial and we have $J - 1$ equations instead of one. The $J - 1$ multinomial logit equations contrast each of categories 1,2, ... $J - 1$ with category J , whereas the single logistic regression equation is a contrast between 'no' and 'yes' or 'successes' and 'failures' (Scott Long, 1997). In multinomial regression analysis each outcome is modelled relative to baseline outcome group. In this study 'non tobacco user' is the baseline group. For better

Table 2
State wise trends in dual burden of tobacco use (in%), GATS 2009–2017, India.

States/ Union Territories	GATS (2009–10)		GATS (2016–17)		Absolute change (T1-T2)	Relative change (T1-T2/ T1*100)
	%	95% CI	%	95% CI		
India	5.3	[5.0,5.7]	3.4	[3.2,3.7]	-1.9	-35.8
North						
Jammu & Kashmir	3.0	[2.1,4.1]	1.4	[0.9,2.2]	-1.6	-53.3
Himachal Pradesh	1.6	[1.1,2.4]	1.2	[0.7,2.0]	-0.4	-25.0
Punjab	1.7	[1.2,2.4]	1.8	[1.1,2.9]	0.1	5.9
Chandigarh	2.1	[1.3,3.3]	1.8	[1.1,2.8]	-0.3	-14.3
Uttarakhand	3.0	[2.0,4.4]	3.9	[3.2,4.8]	0.9	30.0
Haryana	2.3	[1.5,3.5]	2.4	[1.4,4.1]	0.1	4.3
Delhi	3.6	[2.6,5.0]	2.3	[1.5,3.4]	-1.3	-36.1
Central						
Rajasthan	5.4	[4.2,6.9]	2.6	[2.0,3.5]	-2.8	-51.9
Uttar Pradesh	6.2	[5.3,7.2]	7.4	[6.2,8.7]	1.2	19.4
Chhattisgarh	6.7	[5.3,8.4]	2.4	[1.6,3.7]	-4.3	-64.2
Madhya Pradesh	8.8	[7.1,10.8]	4.1	[3.1,5.3]	-4.7	-53.4
East						
West Bengal	6.9	[5.6,8.5]	3.2	[2.5,4.1]	-3.7	-53.6
Jharkhand	7.5	[6.2,9.0]	7.7	[5.8,10.0]	0.2	2.7
Odisha	7.3	[6.0,8.7]	4.3	[3.3,5.5]	-3.0	-41.1
Bihar	9.5	[8.0,11.2]	2.7	[1.9,3.7]	-6.8	-71.6
North-East						
Sikkim	10.4	[7.8,13.8]	2.7	[1.9,4.0]	-7.7	-74.0
Arunachal Pradesh	17.9	[14.9,21.4]	16.5	[12.9,20.7]	-1.4	-7.8
Nagaland	20.0	[16.3,24.2]	8.9	[7.3,10.9]	-11.1	-55.5
Manipur	16.1	[13.9,18.5]	13.5	[11.2,16.2]	-2.6	-16.1
Mizoram	13.2	[10.6,16.2]	9.2	[7.7,11.0]	-4.0	-30.3
Tripura	12.8	[10.5,15.6]	11.7	[8.3,16.2]	-1.1	-8.6
Meghalaya	8.7	[6.0,12.5]	4.9	[3.1,7.7]	-3.8	-43.7
Assam	7.8	[6.7,9.1]	6.8	[5.8,7.9]	-1.0	-12.8
West						
Gujarat	3.2	[2.4,4.1]	1.8	[1.2,2.6]	-1.4	-43.8
Maharashtra	2.8	[2.3,3.6]	1.6	[1.0,2.5]	-1.2	-42.9
Goa	0.7	[0.4,1.2]	1.0	[0.5,2.0]	0.3	42.9
South						
Andhra Pradesh	3.3	[2.4,4.5]	1.0	[0.7,1.6]	-2.3	-69.7
Karnataka	3.1	[2.2,4.4]	2.3	[1.7,3.0]	-0.8	-25.8
Kerala	2.6	[1.9,3.6]	2.0	[1.2,3.2]	-0.6	-23.1
Tamil Nadu	1.5	[1.0,2.1]	1.0	[0.7,1.4]	-0.5	-33.3
Puducherry	1.3	[0.9,1.8]	0.8	[0.4,1.5]	-0.5	-38.5

Note: Andhra Pradesh and Telangana were merged in GATS 2017. Absolute change: GATS 1 - GATS 2; Relative change: (GATS 1 - GATS 2)/GATS 1*100.

representation, we have shown only dual tobacco use results, however detailed regression analysis can be referred in Appendix 1. Study reported the relative risk ratio (RRR) rather than odds or risk ratio along with their 95% confidence intervals (Haan and Uhlenndorf, 2006). The analysis was adjusted for sampling weights and multistage sampling design using `svy` command in STATA. Analysis was carried out in STATA 15 version (Stata, 2013).

Table 3
Prevalence of dual use of tobacco use by selected background characteristics, GATS 2009–17, India.

Background characteristics	GATS I (2009–10)		GATS II (2016–17)		Absolute change	Relative change
	%	95% CI	%	95% CI		
Age	<i>p</i> < 0.001		<i>p</i> < 0.001			
15–21	2.3	[1.7,2.9]	1.4	[1.0,2.0]	–0.9	–39.1
22–35	5.6	[5.1,6.2]	3.6	[3.2,4.0]	–2	–35.7
36–64	6.6	[6.0,7.2]	4.2	[3.8,4.7]	–2.4	–36.4
65+	6.2	[5.2,7.4]	3.7	[3.0,4.4]	–2.5	–40.3
Sex	<i>p</i> < 0.001		<i>p</i> < 0.001			
Female	1.1	[0.9,1.3]	0.5	[0.4,0.7]	–0.6	–54.5
Male	9.3	[8.7,9.9]	6.3	[5.8,6.8]	–3	–32.3
Education	<i>p</i> < 0.001		<i>p</i> < 0.001			
No formal education	6.0	[5.4,6.6]	4.2	[3.8,4.8]	–1.8	–30
Less than primary	8.3	[7.3,9.3]	6.1	[5.2,7.0]	–2.2	–26.5
Primary completed	6.1	[5.3,7.1]	4.7	[4.0,5.5]	–1.4	–23
Less than secondary	5	[4.3,5.7]	3.7	[3.1,4.4]	–1.3	–26
Secondary completed	3.6	[3.0,4.4]	2.1	[1.7,2.7]	–1.5	–41.7
Higher secondary completed	2.9	[2.3,3.8]	1.8	[1.3,2.4]	–1.1	–37.9
College/University completed	2.5	[1.8,3.5]	1.2	[0.8,1.8]	–1.3	–52
Post-graduate degree completed	2.0	[1.2,3.1]	0.5	[0.2,1.1]	–1.5	–75
Don't know/refused	13.7	[8.4,21.5]	2.9	[0.4,16.8]	–10.8	–78.8
Occupation	<i>p</i> < 0.001		<i>p</i> < 0.001			
Government employee	4.9	[3.7,6.6]	2.1	[1.4,3.2]	–2.8	–57.1
Non-government employee	8.8	[7.9,9.7]	6.1	[5.5,6.8]	–2.7	–30.7
Self-employed	8.3	[7.6,9.1]	6.2	[5.5,6.9]	–2.1	–25.3
Student	0.9	[0.5,1.4]	0.4	[0.2,0.7]	–0.5	–55.6
Homemaker	1.4	[1.1,1.8]	0.5	[0.4,0.7]	–0.9	–64.3
Retired	5.7	[4.0,8.0]	2.1	[1.3,3.4]	–3.6	–63.2
Unemployed, able to work	10.1	[7.2,13.8]	3.9	[2.6,5.8]	–6.2	–61.4
Unemployed, unable to work	6.0	[4.2,8.4]	3.4	[2.4,4.8]	–2.6	–43.3
Wealth quintile	<i>p</i> < 0.001		<i>p</i> < 0.001			
Poorest	7.8	[7.1,8.6]	6.0	[5.4,6.7]	–1.8	–23.1
Poorer	5.4	[4.8,6.0]	3.5	[3.1,4.0]	–1.9	–35.2
Middle	4.4	[3.8,5.0]	3.2	[2.6,4.0]	–1.2	–27.3
Richer	4.0	[3.3,4.7]	1.7	[1.4,2.1]	–2.3	–57.5
Richest	2.6	[2.1,3.1]	1.4	[1.1,1.9]	–1.2	–46.2
Awareness of adverse effects of tobacco	<i>p</i> < 0.001		<i>p</i> < 0.001			
No, to all five	7.4	[6.1,9.0]	3.8	[2.7,5.4]	–3.6	–48.6
No, to at least one	5.4	[5.0,5.9]	4.0	[3.6,4.4]	–1.4	–25.9
Yes, to all five	4.9	[4.4,5.3]	3.0	[2.7,3.4]	–1.9	–38.8
Place of residence	<i>p</i> < 0.001		<i>p</i> < 0.001			
Urban	3.6	[3.2,4.0]	2.3	[2.0,2.7]	–1.3	–36.1
Rural	6.0	[5.6,6.5]	4.0	[3.7,4.4]	–2	–33.3
Overall	5.3	[5.0,5.7]	3.4	[3.2,3.7]	–1.9	–35.8

Note: *p* represents the significance level estimated from χ^2 test.

Absolute change: GATS 1 - GATS 2;

Relative change: (GATS 1 - GATS 2)/GATS 1*100.

3. Results

3.1. Sample description

During 2009–10 to 2016–17, sample population with no formal education has declined from 31% to 26% and persons completed higher secondary education has increased from 8% to 11% (Table 1). Occupation wise distribution suggests majority of them were in non-government sector, homemaker, self-employed and students. Over 65% sample comes from rural areas in both the rounds. Awareness of adverse health effects due to tobacco use has increased over the period.

3.2. State wise dual tobacco use and burden during 2009 to 2017

Table 2 shows prevalence of dual use of tobacco across all states and UTs of India during 2009 to 2017. At national level, nearly 32 million Indians used both forms of tobacco, with a relative decline of about 20% i.e. nearly 8 million less users in 2017 when compared to 2009. Prevalence of dual tobacco use was highest in five northeastern states – Arunachal Pradesh (16.5%), Manipur (13.5%), Tripura (11.7%), Mizoram (9.2%), and Nagaland (8.9%) in 2016–17. In rest of the states, dual tobacco use was highest in Jharkhand (7.7%), followed by Uttar Pradesh (7.4%). On the other hand, as many as 11 states recorded less

Table 4
Multinomial logistic regression analysis showing determinants of dual tobacco use based on pooled sample, GATS 2009–2017.

Background characteristics	RRR	P > z	(95%CI)	
Time				
GATS 2009–10 (ref.)				
GATS 2016–17	0.58	< 0.001	0.55	0.61
Age				
15–21 (ref.)				
22–35	3.22	< 0.001	2.82	3.68
36–64	4.41	< 0.001	3.85	5.05
65+	3.72	< 0.001	3.13	4.41
Sex				
Female (ref.)				
Male	15.79	< 0.001	14.30	17.43
Education				
No formal education (ref.)				
Less than primary	0.90	0.017	0.82	0.98
Primary completed	0.70	< 0.001	0.64	0.77
Less than secondary	0.55	< 0.001	0.50	0.60
Secondary completed	0.36	< 0.001	0.32	0.40
Higher secondary completed	0.33	< 0.001	0.29	0.37
College/University completed	0.18	< 0.001	0.16	0.21
Post-graduate degree completed	0.14	< 0.001	0.11	0.18
Occupation				
Student (ref.)				
Government employee	2.49	< 0.001	2.01	3.09
Non-government employee	4.05	< 0.001	3.35	4.90
Self-employed	2.89	< 0.001	2.40	3.49
Student	1.82	< 0.001	1.46	2.25
Homemaker	1.50	< 0.001	1.13	1.99
Retired	3.31	< 0.001	2.65	4.14
Unemployed, able to work	2.10	< 0.001	1.62	2.73
Unemployed, unable to work	1.28	0.618	0.49	3.36
Wealth quintile				
Poorest (ref.)				
Poorer	0.89	0.001	0.82	0.95
Middle	0.77	< 0.001	0.70	0.84
Richer	0.74	< 0.001	0.67	0.81
Richest	0.57	< 0.001	0.50	0.64
Awareness of adverse effects of tobacco				
No, to all five (ref.)				
No, to at least one	0.73	< 0.001	0.65	0.83
Yes, to all five	0.56	< 0.001	0.50	0.64
Place of residence				
Urban (ref.)				
Rural	1.20	< 0.001	1.12	1.28

Note: Estimates are adjusted for state level fixed effects.
Dependent variable: 1-‘non tobacco user’ (reference category), 2-‘smokeless tobacco’, 3-smoked tobacco, 4-dual tobacco user. Refer [Appendix 1](#) for further detailed results of each dependent variable.

than 2% people consuming both forms of tobacco in 2016–17.
During 2009 to 2017, nearly 25 states and UTs have recorded decline in dual use of tobacco. Sikkim (-74%), Bihar (-71.6%) and Andhra Pradesh (-69.7%) have recorded highest relative decline, while the least decline was observed in Arunachal Pradesh (-7.8%), Tripura (-8.6%)

and Assam (-12.8%). In case of Bihar and Andhra Pradesh similar rate of decline was observed for both smoked and SLT use. However, during two consecutive GATS period, six Indian states namely Goa (42.9%), Uttarakhand (30%), Uttar Pradesh (19.4%), Punjab (5.9%), Haryana (4.3%) and Jharkhand (2.7%) have shown increase in dual tobacco use. In Jharkhand, smoked tobacco use has increased by nearly 68%, while in Uttarakhand and Uttar Pradesh SLT use has increased by 38% and 15% respectively during 2009–17.

3.3. Socioeconomic disparity in dual use of tobacco

Table 3 presents the prevalence of dual use of tobacco by key socioeconomic and demographic characteristics during 2009 to 2017. In both rounds of survey, dual use was higher among men (9.3% in 2009–10 and 6.3% in 2016–17) as compared to women (1.1% in 2009–10 and 0.5% in 2016–17). Similarly, during 2009 to 2017 dual use of tobacco was increasing with the increase in the age groups. Respondents who had completed below primary level of education have higher dual use of tobacco than those who had completed secondary education and above. Occupation-wise pattern revealed higher dual use of tobacco among those respondents who were working either in non-government sector or were self employed. Dual use of tobacco was declining with increase in wealth in both the rounds. Furthermore, individuals who were aware of all five adverse health consequences of tobacco use had lower dual tobacco use.

3.4. Determinants of dual use of tobacco during 2009 to 2017

Table 4 shows result of multinomial logistic regression of dual use of tobacco after pooling both rounds of GATS survey adjusting for range of background variables including age, sex, education, occupation, wealth quintile, awareness of adverse effects of tobacco, place and state of residence. The socioeconomic determinants emerged from this analysis was adjusted for time duration as well. Finding suggests risk of dual use of tobacco has declined from 2009–10 to 2016–17 (RRR: 0.58, 95%CI 0.55–0.61). Age was significantly positively associated with dual use of tobacco. For instance, the likelihood of using both forms of tobacco were highest among persons aged 36–64 years (RRR: 4.41, 95%CI 3.85–5.05) as compared to persons aged 15–21 years. The likelihood of both forms of tobacco use significantly declined with increase in education level and household wealth. Awareness regarding all five components of adverse health consequences of tobacco use was negatively associated with dual use of tobacco as compared to those who were not aware at all. Finding suggests that the use of both forms of tobacco was higher in rural areas as compared to urban counterparts (RRR: 1.33, 95%CI 1.25–1.42).

Fig. 1 shows adjusted predicted probability of dual tobacco use across states of India after adjusting for other background variables along with two surveys time-period in the regression model. It indicates higher burden of dual use of tobacco in majority of the north-eastern states of India. The Figure further illustrates that among other states probability of dual use of tobacco during 2009 to 2017 was higher in Jharkhand (PP: 0.076), Uttar Pradesh (PP: 0.072) and Odisha (PP: 0.064).

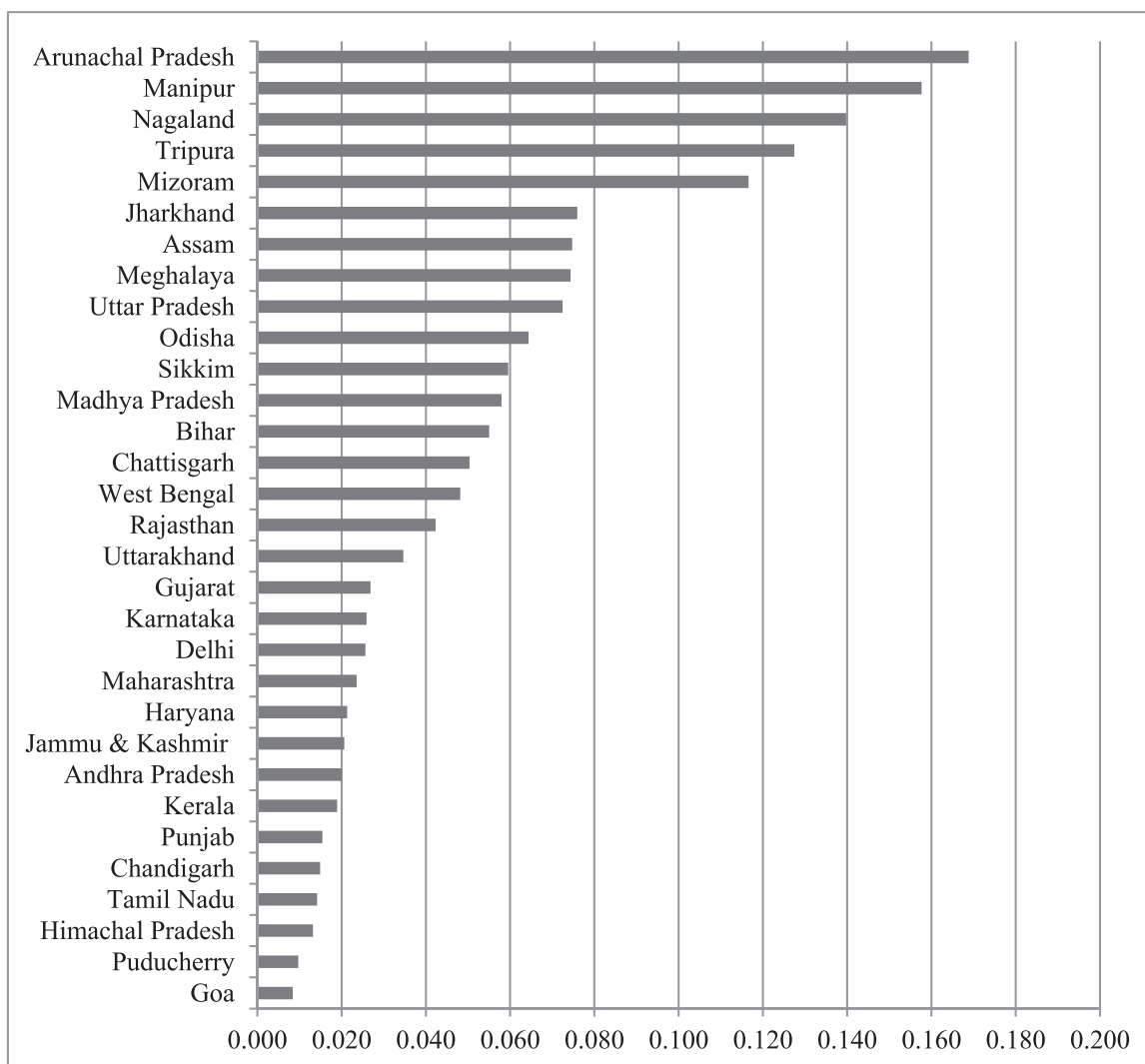


Fig. 1. Statewise predicted probabilities estimation obtained from the pooled sample multinomial regression analysis, GATS 2009–17. Note: Estimates are adjusted for all independent variables listed in Table 4.

4. Discussion

Results based on pooled regression analysis revealed that dual tobacco use has declined significantly in India during 2009–17. The decline in dual tobacco use over the time could be due to regular increase in tobacco taxation (John et al., 2018), extensive awareness programmes targeting both smoking and smokeless tobacco under the National Tobacco Control Programme (Yadav et al., 2018) and enforcement of COTPA, WHO FCTC and MPOWER strategies in the country (WHO, 2017).

Age, sex, education, occupation, wealth, awareness and residence were significantly associated with dual use of tobacco during 2009–17. As evident in previous studies, age and sex are significantly associated with dual use of tobacco in India (Singh and Ladusingh, 2014). Particularly, it has been observed in previous studies that middle-aged adults were more prone to dual use of tobacco (Rani et al., 2003). Gender-gaps suggest considerable higher likelihood of dual use of tobacco among men as compared to women. In India, tobacco use among women has been mostly in the form of SLT and largely been consumed in rural areas. Result further confirms negative effect of education on dual use of tobacco, as documented in previous studies. In the public health literature, education remains to be one of the strongest protective factor against poor health and risky behaviors such as tobacco use (Pampel and Denney, 2011; Sorensen et al., 2005). Studies from India and

elsewhere showed lower likelihood of dual use of tobacco among individuals working in government sector. On the other hand, people either engaged in non-government sector, self-employed or unemployed were more at risk of dual use of tobacco, this is confirmed by previous findings (Sharma et al., 2015).

Finding of this study observed higher dual use of tobacco among poorer section of the population whereas richer are less likely to be a dual user, a pattern opposite to western countries (Lopez et al., 1994). This could be argued that unlike developed countries, less-educated and poor individuals may have taken up both forms of tobacco due to lack of awareness about health risks (Siahpush et al., 2006). The risk of consuming both forms of tobacco was found to be negatively associated with awareness about adverse effect on health and illness. Knowledge and perception on health effects arising from tobacco use are associated with quitting, wherein those individuals with greater awareness exhibit higher quitting intentions (Dawood et al., 2016; Minh An et al., 2013; Raute et al., 2011; Sansone et al., 2012; Singh and Ladusingh, 2014). In a study conducted by Chow and colleagues, across 17 low, middle and high-income countries, knowledge and awareness of health effects were positively associated with higher quit ratios (Chow et al., 2017). However, low levels of awareness were reported in low-and-middle income countries, hence it is essential to develop comprehensive strategies on increasing knowledge and awareness to encourage quitting and health-seeking behaviours in these populations.

Results illustrated higher likelihood of dual use of tobacco in rural areas compared to urban counterparts. This finding is in contradiction with the other studies that either did not show any significant difference in dual use of tobacco between urban and rural areas (Singh and Ladusingh, 2014) or reported lower use among rural population (Sinha et al., 2016). However, a study based on youth aged 15–24 years found higher odds of dual use of tobacco in rural as compared to urban areas (Sharma et al., 2015). Studies from other countries such as Bangladesh (Zaman et al., 2014) and South Africa (Rantao and Ayo-Yusuf, 2012) also documented higher dual use in rural residents than urban counterparts. It has been found that rural population is more vulnerable in terms of risky behavior due to lower education, awareness and access to healthcare facility (Balarajan et al., 2011).

Results suggest higher probability of dual use in states like Arunachal Pradesh, Manipur, Nagaland, Tripura and Mizoram of north-eastern region and Uttar Pradesh, Odisha, Madhya Pradesh, Bihar and Chhattisgarh of central and eastern regions. A study based on first round of GATS documented higher likelihood of dual tobacco use in north-eastern, central and eastern regions (Singh and Ladusingh, 2014). The variations in dual use of tobacco across different states of India could be concurrent with the disparities in demographic and socio-economic status, healthcare infrastructure, social, cultural and health behavior norms.

5. Limitations

Study reports few limitations. First, the cross-sectional design of the study poses restrictions in terms of drawing causal inferences based on study findings. Second, many predictors such as social group (caste), religion etc. could not be included in this study due to non-availability of the information at least in one round of GATS. Third, data from Telangana, a newly formed state were merged with Andhra Pradesh for the second round of GATS to enable two rounds of survey to be pooled for the present analysis. Fourth, since all the information related to tobacco were self-reported, any information or reporting bias from the respondents is difficult to verify. Institutionalized person and non-domiciled migrants, who are largely men and comprise a significant proportion, do not get captured in GATS (Lal et al., 2015).

6. Conclusion

Finding of this study shows that ‘dual users’ represent about 12% of

Appendix 1

Adjusted associations between dual tobacco and its determinants from pooled analysis, GATS 2009–2017.

Background characteristics	Smokeless only			Smoke only				Dual use				
	RRR	P > z	(95%CI)	RRR	P > z	(95%CI)	RRR	P > z	(95%CI)	RRR	P > z	(95%CI)
Time												
GATS 2009–10 (ref.)												
GATS 2016–17	0.87	< 0.001	0.84	0.90	0.74	< 0.001	0.70	0.77	0.58	< 0.001	0.55	0.61
Age												
15–21 (ref.)												
22–35	2.12	< 0.001	1.98	2.27	3.41	< 0.001	3.03	3.83	3.22	< 0.001	2.82	3.68
36–64	2.74	< 0.001	2.56	2.94	6.66	< 0.001	5.91	7.49	4.41	< 0.001	3.85	5.05
65+	3.06	< 0.001	2.79	3.34	6.76	< 0.001	5.90	7.75	3.72	< 0.001	3.13	4.41
Sex												
Female(ref)												
Male	2.47	< 0.001	2.37	2.58	24.23	< 0.001	22.32	26.31	15.79	< 0.001	14.30	17.43
Education												
No formal education (ref.)												
Less than primary	0.94	0.016	0.89	0.99	0.72	< 0.001	0.67	0.77	0.90	0.017	0.82	0.98
Primary completed	0.81	< 0.001	0.77	0.86	0.54	< 0.001	0.50	0.58	0.70	< 0.001	0.64	0.77
Less than secondary	0.74	< 0.001	0.70	0.78	0.43	< 0.001	0.40	0.46	0.55	< 0.001	0.50	0.60
Secondary completed	0.56	< 0.001	0.53	0.60	0.33	< 0.001	0.31	0.36	0.36	< 0.001	0.32	0.40
Higher secondary completed	0.47	< 0.001	0.44	0.51	0.27	< 0.001	0.25	0.30	0.33	< 0.001	0.29	0.37
College/University completed	0.32	< 0.001	0.29	0.35	0.21	< 0.001	0.19	0.23	0.18	< 0.001	0.16	0.21

the overall tobacco users in the country with considerable regional and socioeconomic disparity which warrants greater public health focus and policy action towards the issue. The high burden of dual use in the big states in the central, eastern and north-eastern part of the country also warrants regional policy action in addition to state level efforts to curb dual use of tobacco. Study emphasizes the need of multilevel monitoring of dual tobacco use at community and district level along with identification of target groups and targeted public health messages to this population of tobacco users that underscores the need to quit all tobacco products. Considering awareness of adverse health effects of tobacco use is inversely related to dual use, significant effort should be made to inform about the incremental adverse effects of dual tobacco use. Although, efforts have been made under the NTCP to strengthen tobacco control, along with the intensive awareness campaigns and enforcement of smoke free policies, full implementation of WHO FCTC strategies to control SLT use should be adopted to address the burden of dual use.

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CRediT authorship contribution statement

Prashant Kumar Singh: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing - original draft. **Amit Yadav:** Conceptualization, Investigation, Validation, Visualization, Writing - original draft. **Lucky Singh:** Data curation, Formal analysis, Investigation, Validation, Visualization, Writing - review & editing. **Shalini Singh:** Conceptualization, Investigation, Project administration, Resources, Supervision, Validation, Visualization, Writing - review & editing. **Ravi Mehrotra:** Conceptualization, Project administration, Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Post-graduate degree completed	0.25	< 0.001	0.22	0.29	0.15	< 0.001	0.13	0.18	0.14	< 0.001	0.11	0.18
Don't know/Refused	1.16	0.441	0.79	1.70	0.89	0.674	0.52	1.52	1.72	0.070	0.96	3.10
Occupation												
Government employee (ref.)												
Non-government employee	1.33	< 0.001	1.22	1.45	1.23	< 0.001	1.12	1.35	1.62	< 0.001	1.42	1.85
Self-employed	1.08	0.068	0.99	1.18	1.03	0.488	0.94	1.13	1.16	0.023	1.02	1.32
Student	0.41	< 0.001	0.36	0.46	0.45	< 0.001	0.38	0.53	0.40	< 0.001	0.32	0.50
Homemaker	0.74	< 0.001	0.68	0.81	0.83	0.003	0.74	0.94	0.73	< 0.001	0.61	0.86
Retired	0.76	< 0.001	0.66	0.88	0.74	< 0.001	0.64	0.86	0.60	< 0.001	0.47	0.77
Unemployed, able to work	1.02	0.777	0.90	1.16	0.92	0.283	0.79	1.07	1.33	0.002	1.11	1.59
Unemployed, unable to work	0.93	0.271	0.81	1.06	0.87	0.067	0.74	1.01	0.84	0.125	0.67	1.05
Don't Know/Refused	0.80	0.321	0.51	1.25	1.06	0.814	0.63	1.80	0.51	0.162	0.19	1.32
Wealth quintile												
Poorest												
Poorer	0.92	< 0.001	0.88	0.96	0.91	0.003	0.85	0.97	0.89	0.001	0.82	0.95
Middle	0.79	< 0.001	0.75	0.83	0.79	< 0.001	0.73	0.85	0.77	< 0.001	0.70	0.84
Richer	0.65	< 0.001	0.61	0.69	0.78	< 0.001	0.73	0.84	0.74	< 0.001	0.67	0.81
Richest	0.48	< 0.001	0.44	0.51	0.68	< 0.001	0.63	0.75	0.57	< 0.001	0.50	0.64
Awareness of adverse effects of tobacco												
No, to all five (ref.)												
No, to at least one	1.10	0.374	0.92	1.23	0.74	0.008	0.60	0.92	0.73	< 0.001	0.65	0.83
Yes, to all five	0.86	0.050	0.74	0.97	0.60	< 0.001	0.49	0.75	0.56	< 0.001	0.50	0.64
Place of residence												
Urban (ref.)												
Rural	1.08	< 0.001	1.04	1.12	1.19	< 0.001	1.13	1.25	1.20	< 0.001	1.12	1.28

Note: Estimates are adjusted for state level fixed effects.

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