Distribution and association of depression with tobacco consumption among middle-aged and elderly Indian population: nested multilevel modelling analysis of nationally representative cross-sectional survey

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Abstract

Background Research on the distribution and association of depression with tobacco consumption among young population is commonly prioritised in India, while studies on tobacco use among middle-aged (45–59 years) and elderly (≥ 60 years) adults are noticeably lacking. Thus, we conducted this study with the objectives of estimating the prevalence, distribution and determining the association of depression and tobacco consumption among middle-aged and elderly Indian population; overall and stratified into age group, gender, and geographical location.

Methods Using dataset from Longitudinal Aging Study in India (LASI), a bivariate analysis was conducted among middle-aged (45–59 years) and elderly (≥ 60 years) Indians to estimate the prevalence of depression and tobacco consumption. States and Union Territories were categorised as low, medium, and high as per prevalence of depression and tobacco consumption, and spatial distribution maps were created. To reduce the confounding effects of demographic & socioeconomic and health-related & behavioural covariates; propensity score matching (PSM) was conducted. Nested multilevel regression modelling was employed to explore the association between depression (outcome variable) and tobacco consumption (explanatory variable) using STATA version 17. The *p* value < 0.05 was considered statistically significant.

Results Overall, 36.78% (36.03–37.55%) participants documented using any form of tobacco; with higher consumption of smokeless tobacco (SLT) (19.88%) than smoking (SM) (13.92%). The overall prevalence of depression was 7.62% irrespective of tobacco consumption, and 8.51% among participants consuming any form of tobacco. Mizoram had the highest consumption of tobacco in any form (78.21%), whereas Madhya Pradesh recorded the highest (14.62%) depression prevalence. Bihar, Uttar Pradesh, West Bengal, and Uttarakhand had both high prevalence of depression and any form of tobacco consumption. The average estimated treatment effect (ATE) indicated a positive association both between depression and any form of tobacco consumption (*p* value = 0.001) and with smokeless tobacco (*p* value = 0.001) consumption. Participants ever consuming any form of tobacco had 28% higher odds (aOR-1.28 (1.18–1.38). The odds of having depression were higher among females (aOR = 1.28 (1.17–1.41); richest (aOR-1.48

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(1.32–1.65); living alone (aOR = 1.14 (1.01–1.33). Participants with comorbidity (aOR = 1.20 (1.10–1.30) and multimorbidity (aOR = 1.24 (1.13–1.36)) had higher odds of depression.

Conclusion The study has established significant positive association between depression and tobacco consumption stratified into gender and age group. Prioritisation of mental health disorders like depression and tobacco prevention and cessation programmes must be implemented with focusing on females and the middle-aged population with community awareness and intersectoral collaborative effort irrespective of subnational-variations.

Keywords Depression, Elderly, Older adults, LASI, Longitudinal aging study in India, Smoking, Smokeless tobacco

Introduction

A significant percentage of the population might encounter mental health issues at some point in their lives [1]. These illnesses come in a variety of forms and intensities, and they are linked to an increase in health burden, healthcare expenses, and disability rates [2]. Around the world, mental illness is responsible for one-fifth of the total burden of disease and disability, with major depressive disorder being the primary cause. Increased rates of chronic diseases, including mental health problems, are prevalent in low- and middle-income countries (LMICs) due to the rapid demographic ageing transition, thereby raising the number of older individuals living in such countries [3].

Disability adjusted life years (DALYs) attributable to mental diseases climbed from 80·8 million to 125·3 million between 1990 and 2019, accounting for a rise in the percentage of DALYs from 3·1% to 4·9% globally [4]. In 2017, 197·3 million persons in India received a diagnosis of a mental illness, including 45·7 million with a depression. Three quarters of the worldwide mental health burden in 2017 came from LMICs, with India alone contributing 15%, second only to China (17%) in terms of global mental health burden [5]. Prevalence of depression is found to be associated with increasing age, with people 60 years and beyond having the greatest prevalence rate—roughly 6.5%. The National Mental Health Survey (NMHS 2015-16) revealed that the lifetime and present prevalence of depressive disorders were 6.9 and 3.5%, respectively, among persons 60 years and older in twelve Indian states [6]. The Global Burden of Diseases (GBD) study showed the complexity of risk factors for depressive disorders in India [7].

Beyond national, ethnic, and social borders, tobacco smoking is becoming a more significant worldwide public health concern [8]. The pervasive usage of various tobacco products is a source of concern in low-and middle-income countries (LMICs). Data points to about 1.3 billion tobacco users worldwide, 80% of whom reside in LMICs, where tobacco-related morbidities and deaths are most prevalent [9]. India is the 2nd largest consumer of tobacco products (both smoked and smokeless) among LMICs and continues to be a major producer of the commodity. India's tobacco environment is diverse and complex [10, 11]. Around 267 million tobacco users (smoked and smokeless) in India were above the age of 15, according to the Global Adult Tobacco Survey-2 (GATS-2, 2016–17) [12].

As most of the research was directed to the younger age group, it is critical to comprehend the tobacco usage among middle-aged (45–59 years) and elderly (≥ 60 years) adults in India. India faces particular difficulties due to its ageing population since non-communicable illnesses are more common as people get older [13]. Examining the relationship between tobacco use and health issues, impairments, and higher healthcare use is crucial, given the significant effects smoking has on this ageing population with demographic, socioeconomic, and cultural challenges [14–16]. A complicated web of problems is created when ageing and health disorders like depression and tobacco use intersect. Significant life transitions that older persons must deal with include retirement, the death of a loved one, and deteriorating physical condition. These events can all exacerbate feelings of loneliness, melancholy, and depression susceptibility. In addition, a lot of elderly people have smoked for a longer period of time, which makes quitting challenging, particularly if smoking is a coping method for mental health issues. The combined consequences of depression and tobacco use can worsen pre-existing medical disorders, resulting in a reduction in general wellbeing. Research points out that tobacco users are more likely to be depressed than the ones who have never consumed tobacco in any form [17].

India has made great efforts to combat depression and tobacco smoking, but middle-aged and elderly adults have received less scientific attention than the younger population [18]. Despite the well-established negative effects of tobacco use, there is a substantial deficiency of thorough studies on the association between depression and consumption of tobacco among middle- and elderly-aged adults in LMICs like India [19]. This study aimed

to unveil the curtain from this important public health problem with the following objectives: to estimate the prevalence, distribution and to determine the association of depression and tobacco consumption among middle-aged and elderly Indian populations which is stratified into age group, gender and geographical location.

Methods

The current analysis used Longitudinal Ageing Study in India (LASI)−1st wave data of 73,000 adult Indians spread across 35 Indian states and Union Territories (UTs). It is a longitudinal survey with a national representation that intends to collect detailed information on the psychological, social, economic, and health aspects of ageing in India. It was created to close the knowledge gap about comprehensive and globally comparable survey data on ageing in India. The LASI has been jointly funded by the National Institute on Ageing, United States of America, the Government of India's Ministry of Health and Family Welfare and the Ministry of Social Justice and Empowerment, as well as the United Nations Population Fund [20]. The LASI survey intends to follow a representative sample of the older adult population every five years for the following 25 years, with a revised sample size to account for attrition due to death, migration, non-reachable, and non-response [20].

Sampling and data collection

A nationally representative sampling approach was used to recruit participants using probability proportional to size method for LASI. To ensure a complete and varied sample throughout all states and union territories, they visited households to gather data. Participants had to give their informed permission, and data collecting procedures, which included gathering social, economic, health, and demographic data, were to be followed. This method made it possible to conduct a comprehensive and precise analysis of India's ageing population. In order to provide a comprehensive understanding of the needs and circumstances of India's ageing population, LASI included household schedules for gathering demographic and economic data, individual schedules for gathering health and social information, and biomarker collection using self-reported questionnaires and standardised protocols. Details are provided elsewhere [30].

Eligibility criteria

Participants unable to answer the questionnaire themselves and who did not provide consent were excluded. Originally, 73,396 participants were included in LASI
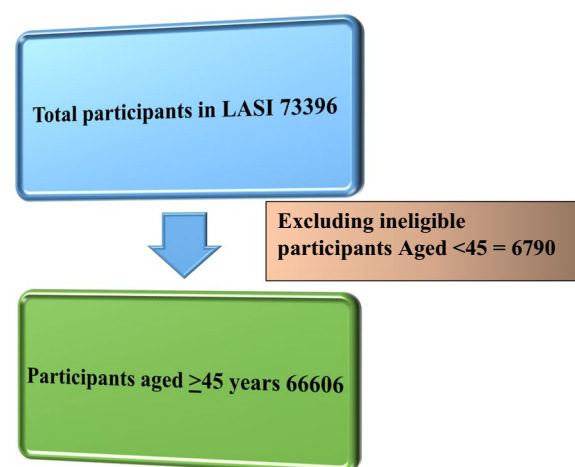
Fig. 1 Flowchart showing participants' selection process in this study

wave 1. In this analysis, participants below 45 years were excluded. Since, LASI- first wave was conducted with the main focus on participants aged 45 years and above, therefore; participants aged < 45 years were excluded (6790). The final sample size was 66,606 in our study (Fig. 1).

Outcome variable

The outcome variable in the present study was the presence/ absence of major depression. LASI survey utilized the Composite International Diagnostic Interview-Short Form (CIDI-SF) scale was used to assess individuals with diagnosable major depressive episodes (MDEs) [21]. It is a reliable, cost-effective, non-clinical survey instrument for diagnostic purposes that is comparable to the original CIDI scale. It provides an accurate diagnosis of depression and is a trustworthy structured instrument for use with experienced interviewers [22–24]. Validation studies have shown that the CIDI-SF scale may accurately produce diagnostic categories for depressive episodes [25]. It is often utilised in comprehensive national surveys, such as the World Mental Health Survey [24], the US National Health Interview Survey [26], and the Canadian National Population Health Survey [22]. In LASI, people were classified as having probable depression (MDEs) if they checked yes to three or more of the CIDI-SF scale's seven symptoms of depression [20, 27].

Explanatory variable

The explanatory variable was self-reported tobacco consumption. The participants were asked- "Have you ever smoked tobacco (cigarette, bidi, cigar, hookah, cheroot) or used smokeless tobacco (such as chewing tobacco, gutka, pan masala, etc.)?" Answers

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were recorded in dichotomous format- "no, yes" and considered as consumption of any form of tobacco. They were also asked- "What type of tobacco product have you used or consumed?" Followings were the options for answering- "smoke tobacco"/smoking, "smokeless tobacco (such as chewing tobacco, gutka, pan masala, etc.)" and "both smoke and smokeless tobacco."

Covariates

These variables were categorised into 'demographic and socio-economic', 'health related', and 'behavioural factors'. Under demographic and socio-economic factors, we have included- gender (male, female), age group (45–59, ≥ 60 years),—religion (Hindu, Muslim, Christian and others), caste (scheduled caste (SC), scheduled tribe (ST), other backward caste (OBC) and others), education (illiterate, less than primary, primary completed, middle completed, secondary school, higher secondary, and Diploma/ graduate), residence (rural, urban), marital status (unmarried, married/ in live-in, Widow/ separated/ divorced), MPCE (monthly per capita expenditure- poorest, poorer, middle, richer, richest) quintile, health insurance (no, yes), occupation (unemployed, professional and semi-professional- 'legislators and senior officials, professionals, technicians and associate professionals', clerical and skilled- 'clerks, service workers and shopkeepers, skilled agriculture and fishery workers, craft and related trade worker, plant and machine operator', unskilled) living alone (no, yes) and region (north, central, east, northeast, west and south).

Under 'health-related factors', we have included- physical activity (everyday, once per week, 1–3 times per week, once per month, never), self-rated health (excellent, very good, good, fair, poor), tobacco abuse (no, yes), comorbidity (no, yes) and multimorbidity (no, yes). Following chronic health conditions were considered- diabetes, hypertension, cancer, diabetes, chronic lung diseases (e.g.- chronic obstructive pulmonary disease, asthma, chronic bronchitis, other chronic lung problems), stroke, chronic heart disease (e.g.- congestive heart failure, myocardial infarction, heart attack, other chronic heart diseases), dyslipidaemia (high cholesterol), thyroid disorders, musculoskeletal disorder (MSD e.g.- rheumatism, arthritis, osteoporosis, other chronic joint or bone disorders), visual impairment chronic renal failure, and hearing impairment. The interviewer asked proper questions related to chronic health conditions with dichotomous answers (no/yes)- "Has any health

professional ever diagnosed you with the following chronic conditions or diseases?" Participants having at least one and two chronic health conditions were described as comorbidity and multimorbidity, respectively. Under 'behavioural factors', we have included alcohol consumption (no, yes) and media (television/ radio/ mobile) exposure (no. yes).

Statistical analysis

Data was analysed in Stata version 17 (StataCorp. 2017. Stata Statistical Software: Release 17. College Station, TX: StataCorp LP.). The characteristics of the participants were described as frequencies and percentages for categorical variables. Individual sample weights were considered during the analysis. Chi-square *p* value were estimated to explore the association between categorical variables. As discussed in the methods section, the prevalence of major depression was established if the score was > = 3. Using this information, the Indian states and Union Territories were categorised into low (0 to 33rd percentile), middle (34 to 67th percentile), and high (67 to 100th percentile) as per prevalence of depression and tobacco consumption each. We have also undertaken spatial mapping to document various Indian states/Union Territories (UTs) into various categories of prevalence of tobacco consumption and depression levels using Microsoft Excel.

To reduce the confounding effects of covariates, we have used propensity score matching (PSM). Additionally, we have applied nested multilevel regression modelling to show the association between depression and tobacco consumption. We have used total 4 logistic regression models. In the Model-1, we have explored the association between depression and tobacco consumption. In Model-2, Model-3, and Model-4; we have subsequently added 'demographic and socio-economic factors'; 'health related', and 'behavioural factors', respectively. We have also estimated goodness of fit of regression models, i,e,. pseudo R^2, log-likelihood, likelihood ratio, AIC (Akaike Information Criterion), BIC (Bayesian Information Criterion), and classification accuracy to evaluate the best fit model [28, 29]. After identifying the best regression model, we have then documented the association between depression and tobacco consumption as per gender and age groups as well. The *p* values of < 0.05 were considered as statistically significant.

Results

The prevalence of depression was 7.62% (7.15–8.12%) among overall participants, irrespective of tobacco consumption. The prevalence of tobacco consumption was 36.78% (36.03–37.55%) for any form; which was higher
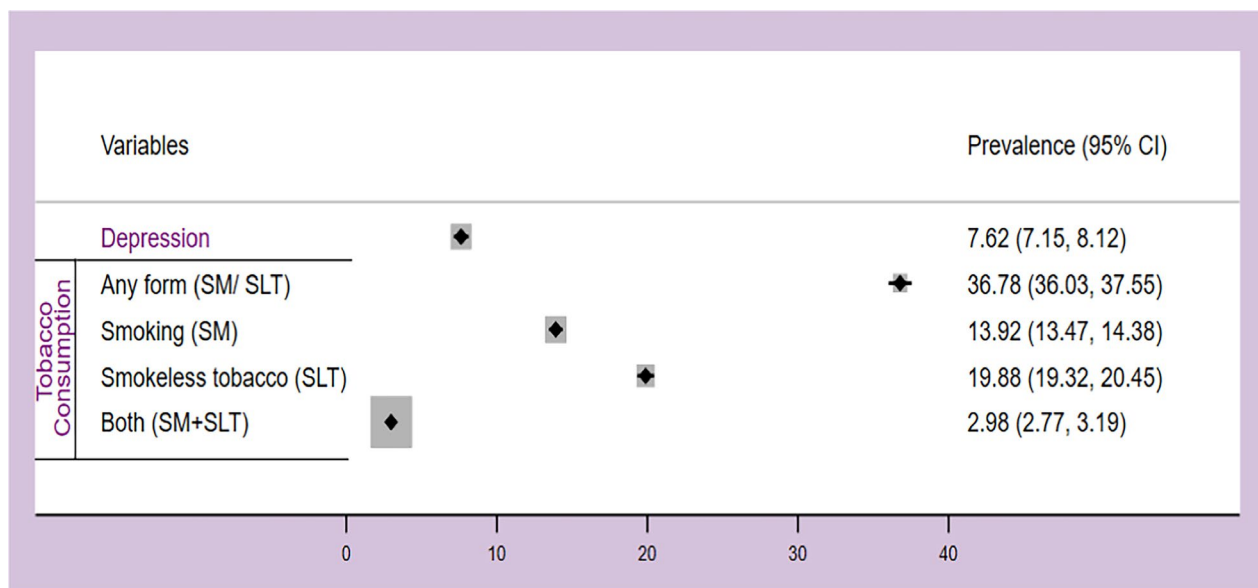
Fig. 2 Prevalence (95% confidence interval) of depression and tobacco consumption among participants

for SLT (19.88% (19.32–20.45%)) than in smoking (13.92% (13.47–14.38%)). Consumption of both smoked and smokeless tobacco consumption was documented in a negligible number of participants (Fig. 2).

Prevalence of depression was 8.51% (7.93–9.10%) among participants consuming any form of tobacco; which were higher in SLT (8.77% (8.08–9.52%)) than in smoking (8.04% (7.04–9.17%)). Participants consuming both forms of tobacco had the highest prevalence of depression (8.90% (7.32–10.78%)). Among demographic and socio-economic factors, prevalence of depression was higher among females (6.80%), elderly (8.00%), Muslims (8.89%), scheduled caste (8.61%), illiterate (8.87%), rural (8.50%), widow/ separated/ divorced (10.06%), richest (9.71%), not having health insurance (7.64%), professional and semi-professional (10.97%), living alone (12.48%) and central region (12.62%). Among health-related factors, depression was higher in participants having physical activity 1–3 times/month (8.69%), poor self-rated health (20.07%), comorbidity (8.41%), and multimorbidity (9.92%). Among behavioural factors, depression was high in participants not exposed to media (9.51%). Depression was almost similar irrespective of alcohol consumption (Table 1).

Geographically, northeast states had relatively higher consumption of tobacco (Table 2, Figs. 3 and 4). Using cross-tabulation, Bihar, Uttar Pradesh, West Bengal, and Uttarakhand had both high prevalence of depression and any form of tobacco consumption. Low prevalence was documented in Sikkim, Arunachal Pradesh, Tamil Nadu, Daman, and Diu. Though tobacco consumption was found low in Punjab, Goa, Delhi, Chandigarh, and Karnataka, depression was still high. On the contrary, Gujarat, Manipur, and Mizoram revealed low depression though tobacco consumption was high (Tables 2 and 3).

The results of the propensity score matching analysis using average estimated treatment effect (ATE) indicated a positive association both between depression and any form of tobacco consumption (p value 0.001) and with smokeless tobacco (p value 0.001) consumption (Supplementary Table S1). Based on this, we undertook the association between depression and tobacco consumption using nested multilevel logistic regression modelling with 4 models. Model-4 was the best with the highest pseudo R^2 and log-likelihood; and lowest AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) values. The results of Model-4 indicated that the odds of having depression were significantly 28% higher (aOR (95% CI): 1.28 (1.18–1.38)) among participants consuming any form of tobacco than the non consumers. Among demographic and socio-economic factors, the odds of having depression were higher among females (28%, aOR (95% CI): 1.28 (1.17–1.41)), other religion (25%, aOR (95% CI): 1.25 (1.07–1.46)), OBC (10%, aOR (95% CI): 1.10 (1.01–1.21)), richest (48%, aOR (95% CI): 1.48 (1.32–1.65)), clerical and skilled occupation (12%, aOR (95% CI): 1.12 (1.02–1.24)), living alone (14%, aOR (95% CI): 1.14 (1.01–1.33)), central region (107%, aOR (95% CI): 2.07 (1.85–2.31)). The odds were significantly lower among participants residing in urban (19%, aOR (95% CI): 0.81 (0.75–0.88)), The odds were increasing from poorest to richest. Decreasing odds were observed with

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Table 1 Various characteristics of Indian population aged ≥ 45 years

Variable	Total N (%)	Depression N (%)	*p* value
Tobacco consumption			
Any form (SM/SLT)			
No	42106 (63.22)	2993 (7.11)	< 0.001
Yes	24500 (36.78)	2084 (8.51)	
Smoking (SM)			
No	57333 (86.08)	4331 (7.55)	0.044
Yes	9273 (13.92)	746 (8.04)	
Smokeless tobacco (SLT)			
No	53363 (80.12)	3914 (7.34)	< 0.001
Yes	13243 (19.88)	1163 (8.77)	
Both (SM + SLT)			
No	64624 (97.02)	4900 (7.58)	0.161
Yes	1982 (2.98)	177 (8.90)	
Demographic and socio-economic factors			
Gender			
Male	31039 (46.60)	2081 (6.80)	< 0.001
Female	35567 (53.40)	2996 (8.32)	
Age group (years)			
45–59 (middle aged)	34704 (52.10)	2400 (7.24)	< 0.001
≥ 60 (elderly)	31902 (47.90)	2677 (8.00)	
Religion			
Hindu	54590 (81.96)	4109 (7.53)	< 0.001
Muslim	7666 (11.51)	682 (8.89)	
Christian	2023 (3.04)	86 (4.22)	
Others	2327 (3.49)	201 (8.62)	
Caste			
Schedule caste	12759 (19.16)	1098 (8.61)	< 0.001
Schedule tribe	5732 (8.61)	255 (4.45)	
OBC	30272 (45.45)	2433 (8.04)	
Others	17843 (26.79)	1291 (7.23)	
Education			
Illiterate	31353 (47.07)	2992 (8.87)	< 0.001
Less than primary	7598 (11.41)	632 (8.69)	
Primary completed	8761 (13.15)	536 (6.68)	
Middle completed	6337 (9.51)	354 (6.35)	
Secondary school	5953 (8.94)	256 (4.84)	
Higher secondary	2,852 (4.28)	158 (5.26)	
Diploma/Graduate	3752 (5.63)	150 (4.01)	
Residence			
Rural	43240 (64.92)	3879 (8.50)	0.270
Urban	23366 (35.08)	1198 (5.72)	
Marital status			
Unmarried	871 (1.31)	35 (4.40)	< 0.001
Married/ in live -in	49949 (74.99)	3369 (6.85)	
Widow/separated/divorced	15786 (23.70)	1673 (10.06)	
MPCE quintile			
Poorest	13,181 (19.79)	1011 (7.27)	< 0.001
Poorer	13,403 (20.12)	952 (6.73)	
Middle	13,371 (20.07)	1013 (7.43)	

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Table 1 (continued)

Variable	Total N (%)	Depression N (%)	*p* value
Richer	13,412 (20.14)	937 (7.24)	
Richest	13,239 (19.88)	1164 (9.71)	
Health insurance			
No	65121 (97.77)	4971 (7.64)	0.013
Yes	1485 (2.23)	106 (6.96)	
Occupation			
Unemployed	34180 (51.32)	2627 (7.83)	< 0.001
Professional and semi-professional	1,597 (2.40)	193 (10.97)	
Clerical and skilled	16683 (25.05)	1385 (7.30)	
Unskilled	14,146 (21.24)	871 (7.07)	
Living alone			
No	64152 (96.32)	4771 (7.44)	< 0.001
Yes	2454 (3.68)	306 (12.48)	
Region			
North	8170 (12.27)	523 (6.40)	< 0.001
Central	13699 (20.57)	1729 (12.62)	
East	15420 (23.15)	1155 (7.49)	
Northeast	2321 (3.48)	105 (4.54)	
West	10990 (16.50)	735 (6.69)	
South	16008 (24.03)	830 (5.19)	
Health related factors			
Physical activity			
Everyday	15672 (23.53)	1086 (6.54)	0.011
More than once/week	4559 (6.84)	344 (7.90)	
Once/week	2396 (3.60)	152 (6.37)	
1–3 times/month	3274 (4.92)	314 (8.69)	
Never	40705 (61.11)	3182 (8.02)	
Self-rated health			
Excellent	2570 (3.91)	115 (4.13)	< 0.001
Very good	12602 (19.18)	534 (4.55)	
Good	25723 (39.16)	1147 (4.69)	
Fair	18137 (27.61)	1829 (9.43)	
Poor	6660 (10.14)	1463 (20.07)	
Comorbidity			
No	21206 (31.84)	1262 (5.94)	< 0.001
Yes	45400 (68.16)	3816 (8.41)	
Multimorbidity			
No	42107 (63.22)	2646 (6.28)	< 0.001
Yes	24499 (36.78)	2431 (9.92)	
Behavioural factors			
Alcohol consumption			
No	54752 (82.20)	4372 (7.72)	0.040
Yes	11854 (17.80)	913 (7.70)	
Media exposure			
No	25487 (38.27)	2424 (9.51)	< 0.001
Yes	41119 (61.73)	2653 (6.45)	

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Table 2 State/Union Territory wise distribution of Depression and tobacco consumption among middle-aged and elderly Indian adults

Variables	Weighted proportion (%)				
	Depression	Tobacco consumption			
		Any form (SM/ SLT)	Smoking (SM)	Smokeless (SLT)	Both (SM + SLT)
North					
Chandigarh	8.30	21.41	15.71	4.22	1.49
Delhi	7.62	20.60	14.59	4.88	1.12
Haryana	5.89	36.94	34.60	2.00	0.44
Himachal Pradesh	5.21	33.39	31.56	1.21	0.66
Jammu & Kashmir	3.88	39.86	30.68	6.92	2.21
Punjab	8.82	11.36	6.04	3.92	1.38
Rajasthan	5.92	37.40	27.07	8.49	1.84
Uttarakhand	6.81	42.22	32.90	7.44	1.89
Central					
Chhattisgarh	4.08	36.05	10.57	24.07	1.41
Madhya Pradesh	14.62	36.90	15.99	16.22	4.70
Uttar Pradesh	12.88	43.56	16.12	23.27	4.15
East					
Bihar	10.00	41.77	9.64	27.29	4.83
Jharkhand	6.35	39.86	2.81	32.77	4.27
Odisha	4.44	65.16	3.02	51.89	10.26
West Bengal	6.94	44.28	20.39	20.05	3.84
North-East					
Arunachal Pradesh	2.19	18.16	8.44	6.27	3.45
Assam	5.77	56.54	7.51	43.82	5.21
Manipur	1.29	57.55	17.87	27.06	12.62
Meghalaya	1.36	37.50	20.23	15.67	1.59
Mizoram	0.77	78.21	35.18	31.73	11.30
Nagaland	2.80	27.05	8.53	10.69	7.83
Sikkim	0.66	17.45	6.99	9.13	1.33
Tripura	3.66	71.22	28.52	35.54	7.16
West					
Dadra and Nagar Haveli	2.77	38.22	10.78	22.96	4.49
Daman and Diu	2.91	22.93	7.92	13.22	1.78
Goa	10.32	17.73	6.69	10.33	0.71
Gujarat	3.08	39.35	13.35	21.46	4.54
Maharashtra	8.33	35.78	5.86	29.24	0.66
South					
Andaman & Nicobar Islands	1.30	34.91	6.82	24.68	3.42
Andhra Pradesh	3.80	25.74	18.28	6.77	0.69
Karnataka	6.76	25.42	9.00	14.93	1.49
Kerala	5.40	20.30	16.26	3.14	0.90
Lakshadweep	2.23	29.26	7.44	19.60	2.23
Puducherry	3.29	13.24	5.54	7.62	0.08
Tamil Nadu	4.22	21.51	13.04	8.10	0.37
Telangana	2.87	26.57	18.22	7.94	0.41
India	7.62	36.78	13.92	19.88	2.98
Categories					
Low (L): 0-33rd percentile		Medium (M): 34-67th percentile		High (H): 68-100th percentile	

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0.66-3.36%	3.37-6.13%	6.14-14.62%
Low	**Medium**	**High**

Depression (%)

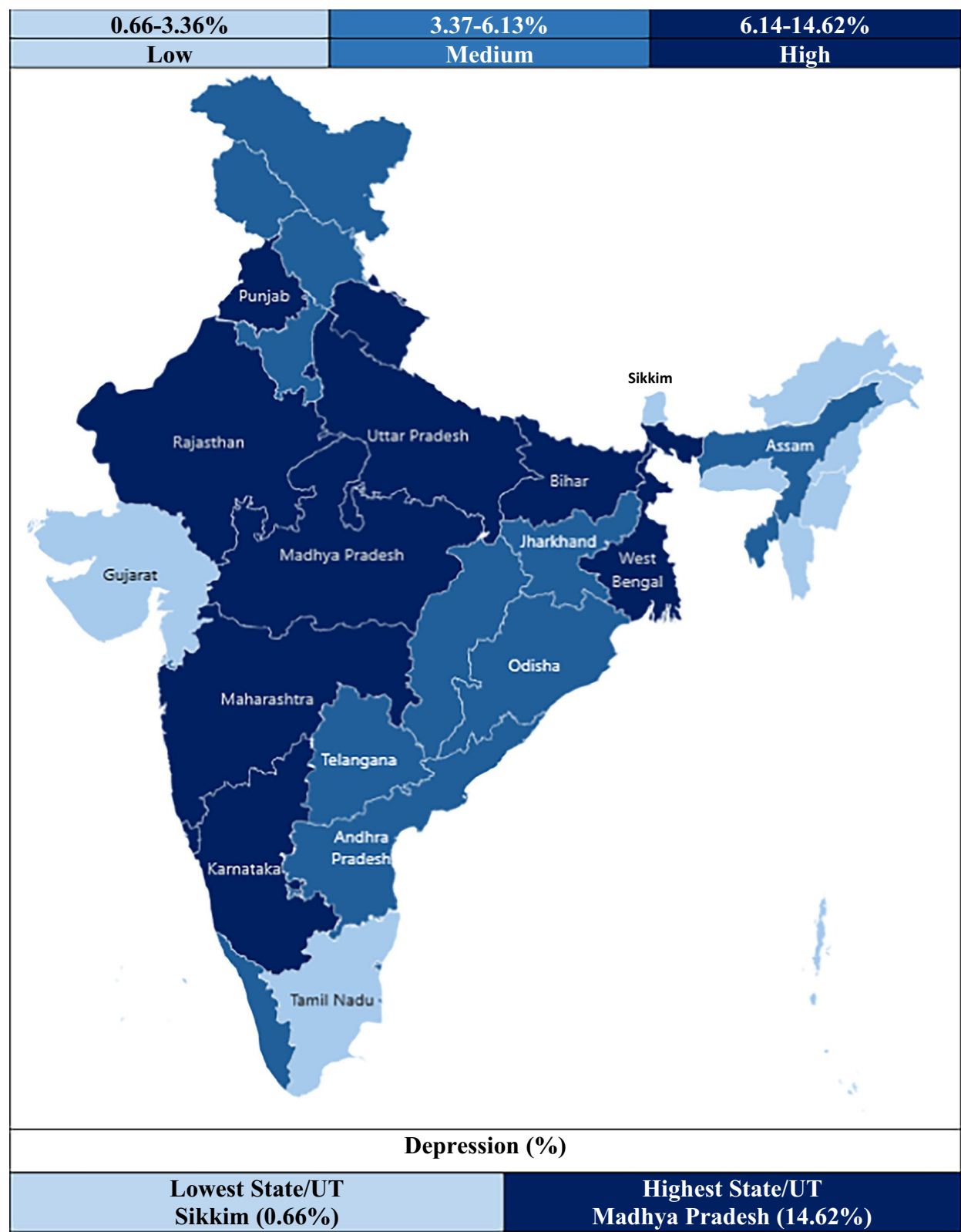| Lowest State/UT	Highest State/UT
Sikkim (0.66%)	**Madhya Pradesh (14.62%)**

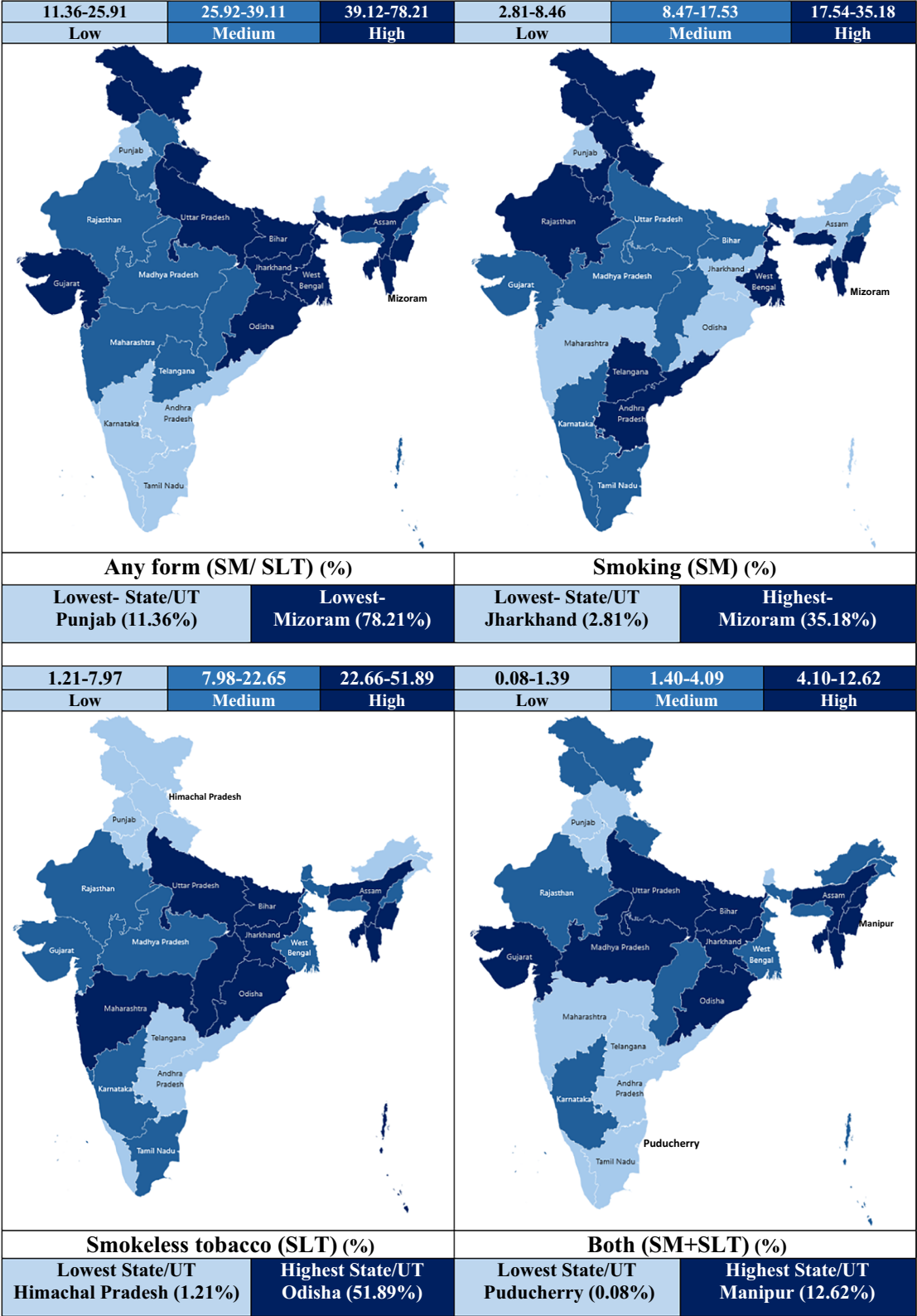**Fig. 3** State/Union Territory wise distribution of prevalence of depression

Fig. 4 State/Union Territory wise distribution of tobacco consumption

Table 3 Categorisation of states and union territories by depression and any form of tobacco consumption

Category		Depression		
		Low	Medium	High
Any form of tobacco consumption	Low	Sikkim, Arunachal Pradesh, Tamil Nadu, Daman and Diu	Puducherry, Kerala, Andhra Pradesh	Punjab, Goa, Delhi, Chandigarh, Karnataka
	Medium	Nagaland, Lakshadweep, Andaman and Nicobar Islands, Meghalaya, Dadra and Nagar Haveli	Telangana, Himachal Pradesh, Chhattisgarh, Haryana	Maharashtra, Madhya Pradesh, Rajasthan
	High	Gujarat, Manipur, Mizoram	Jammu & Kashmir, Jharkhand, Assam, Odisha, Tripura	Bihar, Uttar Pradesh, West Bengal, Uttarakhand

an increase in the education status (secondary school: 15% lower, aOR (95% CI): 0.85 (0.73–0.99). Among health-related factors, the odds of having depression increased with deteriorating self-rated health (poor: aOR (95% CI): 4.81 (3.85–6.02)). Participants with comorbidity (20%, aOR (95% CI): 1.20 (1.10–1.30)) and multimorbidity (24%, aOR (95% CI): 1.24 (1.13–1.36)) had higher odds of depression. Among behavioural factors, participants exposed to media had lower odds of depression (22%, 0.78 (0.72–0.84)) (Table 4).

We have split the population into male/female and age groups and then ran model 4 since model 4 was best in terms of AIC and BIC criteria. The odds of having depression were significantly 28% (aOR (95% CI): 1.28 (1.18–1.38)) higher among participants consuming any form of tobacco than the non consumers, which was even higher among females (30%, aOR (95% CI): 1.30 (1.15–1.46)) than males (28%, aOR (95% CI): 1.28 (1.15–1.42)). The odds were higher among middle-aged (32%, aOR (95% CI): 1.32 (1.17–1.48)) than the elderly (24%, aOR (95% CI): 1.24 (1.11–1.38)). Smokers had 12% (aOR (95% CI): 1.12 (1.01–1.24)) higher odds of depression overall; which was higher in females (23%, aOR (95% CI): 1.23 (1.01–1.50)). Participants consuming SLT had 19% (aOR (95% CI): 1.19 (1.09–1.29)) higher odds of depression overall; which was higher in females (24%, aOR (95% CI): 1.24 (1.10–1.40)) and middle-aged (24%, aOR (95% CI): 1.24 (1.10–1.42)) participants (Table 5).

Discussion

The results of the present study have significant importance for future research agenda on mental health and tobacco linkages for Indian people 45 years and older, as well as for mental health interventions at the national and sub-national levels.

As per the present study, the prevalence of depression was reported to be 7.62% for the overall Indian population. In comparison, a recent analysis of LASI Wave I reported depression was 27.6% [30]. The drastic variation

is due to the difference in the scales used to classify depression. Previous literature indicates that the Center for Epidemiologic Studies Depression Scale (CESD) used in the latter study, measures psychological distress and should be interpreted with caution. It is not interchangeable with major depression as measured by the CIDI-SF used in our analysis [31]. Overall, 36.78% of participants documented using any form of tobacco (57.58% in males and 19.11% in females); with higher consumption of SLT (19.88%) than smoking/SM (13.92%). Only 2.98% consumed both. Tobacco consumption in all categories was higher among the elderly than among middle-aged participants. These findings were much lower (SM=28.6%, SLT=23.5%, 45–60 years) than the Global Adult Tobacco Survey (GATS)−2 (2016–2017) suggesting a decreasing trend [12]. National Family Health Survey-% (NFHS-5) supported this decreasing trend, documenting that consumption of any form of tobacco was 38.0% in males (15–54 years) and 8.9% in females (15–49 years) [32]. A study on tribal population (40–65 years) documented higher tobacco consumption (48.1%) [33]. Community-based research documented that tobacco consumption ranges from 31 to 42% among the elderly [34, 35]. As per the results of the present study, depression was documented among 8.51% of participants consuming any form of tobacco; which was higher in SLT (8.77%) than smoking (8.04%). Similar findings were documented among the elderly population of Uttar Pradesh (8.56%) [36] and Maharashtra (9.00%) [37].

Overall, the Northeast Indian states had reported relatively higher consumption of tobacco. Participants residing in the northeast reported the highest odds of tobacco consumption. As per the previous literary evidence, tobacco is mostly used in smokeless form in the northeast [38]. Men over the age of 15 are more likely than women to consume tobacco (smokeless or smoked) at 47% vs 14% [39]. Patterns of tobacco use are influenced by historical background, cultural traditions, and local standards. In

Table 4 Nested multilevel regression modelling showing association of depression with any form of tobacco consumption and various covariates among Indian population aged ≥ 45 years

Characteristics		Depression			
		Model-1	Model-2	Model-3	Model-4
		Odds ratio (95% CI)	Odds ratio (95% CI))	Odds ratio (95% CI)	Odds ratio (95% CI)
Tobacco consumption (any form)					
No		Reference	Reference	Reference	Reference
Yes		1.24 (1.16–1.32)*	1.38 (1.28–1.49)*	1.29 (1.19–1.39)*	1.28 (1.18–1.38)*
Demographic and socio-economic factors	Gender				
	Male		Reference	Reference	Reference
	Female		1.29 (1.19–1.41)*	1.24 (1.14–1.35)*	1.28 (1.17–1.41)*
	Age group (years)				
	45–59 (middle aged)		Reference	Reference	Reference
	≥60 (elderly)		0.95 (0.88–1.02)	0.99 (0.92–1.04)	0.99 (0.91–1.02)
	Religion				
	Hindu		Reference	Reference	Reference
	Muslim		1.08 (0.98–1.20)	0.98 (0.88–1.09)	0.98 (0.88–1.09)
	Christian		0.88 (0.74–1.05)	0.84 (0.71–1.01)	0.85 (0.71–1.01)
	Others		1.27 (1.09–1.47)*	1.25 (1.07–1.45)*	1.25 (1.07–1.46)*
	Caste				
	Schedule caste		Reference	Reference	Reference
	Schedule tribe		0.51 (0.45–0.59)*	0.61 (0.53–0.70)*	0.59 (0.51–0.68)*
	OBC		1.04 (0.95–1.14)	1.10 (1.01–1.21)*	1.10 (1.01–1.21)*
	Others		0.94 (0.85–1.04)	0.95 (0.85–1.06)	0.97 (0.87–1.07)
	Education				
	Illiterate		Reference	Reference	Reference
	Less than primary		1.12 (0.98–1.24)	1.05 (0.94–1.17)	1.09 (0.97–1.21)
	Primary completed		0.96 (0.86–1.06)	0.92 (0.82–1.01)	0.95 (0.85–1.06)
	Middle completed		0.89 (0.79–1.02)	0.88 (0.77–1.00)	0.92 (0.81–1.05)
	Secondary school		0.82 (0.72–0.95)*	0.81 (0.70–0.93)*	0.85 (0.73–0.99)*
	Higher secondary		0.77 (0.63–0.93)*	0.80 (0.65–0.97)*	0.84 (0.69–1.03)
	Diploma/Graduate		0.66 (0.54–0.81)*	0.73 (0.69–0.89)*	0.77 (0.63–0.95)*
	Residence				
	Rural		Reference	Reference	Reference
	Urban		0.76 (0.70–0.82)*	0.78 (0.72–0.84)*	0.81 (0.75–0.88)*
	Marital status				
	Unmarried		Reference	Reference	Reference
	Married/in live-in		0.73 (0.54–0.98)*	0.73 (0.72–0.84)*	0.75 (0.55–1.02)
	Widow/separated/divorced		1.16 (0.85–1.57)	1.11 (0.81–1.52)	1.13 (0.82–1.55)
	MPCE quintile				
	Poorest		Reference	Reference	Reference
	Poorer		0.99 (0.90–1.11)	0.98 (0.88–1.10)	1.00 (0.90–1.11)
	Middle		1.02 (0.91–1.13)	0.99 (0.89–1.10)	1.01 (0.91–1.13)
	Richer		1.24 (1.11–1.37)*	1.16 (1.04–1.29)*	1.20 (1.07–1.33)*
	Richest		1.56 (1.40–1.73)*	1.42 (1.28–1.59)*	1.48 (1.32–1.65)*
	Health Insurance				
	No		Reference	Reference	Reference
	Yes		0.94 (0.73–1.22)	0.95 (0.73–1.22)	0.95 (0.73–1.23)
	Occupation				
	Unemployed		Reference	Reference	Reference
	Professional and semi-professional		0.93 (0.71–1.23)	1.07 (0.81–1.41)	1.09 (0.82–1.43)

Table 4 (continued)

Characteristics		Depression			
		Model-1	Model-2	Model-3	Model-4
		Odds ratio (95% CI)	Odds ratio (95% CI))	Odds ratio (95% CI)	Odds ratio (95% CI)
	Clerical and skilled		0.99 (0.91–1.08)	1.12 (1.02–1.23)*	1.12 (1.02–1.24)*
	Unskilled		0.93 (0.84–1.02)	1.01 (0.92–1.12)	1.02 (0.93–1.13)
	Living alone				
	No		Reference	Reference	Reference
	Yes		1.17 (1.01–1.36)*	1.18 (1.01–1.37)*	1.14 (1.01–1.33)*
	Region				
	North		Reference	Reference	Reference
	Central		2.00 (1.80–2.23)*	2.12 (1.90–2.37)*	2.07 (1.85–2.31)*
	East		1.14 (1.02–1.27)*	1.09 (0.97–1.21)	1.07 (0.95–1.19)
	Northeast		0.47 (0.40–0.55)*	0.53 (0.45–0.63)*	0.53 (0.45–0.63)*
	West		1.15 (0.93–1.18)	1.19 (1.05–1.35)*	1.19 (1.05–1.35)*
	South		0.73 (0.65–0.81)*	0.68 (0.60–0.76)*	0.69 (0.62–0.78)*
Health related factors	Physical activity				
	Everyday			Reference	Reference
	More than once/week			1.01 (0.88–1.17)	1.02 (0.87–1.17)
	Once/week			0.91 (0.75–1.10)	0.92 (0.76–1.11)
	1–3 times/month			1.11 (0.95–1.30)	1.11 (0.95–1.30)
	Never			0.90 (0.83–1.01)	0.90 (0.82–1.01)
	Self-rated health				
	Excellent			Reference	Reference
	Very good			0.83 (0.65–1.05)	0.83 (0.66–1.05)
	Good			1.18 (0.94–1.46)	1.17 (0.94–1.46)
	Fair			2.24 (1.80–2.79)*	2.23 (1.79–2.77)*
	Poor			4.90 (3.92–6.13)*	4.82 (3.85–6.02)*
	Comorbidity				
	No			Reference	Reference
	Yes			1.19 (1.10–1.29)*	1.20 (1.10–1.30)*
	Multimorbidity				
	No			Reference	Reference
	Yes			1.23 (1.12–1.34)*	1.24 (1.13–1.36)*
Behavioural factors	Alcohol consumption				
	No				Reference
	Yes				1.10 (0.99–1.22)
	Media Exposure				
	No				Reference
	Yes				0.78 (0.72–0.84)*
Pseudo R^2		0.0013	0.0493	0.0952	0.0968
LL		− 15,170.41	− 14,441.83	− 13,744.13	− 13,720.13
LR		40.23	1457.17	1395.39	48.01
p value		< 0.001	< 0.001	< 0.001	< 0.001
AIC		30,344.82	28,949.65	27,574.26	27,530.25
BIC		30,363.00	29,249.71	27,965.25	27,939.42

Model 1—Association depression (outcome variable) with any form of tobacco consumption (explanatory variable)

Model 2—1 + Demographic and socio-economic factors (Gender, age group, religion, caste, wealth index, education, marital status, residence, health insurance, occupation, living alone and region)

Model 3—Model 2 + Health related factors (physical activity, self-rated health, comorbidity and multimorbidity)

Model 4—Model 3 + Behavioural factors (alcohol consumption, media exposure)

Classification accuracy = 93.84%

* *p* value < 0.05 = significant

CI Confidence Interval, *LL* Log-likelihood, *LR* Likelihood Ratio, *AIC* Akaike Information Criterion, *BIC* Bayesian Information Criterion

Table 5 Nested multilevel regression of depression with tobacco consumption among middle aged and elderly Indian adults with various demographic, socio-economic, health related and behavioural determinants as per gender and age-group (Model-4) (*p value < 0.05)

Characteristics		Tobacco consumption (Any form)			
		Tobacco (any form)	Smoking (SM)	Smokeless Tobacco (SLT)	Tobacco (both SM + SLT)
		Adjusted Odds ratio (95% CI)	Adjusted Odds ratio (95% CI)	Adjusted Odds ratio (95% CI)	Adjusted Odds ratio (95% CI)
Overall (≥ 45 years)	Depression	1.28 (1.18–1.38)*	1.12 (1.01–1.24)*	1.19 (1.09–1.29)*	1.17 (0.97–1.40)
	Pseudo R^2	0.0968	0.0958	0.0961	0.0957
Male	Depression	1.28 (1.15–1.42)*	1.08 (0.96–1.21)	1.17 (1.03–1.32)*	1.13 (0.92–1.38)
	Pseudo R^2	0.1009	0.997	0.1000	0.0997
Female	Depression	1.30 (1.15–1.46)*	1.23 (1.01–1.50)*	1.24 (1.10–1.40)*	1.36 (0.81–2.26)
	Pseudo R^2	0.0938	0.0929	0.0934	0.0928
45–59 years (Middle aged)	Depression	1.32 (1.17–1.48)*	1.12 (0.95–1.29)	1.24 (1.10–1.42)*	1.18 (0.90–1.56)
	Pseudo R^2	0.1057	0.1045	0.1051	0.1044
≥ 60 years (Elderly)	Depression	1.24 (1.11–1.38)*	1.11 (0.98–1.28)	1.15 (1.02–1.29)*	1.14 (0.89–1.46)
	Pseudo R^2	0.0940	0.932	0.934	0.0931

Model 1—Association depression (outcome variable) with any form of tobacco consumption (explanatory variable)

Model 2—1 + Demographic and socio-economic factors (Gender, age group, religion, caste, wealth index, education, marital status, residence, health insurance, occupation, living alone and region), As per gender- all except gender, as per age group- except age group

Model 3—Model 2 + Health related factors (physical activity, self-rated health, comorbidity and multimorbidity)

Model 4—Model 3 + Behavioural factors (alcohol consumption, media exposure)

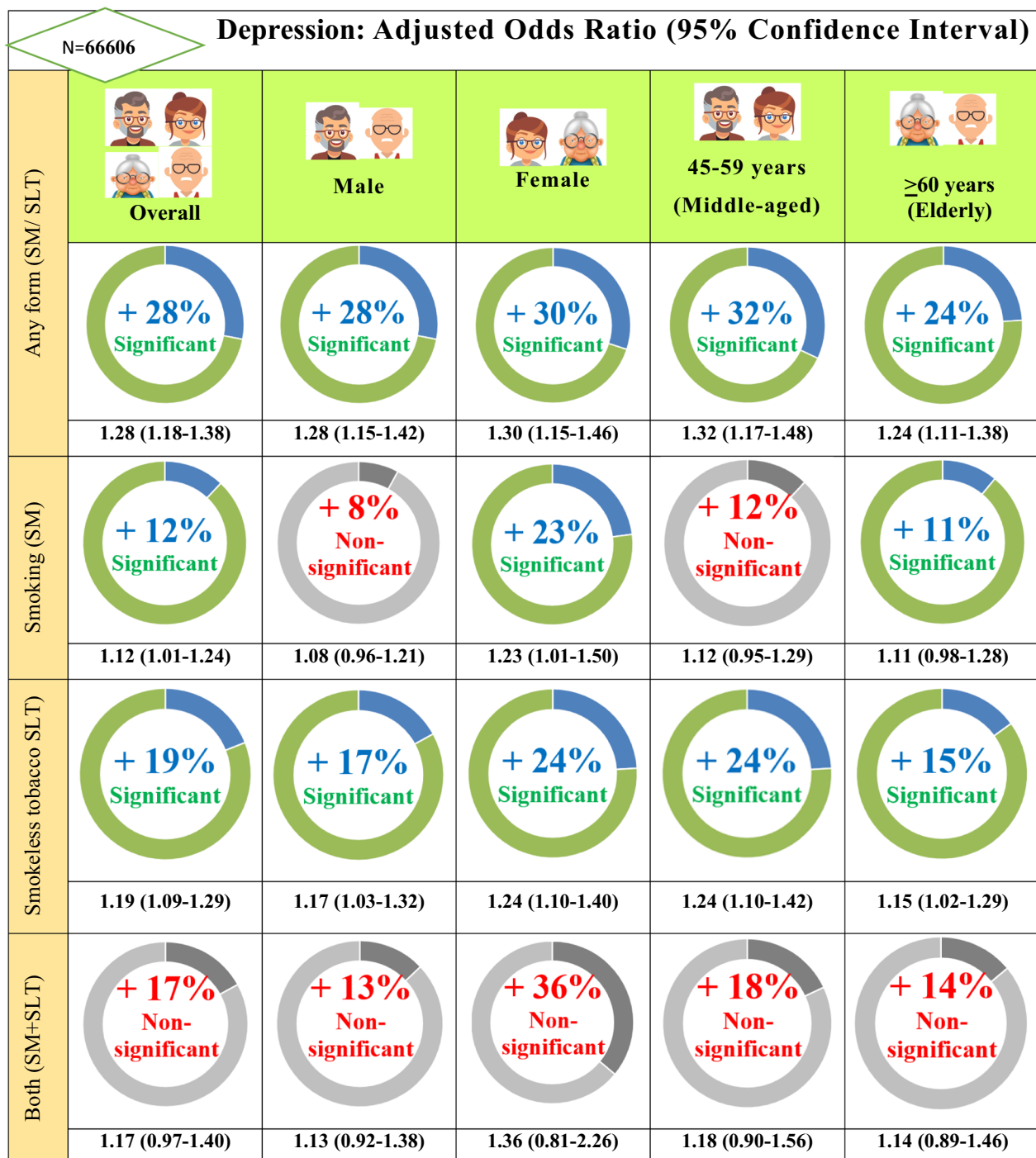Classification accuracy (Model 4) = 93.84%

* p value < 0.05 = significant

CI Confidence Interval, *LL* Log-likelihood, *LR* Likelihood Ratio, *AIC* Akaike Information Criterion, *BIC* Bayesian Information Criterion

these areas, it's common to find smokeless tobacco (such as gutka, khaini, and zarda). The northeastern states continue to have a significant tobacco-related health burden despite general success in lowering tobacco use. Enforcing stricter tobacco laws is still essential for public health [40]. The empowered action group states like Bihar, Uttar Pradesh, and Uttarakhand reported both a high prevalence of depression and any form of tobacco consumption [41]. The high depression rates may be attributable to socio-economic inequality, urban–rural disparity and a lack of adequate mental health infrastructure in these states as per the literary evidence [41]. Further, the high tobacco use rates in these states can be linked to several variables, including demographics, socio-economic position, socio-cultural influences, increased rural predominance, and religious beliefs [42].

The current research revealed that among participants aged ≥ 45 years ever consuming any form of tobacco had higher odds (any tobacco: 28%, smoking: 12%, SLT: 19) of depression than non-consumers which was even higher in females and middle-aged participants (Fig. 5). Similar findings were documented in Asian contexts like Malaysia (smokers: 68% higher odds of depression, aOR (95% CI): 1.68 (1.23–2.29)) and China (smokers: 20% higher,

aOR (95% CI): 1.20 (1.05–1.37)) among participants of similar age group [43, 44]. A similar finding was revealed in American middle-aged (40% higher odds, aOR (95% CI): 1.40 (1.20–1.60)) [45] and Canada (current smokers: 21% higher odds of depression, aOR (95% CI): 1.21 (1.12–1.30)) among participants aged ≥ 65 years [46]. Leventhal et al. indicated that anhedonia enhanced the pleasure-enhancing effects of smoking by increasing the reward associated with smoking. Furthermore, long-term smoking tends to exacerbate side effects and anhedonia, which impede attempts to cessate [47, 48]. Tobacco consumers with depression history typically smoke more cigarettes/ SLT, more often, and are more dependent on them. This may result in worse outcomes when trying to quit tobacco [49]. Nicotine is often used by smokers as a mood enhancer to combat depression and stress (model of self-medication) [50]. Tobacco use and mental health conditions like depression have a complicated interaction that can reinforce one another and lead to a vicious cycle [51].

Females were more likely than males to experience depression because of hormonal variations, socialization, societal positions, coping methods, and stressors in life [52]. The richest were more likely to be

Depression: Adjusted Odds Ratio (95% Confidence Interval)

N=66606

Any form (SM/ SLT)	Overall	Male	Female	45-59 years (Middle-aged)	≥60 years (Elderly)
	+ 28% Significant	+ 28% Significant	+ 30% Significant	+ 32% Significant	+ 24% Significant
	1.28 (1.18-1.38)	1.28 (1.15-1.42)	1.30 (1.15-1.46)	1.32 (1.17-1.48)	1.24 (1.11-1.38)
Smoking (SM)	+ 12% Significant	+ 8% Non-significant	+ 23% Significant	+ 12% Non-significant	+ 11% Significant
	1.12 (1.01-1.24)	1.08 (0.96-1.21)	1.23 (1.01-1.50)	1.12 (0.95-1.29)	1.11 (0.98-1.28)
Smokeless tobacco SLT)	+ 19% Significant	+ 17% Significant	+ 24% Significant	+ 24% Significant	+ 15% Significant
	1.19 (1.09-1.29)	1.17 (1.03-1.32)	1.24 (1.10-1.40)	1.24 (1.10-1.42)	1.15 (1.02-1.29)
Both (SM+SLT)	+ 17% Non-significant	+ 13% Non-significant	+ 36% Non-significant	+ 18% Non-significant	+ 14% Non-significant
	1.17 (0.97-1.40)	1.13 (0.92-1.38)	1.36 (0.81-2.26)	1.18 (0.90-1.56)	1.14 (0.89-1.46)

Fig. 5 Pictorial abstract showing nested multilevel regression modelling: Model-4 (Adjusted odds ratio with 95% confidence interval) of depression and tobacco consumption

depressed probably due to high expectations, stress, work-life imbalance. The higher risk of depression for those who live alone can be linked to environmental variables, health behaviours, stress, economic pressure, social isolation, and loneliness [53, 54]. Since cities provide potential advantages to mental health, such as increased access to mental health services and social activities, therefore; participants in urban areas are less likely to be depressed [55]. Lower odds of depression are linked to higher educational attainment. Reduced

rates of depression may result from education's positive effects on one's financial situation, lifestyle, and self-efficacy. Education could also present chances to create treatments that lessen the impact of depression as an illness [56]. Due to the added stress of treating several chronic diseases, participants with low self-rated health, comorbidity, and multimorbidity are likely to experience higher levels of depression. Multimorbidity's impact on self-rated health can be mitigated by depression, and multimorbidity clusters with depressive symptoms are linked to higher rates of disability and lower self-rated health. The way a person feels about their quality of life in connection to their health has an impact on the association between multimorbidity and depression as well [57]. Participants exposed to media were less likely to be depressed probably due to perceived health care awareness.

Strengths and limitations

Our study had significant strengths. It is based on the data sourced from the first largest, and most thorough survey in India on older adults and the present study attempts to provide countrywide distribution and association of depression and tobacco consumption stratified into smoking and SLT focusing on middle aged and elderly population in India. Further, the findings offer thorough fresh perspectives of the subnational disparities on tobacco and depression prevalence in India. It is based innovative large-scale survey methodology, internationally comparable survey instruments, and standardised research and quality control standards that are not usually found in other studies. To identify depression as a serious mental health issue with substantial state and socio-economic patterns and state-specific policy implications, this study relies heavily on the representativeness of data at the national, state, and socio-economic spectrum, which in term leads to higher generalisability. Additionally, the present study is based on robust econometric technique of nested multilevel modelling which attempts to identify the most significant predictors of the association between depression and tobacco consumption.

Though there were some limitations. Further information on the clinical evaluation of depression using the CIDI-SF scale and the efficacy of therapy in cases with identified disorders was absent from the study, which would have been helpful in providing more context for understanding regional patterns of depression. The cross-sectional aspect limits our capacity to clearly prove the causal relationship of the associations, even if the data was useful in generating hypotheses of linkages. Due to self-reporting style of questionnaire, recall bias and social desirability bias could not be ignored. We were unable to measure the lifetime consumption of tobacco and pinpoint the exact pathways between tobacco consumption and depression.

Policy implication and recommendation

The state-funded government psychiatric hospitals and nursing homes; private psychiatric hospitals and nursing homes; non-government organisations; and the most significant, unofficial source—family members serving as caregivers—are the four categories of resources available in India to treat mental health difficulties suffered by older adults. However, rather than focusing on the development of basic care or rehabilitative programmes, the focus of mental health treatment in India remains on tertiary care and acute management. Additionally, the linkages between tobacco consumption and mental health research especially in middle aged and elderly population has been under-researched particularly in low- and middle-income countries (LMIC) like India [58].

Dedicated policy related attempts have been made in India to control the use of tobacco consumption, however; broader public awareness campaign is needed to highlight the harm that tobacco smoking causes. By combining tobacco cessation programmes with health and development initiatives, barriers to tobacco control may be addressed and the burden brought on by tobacco use can be decreased. Effective educational initiatives that raise public awareness of the health risks associated with tobacco use may be beneficial in the battle against tobacco use cessation [59–61].

Only selected groups, such as the Association of Gerontology, the Geriatric Society of India, the Indian Academy of Geriatrics, and the Indian Association for Geriatric Mental Health, engage in advocacy and research. In order to address this issue, government programmes can initiate capacity building and training programs for peripheral health professionals, which include medical schools and regular community health camps in identifying mental health difficulties in older adults and the elderly, which can subsequently facilitate successful referrals between them and psychiatrists. To protect the mental well-being of older adults and the elderly, certain new projects, including day care centres, old age residential homes, counselling, memory clinics, helplines, and recreational facilities, may be implemented in both rural and urban settings [62]. We recommend evidence-based community level pragmatic trials with multiple controlled follow ups to draw more scientific inference [63, 64].

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Conclusion

We have documented wide range of distribution of depression and tobacco consumption across the nation. We have established significant positive association between depression and tobacco consumption stratified into gender and age group. This association was consistent even after adjusting the confounding effects of covariates. These results would have significant public health implication in view of gradual surge in Indian aging population especially among the richest, participants living alone, having comorbidity and multimorbidity. Appropriate health interventions and health policy reforms should be implemented with special focus on females and middle-aged population through community awareness and intersectoral collaborative efforts irrespective of subnational variations.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41043-025-00753-1.

Supplementary file1

Declarations

Ethical Approval
The dataset of LASI is available in the public domain and can be retrieved upon data request, therefore the ethical approval for the present study was not deemed necessary. However, the ethical approval to conduct LASI was given by the Indian Council of Medical Research's (ICMR) Central Ethics Committee on Human Research (CECHR) as per the Helsinki declaration [20].

Consent to participate
Informed consent was obtained from the participants during the survey.

Competing interests
The authors declare no competing interests.

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