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Areca nut use among the adult population in India: a nationally representative cross-sectional study

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Areca nut use among the adult population in India: a nationally representative cross-sectional study

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Areca nut use among the adult population in India: a nationally representative cross-sectional study

Abstract

Objective: Areca nut is one of the widely consumed substance abuse globally, after nicotine, ethanol and caffeine and classified as carcinogenic to humans.This study examines the disparity and determinants of areca nut use with and without tobacco in India.

Design: Nationally representative cross-sectional study.

Participants: We utilized nationally representative Global Adult Tobacco Survey (GATS) 2016-17. The analytical sample size was 74,037 individual's aged 15 years and above.

Measures: Current use of areca nut without tobacco and with tobacco.

Method: We examined determinants of areca nut consumption (without tobacco and with tobacco) using multinomial logistic regression, accounting for complex survey design.

Results: Finding shows 23.9% (95%CI 23.1-24.8) adult population consume areca nut, which accounts for approximately 223.79 million users in India. Out of total areca nut users, 9.7% (95%CI 9.1-10.4) users consumed areca nut with tobacco. When compared to females, males were more prone to consume areca nut without tobacco (RR=1.13;95%CI 1.07-1.20) and with tobacco (RR=2.02; 95%CI 1.85-2.21). Age, marital status, education, occupation, caste, religion and region were significantly associated with areca nut use. However, the direction of association differs with respect to the use of areca nut with tobacco and without tobacco.

Conclusion: Areca nut is not explicitly covered by the WHO Framework Convention on Tobacco Control. The ongoing tobacco control efforts would not yield the desired outcome until greater attention to areca nut use is reflected in the formulated health policies in the country.

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Key words: Areca nut, smokeless tobacco, GATS, India

Strength and Limitations of this study

- Despite growing scientific evidence of high addictiveness and several ill effects associated with areca nut use, research on areca nut has not received much attenstion.
- Using nationally representative survey, our analysis show nearly one-fourth adult population (223.79 million) adults consume areca nut in India, with higher use among adult men than women.
- Considerbale regional variation exists with four states namely Uttar Pradesh (49.9 million), Maharashtra (26.7 million), Karnataka (19.8 million) and Tamil Nadu (17.7 million) accounts for half of the areca nut users in the country.
- Age, sex, education, occupation, social group and regious affiliation significantly determines areca nut use in the country.
- Study is based on 15 years and older population, whereas the areca nut habits often start at younger age.

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This research study received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing Interests statement

None declared.

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Authors' contribution

PKS conceived the study. PKS and LS performed statistical analysis. PKS, LS and AY analyzed and interpreted the data. PKS and AY drafted the manuscript. SM, DN, KS and SS provided comments and contributed to the development of the final draft of the manuscript. All authors have supervised and approved the manuscript.

Data sharing statement

Data utilized by the study is available by emailing prashants.geo@gmail.com.

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Introduction

Areca nut is one of the widely consumed substance abuse globally, after nicotine, ethanol and caffeine[1,2]. Owing to its addictive properties, areca nut is estimated to be consumed by hundreds of millions of people across various countries [3]. However, addiction to areca nut is largely prevalent in many Asia-Pacific countries and by emigrants from these countries in other parts of world. In countries such as mainland China, Taiwan, areca nut has been used in other preparations as well [3].

The International Agency for Cancer Research (IARC) classified area nut use with or without tobacco as carcinogenic to humans[4]. A meta analysis found that areca nut use with tobacco (Relative Risk 7.03; 95%CI, 4.68–10.56) and areca nut use without tobacco (Relative Risk 3.22; 95%CI, 2.11–4.92) cause cancer of oral cavity in Indian subcontinent[5]. Furthermore, studies have documented that areca nut use adversely affects all organs of the human body[1,6]. Studies also found that areca nut use has been associated with dependence in users [7] and withdrawal effects with high severity of dependence [8] similar to those observed for nicotine dependence [8]. Childern in their early age typically begin chewing habits with different kinds of areca nut product[9].

Despite growing scientific evidence of high addictiveness and several ill effects associated with areca nut use, research on areca nut has not received much attenstion[3]. The large global and national movement that addresses tobacco control under the ambit of the WHO Framework Convention on Tobacco Control (FCTC) has focused primarily on smoking and has been less effective in controlling SLT[10]. Tobacco control policies, though, applicable to areca nut products containing tobacco, considerable number of people consume areca nut without tobacco, which poses greater public health challenges in controlling and regulating the substance [11].

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Existing studies on areca nut lack representativeness. We searched PubMed for articles with no language restrctions from all time to 20 March 2020, using the search terms ["disparity" OR "determinant" OR "factor"] AND ["areca nut" OR "betel nut" OR "supari" OR "suppari" OR "supaari" OR "betel quid"] AND ["India"] to review published and peer-reviewed literature. All existing studies that we indentified were restricted to a specific geographical area or population groups in India and none of them were nationally representative. None of the existing studis have examined diverse habits of areca nut use, it's disparity and determinants using nationally representative survey. A recent global review calls for more research to understand the epidemiology of areca nut use across different populations and geographies [3].

While India's share to overall areca nut production and consumption remains at the top, no attempts have been made to explore the patterns and determinants of the use of areca nut based on large scale representative surveys. This study aims to examine the disparity and determinants of acreca nut use, with and without tobacco using nationally-representative Global Adult Tobacco Survey (GATS) conducted in 2016-17.

Methods and materials

Study Design and Partcipants

We utilized nationally representative cross-sectional Global Adult Tobacco Survey (GATS) 2016-17, conducted in all 29 states and three three Union Territories (UTs) of India [12]. The study included whole GATS sample of 74,037 adults aged 15 and above. A multi-stage sampling design separately for rural and urban areas was adopted to draw a representative sample considering the 2011 census population figures. The household and individual response rate was 93%. Further details related to survey methodology, sampling design, household and individual

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selection, data collection, management and monitoring procedures have been described elsewhere[12].

Dependent variables

The outcome variable was current use of areca nut use, assessed based on following questions covered in the GATS:

1. Do you consume *pan masala* without tobacco?
2. Do you consume betel quid without tobacco?
3. Do you consume areca nut of any type, plain, powdered or flavoured?
4. On average, how many times a day do you use the following products? Also, let me know if you use the product, but not every day – Betel quid with tobacco?
5. On average, how many times a day do you use the following products? Also, let me know if you use the product, but not every day –*Gutka*, areca nut-tobacco lime mixture, or *mawa*?
6. On average, how many times a day do you use the following products? Also, let me know if you use the product, but not every day – *Pan masala* with tobacco?

Based on the above-mentioned questions asked in GATS, we constructed three sets of variables: (i) areca nut use without tobacco, (ii) areca nut use with tobacco and (iii) areca nut use with and without tobacco. Definition of specific products can be found with the GATS 2 national report[13].

(i) Areca nut use without only tobacco includes

   a. *Pan masala* without tobacco
   b. Betel quid without tobacco

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c. Areca nut of any type

(ii) Areca nut use with only tobacco includes

a. *Gutka*, areca nut-tobacco lime mixture, o*r mawa*

b. *Pan masala* with tobacco

c. Betel quid with tobacco

(iii) Both forms - Areca nut use with and without tobacco at the same time.

(iv) Any form –who uses any of these products

Independent variables

A range of socioeconomic, demographic, awareness related and contextual level variables included in this study[14–18]. These variables include age (categoried as 15-18, 19-23, 24-30, 31-40, 41-50, 51-60 and 60+) and sex as male and female. Individual's education was measured as: (i) no education, (ii) below than primary, (iii) primary completed, (iv) below than secondary, (v) secondary completed, (vi) completed higher secondary, (vii) completed college/university and (viii) completed post-graduate level. Individual's occupation on the other side was assessed based on self-reported information as (i) student, (ii) government sector, (iii) non-government sector, (iv) causal/ daily labourer, (v) self-employed, (vi) homemaker, (vii) retired and (viii) unemployed.

A wealth index was calculated based on availiability of electricity, flush toilet, radio, television, fixed telephone or cell phone, refrigerator, washing machine, moped/scooter/motorcycle and car using PCA (Principle Component Analysis) methodology[19]. Individual's were divided into five wealth quintiles based on their household score ranges from 1 being poorest to 5 being wealthiest, with each category representing 20 percent of the score [19].

A composite knowledge variable which measures the poor health impact of smokeless tobacco

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use was constructed based considering following information asked in the survey: smokeless tobacco causes serious illness (yes/no), smokeless tobacco cause oral cancer (yes/no), smokeless tobacco cause dental diseases (yes/no), smokeless tobacco cause harm to fetus during pregnancy (yes/no), and do you think tobacco leads to addiction (yes/no). The new knowledge variable categorised as: (i) 'no, to all five awareness' (ii) 'no, to at least one awareness' and (iii) 'yes, to all five awareness'. Social (caste) group was categorised based on individual's self-reporting as Scheduled Castes (SCs), Scheduled Tribes (STs), Other Backward Classes (OBCs) and others. These broad categorization of social group is based on their socioeconomic disadvantage in education, health, nutrition, employement by federal government. Religion captures self-reported follower/believer of Hinduism, Islam, Christianity and others (which mainly include Sikhs, Jains, Buddhists and non-believers). Study also considered place of residence as rural and urban as well as all 29 states and three UTs in the analysis.

Analytical Strategy

At first, prevalence of areca nut consumption with and without tobacco at national and sub-national levels along with rural-urban and male-female differences was shown. x^2 tests were performed to examine the differences in prevalence of areca nut use with all independent variables. To examine the associated between areca nut use with various socioeconomic and demographic charecterstics, multinomial logistic regression was used. In the multinomial logit regression, it is assumed that log odds of outcome/dependent variable either follow linear form or non-binary form; and each outcome/dependent variable is modelled relative to the baseline group or outcome[20]. In this study, instead of binomial we have considered (i) 'non-areca nut user (baseline group)', (ii) 'areca nut use with tobacco', (iii) areca nut use without tobacco' and lastly (iv) 'dual user'. The study reported the relative risk ratio (RR) along with 95% confidence

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intervals [21]. We calculated the population burden based on GATS weighted sample population figures, which were provided in the GATS India report. Approporaite adjustement for sampling weights was considered during the analysis using STATA 15 version [22].

Ethics statement

The second round of GATS obtained ethical clearance from the Ethics Committee of Tata Institute of Social Sciences[13]. No ethics clearance was required for this study, as we used secondary analysis using publicly available data.

Patient and public involvement

No patients were involved in the development of the research question or the outcome measures nor the design of the study.

Results

Descriptive statistics

Of the 74037 sample, 40265 (48.9%) were women and 33772 (51.1%) were men, and 47549 (65.5%) individuals were resided in rural areas. One out of four respondents were illiterate and nearly 78% were aware about the adverse health effects of SLT use (Supplementary table 1).

We found that overall, betel quid without tobacco (8.7%; 95%CI 6.7-10.2) was consumed largely, followed by areca nut of any type (8%; 95%CI 5.9-10.3) at the national level (Table 1). Among men, the prevalence of *gutka,* areca nut-tobacco lime mixture or *mawa* was consumed the most (17.8%; 95%CI 15.1-20.2), whereas, among women, betel quid without tobacco was largely consumed (9.0%; 95%CI 6.1-11.9). In urban areas, both betel quid without tobacco and areca nut of any type were largely consumed, while in the rural areas it was mainly betel quid without tobacco. Regional pattern suggests that betel quid with tobacco were predominately

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consumed in many north-eastern states, while betel quid without tobacco was mainly used in south (Supplementary table 2).

Regional and socioeconomic disparity in areca nut

We found 23.9 (95%CI 23.1-24.8) adults were consuming areca nut at national level and out of this 14.2% (95%CI 13.6-14.9) were comsuming without tobacco (Table 2). Areca nut use without tobacco was largely being consumed across north-eastern states, apart from other bigger states like Karnataka (28.8%; 95%CI 25.6-32.1), Tamil Nadu (25.5%; 95%CI 21.9-29.5) and Maharashtra (20%; 95%CI 17.0-22.5). Nearly 223.4 million people out of total 932,488,000 population aged 15 and above consume areca nut in India (Table 3). The distribution of areca nut user both in terms of population and proportion across states were as follows: Uttar Pradesh with 49.9 million users contributes to nearly 22% of all areca nut users, followed by Maharashtra with 26.7 million users (12%), Karnataka with 19.8 million (9%) and Tamil Nadu with 17.7 million users (8%). Together, these four states share nearly 51% of all areca nut users in the country. Not much difference exists between urban and rural areas in areca nut usage patterns (Supplementary table 3). In 18 states/UTs, however, areca nut use was higher in urban areas than rural counterparts. In 13 states/UTs, the opposite pattern was evident. Consumption of areca nut in any form was higher among males as compared to females both at national level as well as in majority of states (Supplementary table 4).

All forms of areca nut use was higher in the age group 31-50 years (Table 4). 28.8% men (95%CI 27.7-30.0) and 27.1% widowed/separated/divorced (95%CI 25.3-29.1) were consuming areca nut. Individuals who had completed below the primary level of schooling consumed higher proportion of areca nut. Areca nut use was highest among daily wage labourers (30.2%; 95%CI

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28.7-31.7). We found that STs (25.6%; 95%CI 23.0-27.5) and Muslims (30.8%; 95%CI 28.4-33.2) were consuming higher rates of areca nut.

Determinants of areca nut use

Regression results suggest that the likelihood of areca nut use in both forms were positively associated with increase in age (Table 5), except that areca nut use without tobacco was lower among the age group 51 and above, as compared to the 15-18 age groups. Probability of areca nut use was higher among males as compared to females in all three forms. The likelihood of areca nut use without tobacco was higher across all the educational categories as compared to illiterate. However, areca nut with tobacco and dual-use was declining with increase in education. The likelihood of areca nut use with tobacco and dual-use was significantly higher among SCs than other social groups. Probability of all the three forms of areca nut use was higher among Muslims as compared to Hindus.

Discussion

The findings of the study revealed that nearly one out of every four adults in India consumes areca nut, that is, almost 223.79 million people, making areca nut a much bigger public health challenge in dealing with substance abuse and addiction in the country. Moreover, nearly 10% consumed areca nut with tobacco. Thus, considering the wide range of adverse health impacts, effective implementation on banning of tobacco as an ingredient with areca nut products under regulation 2.3.4 of the Food Safety and Standards Regulation, 2011 and ban on manufacture and sale of areca nut products, as implemented in some of the states, is urgently needed [1].

We found considerable regional and socioeconomic differences in the use of areca nut. In four states, Meghalaya, Assam, Mizoram and Manipur, over half of the population consume areca

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nut. Further, Karnataka, Uttar Pradesh, Tamil Nadu, Maharashtra and Odisha, constitute nearly 55% of the country's areca nut users. As far as other SES determinants are concerned, the findings confirmed age, gender, marital status, education, occupation, social group and religion are significantly associated with areca nut use. However, the direction of association differs with respect to areca nut use with and without tobacco.

We found protective effect of secondary and above level education in the case of areca nut use with tobacco and in both forms. A study from Pakistan also observed that the use of areca nut users increased by grade among school children aged 4 to 16 years [18]. Areca nut use were higher among male than among female, a finding that is consistent with other studies conducted in Tamil Nadu and Assam in India [17,23] and elsewhere [11]. However, finding also showed that in 11 states, areca nut use was higher among women as compared to men. The age-wise pattern suggests that areca nut use without tobacco began to decline from age 51 onwards. But in the case of areca nut consumption with tobacco and in both forms, it increased with age. People in more advanced ages who consume areca nut with tobacco were highly addicted and less aware about the cessation methods.

Similar to other studies from India and other neighbouring countries [15,24], we also observed higher use of areca nut with tobacco among daily wage/casual labourers. This study further adds that areca nut use without tobacco too was largely consumed by daily wage/casual labourers, followed by non-government sector. Evidences suggests that many misconceptions including consuming areca nut improves concentration, pleasure, helps in anxiety and muscle relazation and suppresses appetite increases the likelihood of consumption among those who are engaged in casual labour and have long working hours [14,25,26]. We found higher use of areca nut among STs and SCs than other caste groups. Further, Muslims were more likely to consume all three

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forms of areca nut as compared with Hindus. Previous studies documented higher use of tobacco including SLT, among SCs/STs and Muslims [16,27].

State-wise urban-rural differences suggest that in 18 states, areca nut use was higher in urban areas than in rural areas. Regression results also revealed higher use areca nut without tobacco in urban areas than rural counterparts. Studies from India and Pakistan documented that *pan masala* and *gutka* are very popular even in urban areas due to aggressive advertising, targeting middle class and adolescents, which improved sale many tobacco and related products including areca nut [28].

Out study had some limitations. Information related to areca nut use in different forms in the GATS was based on respondents self-reporting. Thus, the study cannot rule out social desirability bias – a tendency among some people to respond to questions in a way which they deem to be more acceptable than would be their 'correct' answer [29]. Considering the cross-sectional design of the survey, we did not examine the cause and effect relationship between socioeconomic charecterstics and areca nut use. Similarly, the available data did not allow us to estimate trends of areca nut usage over time, but future analyses of repeated GATS may inform on important trends. Another limitation is that the study is based on 15 years and older population, whereas the areca nut habits often start at younger age. The future Global Youth Tobacco Survey (GYTS) should have areca nut related questions similar to GATS so that detailed usage pattern of areca nut could be examined among younger population of the country.

Conclusion

It is now well established that areca nut use in any form is highly addictive, a well known risk factor for oral, pharynx and oesophageal cancers and is associated with many adverse health effects. This study adds to the existing knowledge that areca nut consumption in India was much

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higher than the overall smokeless tobacco. Moreover, a significant proportion of areca nut was consumed along with tobacco, which elevates the adverse health impacts and co-morbidities further. Thus, it calls for urgent policy intervention to prevent both new generations from taking up areca nut use habit and helping current users to quit. Such policy efforts to control areca nut use should be guided by the huge differences in its use across states, gender and socioeconomic groups in the country. Unlike tobacco, for which the WHO FCTC provides evidence-based policies, no global policy exists for the regulation and control of areca nut use and its cessation. Also, there is a need for further research and population-based interventions to find treatment for areca nut dependence. In addition, research is needed to examine the intention to quit among areca nut users, separately for all three categories - those who use areca nut with tobacco, without tobacco and those who use both forms, to develop an appropriate intervention model for cessation. This information may be collected within the GATS survey by adding a few additional questions on areca nut for future analysis. Given that areca nut use follows a complex pattern by SES and regional trajectories, separately for with and without tobacco, future research is needed to explore the various intersections between SES and areca nut use in different regions of India to gain better clarity.

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Declaration of Interests

None declared.

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Table 1. Prevalence (in %) and Number of Users of Different Types of Areca Nut in India, GATS 2016-17

Tobacco Products	**Total**		**Men**		**Women**		**Urban**		**Rural**	
	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)
Pan masala without tobacco	4.8 (3.2-5.6)	44759	6.2 (4.1-8.3)	57814	3.2 (1.9-5.1)	29840	5.2 (3.1-7.7)	48489	4.5 (2.2-6.8)	41962
Pan masala with Tobacco	2.8 (1.6-3.8)	26110	4.5 (2.8-5.7)	41962	1.1 (0.6-2.1)	10257	2.3 (1.1-3.8)	21447	3.1 (1.2-5.2)	28907
Betel Quid without Tobacco	8.7 (6.7-10.2)	81126	8.4 (5.9-10.8)	78329	9.0 (6.1-11.9)	83924	9.1 (6.8-12.6)	84856	8.4 (5.7-10.8)	78329
Betel Quid with Tobacco	5.8 (3.8-7.2)	54084	7.1 (5.2-9.3)	66207	5.5 (3.2-7.8)	51287	4.3 (2.8-6.3)	40097	6.6 (4.2-8.3)	61544
Areca Nut of Any Type	8.0 (5.9-10.3)	74599	8.3 (5.8-11.2)	77397	7.7 (5.1-9.2)	71802	9.1 (6.5-13.1)	84856	7.5 (4.8-9.8)	69937
Gutka, Areca Nut-Tobacco Lime Mixture, or *Mawa*	6.8 (5.7-8.6)	63409	17.8 (15.1-20.2)	100709	2.7 (1.2-4.1)	25177	6.3 (3.1-8.7)	58747	7.1 (4.5-9.8)	66207

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Table 2. Prevalence (in %) of Areca Nut Use in Different Forms across States & Union Territories of India, GATS 2016-17

States/UTs	Areca nut use without tobacco only		Areca nut use with tobacco only		Both Forms		Any Form	
North region								
Jammu & Kashmir	0.5	[0.2,1.2]	0.9	[0.5,1.5]	0.0	[0.0,0.1]	1.4	[0.8,2.1]
Himachal Pradesh	1.2	[0.8,1.9]	0.3	[0.1,0.8]	0.0	[0.0,0.2]	1.5	[1.1,2.3]
Punjab	1.0	[0.6,1.6]	2.0	[0.9,4.2]	0.1	[0.0,0.6]	3.1	[1.8,5.2]
Chandigarh	1.7	[1.1,2.7]	1.6	[0.9,3.0]	0.1	[0.0,0.3]	3.4	[2.3,5.1]
Uttarakhand	17.5	[14.0,21.6]	3.8	[2.9,4.8]	1.3	[0.7,2.1]	22.6	[18.5,27.1]
Haryana	2.6	[1.7,4.0]	2.4	[1.0,5.3]	0.2	[0.1,0.6]	5.2	[3.3,8.1]
Delhi	15.7	[13.0,18.7]	2.0	[1.3,2.9]	1.0	[0.6,1.7]	18.7	[15.6,22.0]
Central region								
Rajasthan	7.5	[6.3,9.1]	6.5	[5.3,7.9]	1.4	[0.7,2.5]	15.4	[13.4,17.6]
Uttar Pradesh	18.3	[16.4,20.3]	12.4	[11.0,14.0]	3.5	[2.7,4.4]	34.2	[31.9,36.5]
Chhattisgarh	8.4	[6.4,10.8]	7.4	[5.9,9.3]	1.2	[0.7,1.8]	17.0	[14.2,20.1]
Madhya Pradesh	8.6	[7.2,10.2]	13.4	[11.3,15.9]	2.1	[1.4,3.0]	24.1	[21.2,27.2]
East region								
West Bengal	13.4	[10.7,16.7]	4.1	[3.0,5.5]	3.7	[2.8,5.0]	21.2	[18.2,24.6]
Jharkhand	8.3	[6.6,10.3]	8.2	[6.4,10.5]	1.1	[0.6,2.0]	17.6	[14.3,21.4]
Odisha	11.3	[8.6,14.6]	11.5	[9.6,13.8]	4.8	[3.4,6.6]	27.6	[23.1,32.6]
Bihar	7.0	[5.4,9.1]	5.0	[4.0,6.3]	0.5	[0.3,0.9]	12.5	[10.5,14.8]
Northeast region								
Sikkim	11.5	[8.9,14.9]	1.5	[0.9,2.6]	0.7	[0.4,1.2]	13.7	[10.8,17.4]
Arunachal Pradesh	17.4	[14.4,20.8]	18.6	[13.0,25.8]	3.7	[2.6,5.2]	39.7	[32.6,47.0]
Nagaland	9.6	[7.6,12.2]	15.1	[12.7,17.8]	5.8	[4.3,7.8]	30.5	[27.3,34.0]
Manipur	23.7	[20.2,27.5]	21.0	[18.3,24.0]	6.0	[4.6,7.8]	50.7	[47.0,54.4]
Mizoram	52.9	[48.3,57.5]	0.8	[0.4,1.7]	4.4	[3.2,5.9]	58.1	[53.0,62.9]
Tripura	14.3	[11.6,17.4]	17.0	[14.0,20.6]	14.0	[11.0,17.7]	45.3	[42.0,48.7]
Meghalaya	63.2	[57.5,68.5]	1.6	[0.9,2.8]	6.0	[4.3,8.2]	70.8	[65.4,75.5]
Assam	45.6	[42.8,48.4]	11.4	[9.9,13.2]	10.6	[9.2,12.2]	67.6	[64.7,70.5]
West region								
Gujarat	8.3	[6.5,10.5]	11.1	[8.8,13.9]	1.1	[0.8,1.7]	20.5	[17.8,23.5]
Maharashtra	19.6	[17.0,22.5]	6.9	[5.5,8.8]	2.9	[2.0,4.2]	29.4	[25.3,34.0]
Goa	17.3	[14.6,20.4]	1.3	[0.7,2.2]	1.1	[0.7,1.9]	19.7	[16.7,23.1]
South region								
Andhra Pradesh	6.7	[5.2,8.7]	1.3	[0.7,2.4]	1.2	[0.6,2.4]	9.2	[7.1,11.7]
Telangana	8.7	[6.9,11.0]	2.8	[1.8,4.3]	2.0	[1.2,3.3]	13.5	[11.3,16.2]
Karnataka	28.8	[25.6,32.1]	7.7	[6.2,9.4]	4.3	[3.4,5.3]	40.8	[36.3,45.2]
Kerala	3.1	[2.2,4.3]	2.6	[1.9,3.6]	0.4	[0.2,1.0]	6.1	[4.7,7.9]
Tamil Nadu	25.5	[21.9,29.5]	3.7	[2.5,5.6]	1.2	[0.8,1.7]	30.4	[27.1,34.0]

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Puducherry	17.7	[14.7,21.1]	1.9	[1.0,3.4]	1.4	[0.9,2.1]	21.0	[17.6,24.9]
India	**14.2**	**[13.6,14.9]**	**7.3**	**[6.9,7.7]**	**2.4**	**[2.2,2.7]**	**23.9**	**[23.1,24.8]**

Table 3. Population and Share of Areca Nut Use by States & Union Territories of India, GATS 2016-17

States/UTs	Population	Share (in%)
Chandigarh	33,040	0.0
Sikkim	68,448	0.0
Himachal Pradesh	88,112	0.0
Jammu & Kashmir	1,21,264	0.1
Puducherry	2,11,680	0.1
Goa	2,37,779	0.1
Arunachal Pradesh	4,15,800	0.2
Nagaland	4,59,940	0.2
Mizoram	4,88,040	0.2
Punjab	6,99,081	0.3
Haryana	10,48,632	0.5
Manipur	11,31,624	0.5
Tripura	13,16,418	0.6
Meghalaya	14,93,184	0.7
Kerala	16,50,843	0.7
Uttarakhand	17,56,575	0.8
Delhi	27,61,914	1.2
Chhattisgarh	32,62,714	1.5
Andhra Pradesh	36,54,056	1.6
Telangana	38,09,088	1.7
Jharkhand	42,61,840	1.9
Rajasthan	79,00,200	3.5
Odisha	89,84,904	4.0
Bihar	90,95,000	4.1
Gujarat	98,13,760	4.4
Madhya Pradesh	1,31,45,827	5.9
West Bengal	1,54,75,728	6.9
Assam	1,58,33,272	7.1
Tamil Nadu	1,77,53,296	7.9
Karnataka	1,98,34,738	8.9
Maharashtra	2,67,53,412	12.0
Uttar Pradesh	4,99,32,289	22.3
India	22,37,97,120	100.0

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Table 4. Areca Nut Use Pattern by Demographic and Socioeconomic Characteristics, GATS 2016-17

Background Variables	Areca nut use without tobacco only		Areca nut use with tobacco only		Both Forms		Any Forms	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Age								
15-18	15.7	[13.9,17.6]	1.9	[1.4,2.5]	0.7	[0.5,1.2]	18.3	[16.5,20.3]
19-23	14.8	[13.3,16.4]	5.4	[4.5,6.4]	1.3	[0.9,1.9]	21.5	[19.8,23.3]
24-30	14.1	[13.1,15.2]	8.2	[7.3,9.1]	2.4	[2.0,2.9]	24.7	[23.3,26.1]
31-40	14.6	[13.6,15.6]	9.3	[8.6,10.1]	2.7	[2.4,3.2]	26.7	[25.4,28.0]
41-50	15.2	[14.1,16.3]	8.1	[7.3,9.0]	3.1	[2.6,3.7]	26.4	[25.0,27.9]
51-60	13.5	[12.2,14.8]	8	[7.0,9.0]	3.2	[2.6,3.9]	24.6	[23.1,26.3]
60+	11.1	[9.9,12.3]	7.8	[6.6,9.0]	3.2	[2.6,4.0]	22.0	[20.2,23.9]
Sex								
Female	13.2	[12.5,14.0]	3.4	[3.0,3.8]	2.3	[2.0,2.6]	18.9	[18.0,19.9]
Male	15.2	[14.4,16.1]	11	[10.4,11.8]	2.6	[2.3,2.9]	28.8	[27.7,30.0]
Marital Status								
Married	13.7	[13.1,14.4]	8.1	[7.6,8.6]	2.7	[2.4,3.0]	24.5	[23.6,25.4]
Unmarried	15.8	[14.6,17.1]	4.6	[3.9,5.3]	1	[0.8,1.4]	21.4	[20.0,22.9]
Widowed/Separated/Divorced	14.3	[12.8,15.9]	8.3	[7.1,9.7]	4.5	[3.7,5.5]	27.1	[25.3,29.1]
Education								
No formal Education	11.2	[10.3,12.1]	8.7	[8.0,9.6]	3.7	[3.2,4.2]	23.6	[22.4,25.0]
<Primary completed	14.7	[13.4,16.1]	9.7	[8.6,10.9]	2.9	[2.4,3.6]	27.4	[25.6,29.2]
Primary completed	15.4	[14.1,16.9]	10.0	[8.9,11.2]	2.5	[2.0,3.0]	27.9	[26.2,29.7]
<Secondary completed	16	[14.7,17.3]	8.5	[7.6,9.5]	2.4	[1.9,2.9]	26.8	[25.3,28.3]
Secondary completed	15.1	[13.8,16.5]	5.1	[4.4,5.8]	1.7	[1.3,2.4]	21.9	[20.5,23.5]
Higher Secondary completed	15.6	[14.0,17.3]	4.4	[3.6,5.3]	1.4	[0.9,2.1]	21.4	[19.7,23.3]
College/University completed	15.5	[13.9,17.3]	3.0	[2.3,3.8]	1.1	[0.7,1.7]	19.6	[17.8,21.5]
Post-graduate completed	12.8	[10.7,15.2]	2.8	[1.6,4.6]	0.9	[0.4,2.4]	16.5	[14.0,19.3]
Occupation								
Student	14.8	[13.2,16.6]	0.8	[0.5,1.2]	0.3	[0.2,0.6]	15.8	[14.2,17.6]
Government Employee	17.4	[14.9,20.3]	6.7	[5.1,8.8]	1.9	[1.1,3.4]	26.1	[23.2,29.2]
Non-government Employee	16.9	[15.3,18.6]	10.4	[8.7,12.3]	2.7	[2.0,3.8]	30.0	[27.7,32.5]
Daily Wage/Casual Labourer	15.3	[14.2,16.5]	11.4	[10.4,12.4]	3.5	[3.0,4.1]	30.2	[28.7,31.7]
Self-employed	14.9	[13.8,16.2]	11.7	[10.7,12.7]	3.1	[2.7,3.7]	29.7	[28.2,31.4]
Homemaker	12.4	[11.6,13.3]	3.5	[3.1,4.1]	1.9	[1.6,2.3]	17.9	[16.9,18.9]
Retired	9.1	[7.2,11.6]	6.3	[4.1,9.5]	2.6	[1.2,5.7]	18.0	[14.7,22.0]
Unemployed able to work	14.6	[11.9,17.8]	6.5	[4.6,9.2]	2.8	[1.7,4.6]	23.9	[20.3,28.0]
Unemployed unable to work	10.7	[8.5,13.2]	7	[5.2,9.4]	3.4	[2.1,5.4]	21.1	[18.2,24.4]
Knowledge of Adverse Health Impact of SLT Use								
No	11.5	[8.3,15.7]	7.7	[5.6,10.4]	3.7	[2.2,6.1]	22.9	[18.6,27.8]
Partial	15.2	[14.1,16.3]	9	[8.2,9.9]	3.4	[2.9,3.9]	27.5	[26.1,29.0]
Full	14	[13.4,14.8]	6.8	[6.4,7.3]	2.2	[2.0,2.4]	23.1	[22.2,24.0]
Caste								

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Others	14.2	[13.2,15.2]	6.1	[5.5,6.9]	2.6	[2.2,3.0]	22.9	[21.6,24.3]
Scheduled Castes	12.3	[11.1,13.5]	8.4	[7.5,9.3]	2.6	[2.2,3.0]	23.2	[21.8,24.6]
Scheduled Tribes	14.3	[12.7,16.0]	8.5	[7.2,9.5]	2.8	[2.1,3.3]	25.6	[23.0,27.5]
Oother Backward Castes	15.1	[14.2,16.1]	7.3	[6.8,7.9]	2.3	[2.0,2.6]	24.7	[23.5,25.9]
Religion								
Hindu	13.6	[12.9,14.3]	7.3	[6.9,7.8]	2.3	[2.1,2.6]	23.2	[22.3,24.1]
Muslim	19	[17.2,20.9]	8.5	[7.3,9.9]	3.3	[2.8,4.0]	30.8	[28.4,33.2]
Christian	16.2	[13.6,19.1]	3.5	[2.8,4.4]	2.3	[1.4,3.7]	21.9	[18.9,25.3]
Others	8.4	[6.5,10.7]	4.1	[2.7,6.0]	1.7	[1.0,3.1]	14.1	[11.4,17.4]
Wealth Quintile								
Poorest	12.1	[11.1,13.1]	9.6	[8.8,10.4]	3.1	[2.7,3.6]	24.7	[23.4,26.2]
Poorer	13.7	[12.8,14.8]	8.6	[7.8,9.4]	2.9	[2.5,3.4]	25.2	[23.9,26.6]
Middle	14.6	[13.5,15.8]	8.2	[7.3,9.2]	2.4	[1.9,2.9]	25.2	[23.7,26.8]
Richer	16.1	[14.8,17.5]	5.4	[4.7,6.1]	2.0	[1.5,2.6]	23.4	[21.9,25.0]
Richest	15.7	[14.3,17.3]	2.7	[2.2,3.3]	1.1	[0.8,1.6]	19.5	[18.0,21.1]
Place of Residence								
Urban	15.7	[14.6,16.9]	6.1	[5.4,6.8]	2.0	[1.7,2.4]	23.8	[22.3,25.4]
Rural	13.5	[12.7,14.2]	7.9	[7.4,8.5]	2.7	[2.4,3.0]	24.1	[23.1,25.0]
Region								
North	5.6	[4.9,6.4]	2.0	[1.4,2.8]	0.4	[0.3,0.6]	8.0	[7.0,9.1]
Central	13.6	[12.5,14.8]	11.1	[10.2,12.1]	2.6	[2.2,3.2]	27.3	[25.9,28.8]
East	10.1	[8.9,11.6]	6.1	[5.4,6.9]	2.4	[2.0,3.0]	18.7	[17.1,20.4]
Northeast	39.9	[37.8,42.0]	11.9	[10.8,13.2]	9.6	[8.6,10.7]	61.4	[59.3,63.5]
West	15.7	[13.8,17.8]	8.3	[7.0,9.8]	2.3	[1.6,3.2]	26.3	[23.3,29.5]
South	17.3	[15.8,18.8]	3.9	[3.3,4.6]	1.9	[1.6,2.3]	23.1	[21.4,24.9]

Chi^2 p-value <0.001

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Table 5. Multinomial Regression Analysis showing Determinants of Areca Nut Use, India GATS 2016-17

	Areca nut use without tobacco only				Areca nut use with tobacco only				Both Forms			
Background Variables	**RRR**	**p-value**	**95%CI**		**RRR**	**p-value**	**95%CI**		**RRR**	**p-value**	**95%CI**	
Age												
15-18 (ref.)	1.00				1.00				1.00			
19-23	0.91	0.106	0.81	1.02	1.73	<0.001	1.33	2.25	1.53	0.034	1.03	2.26
24-30	0.92	0.202	0.81	1.04	2.37	<0.001	1.83	3.08	2.26	<0.001	1.54	3.33
31-40	0.92	0.191	0.81	1.04	2.71	<0.001	2.08	3.52	2.72	<0.001	1.84	4.03
41-50	0.91	0.159	0.80	1.04	2.42	<0.001	1.85	3.16	2.59	<0.001	1.74	3.86
51-60	0.77	<0.001	0.67	0.89	2.14	<0.001	1.62	2.81	2.53	<0.001	1.68	3.80
60+	0.65	<0.001	0.56	0.75	2.04	<0.001	1.54	2.70	2.36	<0.001	1.55	3.58
Sex												
Female (ref.)	1.00				1.00				1.00			
Male	1.13	<0.001	1.07	1.20	2.02	<0.001	1.85	2.21	1.81	0.001	1.72	1.92
Marital Status												
Married (ref.)	1.00				1.00				1.00			
Unmarried	0.94	0.160	0.86	1.02	1.06	0.382	0.93	1.20	1.12	0.273	0.92	1.36
Widowed/Separated/Divorced	1.37	<0.001	1.24	1.50	1.62	<0.001	1.42	1.83	1.59	<0.001	1.35	1.88
Education												
No formal Education (ref.)	1.00				1.00				1.00			
<Primary completed	1.23	<0.001	1.14	1.34	1.01	0.867	0.91	1.12	0.93	0.318	0.80	1.08
Primary completed	1.20	<0.001	1.11	1.30	1.06	0.264	0.96	1.17	0.82	0.016	0.70	0.96
<Secondary completed	1.37	<0.001	1.27	1.48	0.99	0.774	0.89	1.09	0.90	0.177	0.77	1.05
Secondary completed	1.23	<0.001	1.13	1.34	0.79	<0.001	0.70	0.89	0.75	0.003	0.62	0.91
Higher Secondary completed	1.23	<0.001	1.11	1.35	0.74	<0.001	0.64	0.86	0.74	0.011	0.59	0.93
College/University completed	1.18	0.003	1.06	1.31	0.53	<0.001	0.44	0.63	0.53	<0.001	0.40	0.71
Post-graduate completed	1.18	0.023	1.02	1.36	0.35	<0.001	0.25	0.48	0.43	<0.001	0.27	0.68
Occupation												
Student (ref.)	1.00				1.00				1.00			
Government Employee	1.15	0.060	0.99	1.34	3.43	<0.001	2.49	4.73	2.56	<0.001	1.63	4.00
Non-government Employee	1.59	<0.001	1.39	1.81	4.87	<0.001	3.64	6.53	4.17	<0.001	2.75	6.30
Daily Wage/Casual Labourer	1.65	<0.001	1.46	1.87	4.51	<0.001	3.40	5.99	3.95	<0.001	2.66	5.87
Self-employed	1.30	<0.001	1.15	1.47	4.34	<0.001	3.27	5.75	2.87	<0.001	1.94	4.27
Homemaker	1.26	<0.001	1.11	1.42	2.61	<0.001	1.95	3.49	2.11	<0.001	1.42	3.13
Retired	0.95	0.604	0.77	1.17	2.28	<0.001	1.56	3.33	2.21	0.004	1.29	3.77
Unemployed able to work	0.91	0.287	0.76	1.08	2.91	<0.001	2.09	4.05	2.04	0.003	1.28	3.25
Unemployed unable to work	1.24	0.039	1.01	1.52	2.56	<0.001	1.79	3.67	2.49	0.000	1.51	4.09
Knowledge of Adverse Health Impact of SLT use												
No (ref.)	1.00				1.00				1.00			
Partial	1.37	0.001	1.13	1.66	1.36	0.017	1.06	1.76	1.60	0.009	1.12	2.28
Full	1.22	0.056	1.01	1.48	1.04	0.759	0.81	1.34	1.23	0.249	0.87	1.74
Caste												
Others (ref.)	1.00				1.00				1.00			
Scheduled Castes	1.05	0.197	0.97	1.13	1.17	0.004	1.05	1.29	1.25	0.005	1.07	1.46

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Scheduled Tribes	1.11	0.016	1.02	1.20	0.96	0.459	0.85	1.08	0.91	0.295	0.77	1.08
Oother Backward Castes	0.95	0.087	0.89	1.01	0.96	0.346	0.88	1.05	0.80	0.001	0.70	0.92
Religion												
Hindu (ref.)	1.00				1.00				1.00			
Muslim	1.35	<0.001	1.26	1.45	1.22	<0.001	1.11	1.35	1.41	<0.001	1.22	1.63
Christian	0.83	<0.001	0.77	0.91	0.59	<0.001	0.52	0.68	0.58	<0.001	0.49	0.69
others	0.61	<0.001	0.55	0.68	0.50	<0.001	0.42	0.60	0.36	<0.001	0.27	0.47
Wealth Quintile												
Poorest (ref.)	1.00				1.00				1.00			
Poorer	0.94	0.062	0.88	1.00	0.96	0.321	0.88	1.04	1.11	0.097	0.98	1.25
Middle	1.02	0.573	0.95	1.11	0.97	0.628	0.88	1.08	1.00	0.964	0.85	1.17
Richer	1.03	0.403	0.96	1.12	0.79	<0.001	0.70	0.89	0.79	0.010	0.66	0.95
Richest	1.04	0.305	0.94	1.15	0.54	<0.001	0.46	0.63	0.83	0.096	0.67	1.03
Place of Residence												
Urban (ref.)	1.00				1.00				1.00			
Rural	0.94	0.024	0.90	0.99	0.94	0.092	0.87	1.01	1.07	0.262	0.95	1.20
Region												
North (ref.)	1.00				1.00				1.00			
Central	2.28	<0.001	2.07	2.51	6.08	<0.001	5.26	7.04	6.45	<0.001	4.78	8.71
East	2.01	<0.001	1.82	2.22	3.38	<0.001	2.90	3.95	6.25	<0.001	4.64	8.44
Northeast	11.85	<0.001	10.84	12.95	14.81	<0.001	12.77	17.18	51.51	<0.001	38.90	68.23
West	3.40	<0.001	3.10	3.73	4.84	<0.001	4.14	5.65	5.85	<0.001	4.26	8.03
South	3.67	<0.001	3.37	4.01	2.29	<0.001	1.95	2.68	6.14	<0.001	4.57	8.25

Note: Ref- Reference

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Supplementary Table 1. Sample Description of the Study Population

Background Variables	*N*	%	Background Variables	*N*	%
Age			**Knowledge of Adverse Health Impact of SLT Use**		
15-18	4641	10.5	No	1051	1.4
19-23	7161	13.8	Partial	14459	20.5
24-30	13867	18.2	Full	58527	78.1
31-40	18839	21.0	**Caste**		
41-50	13245	15.3	Others	21734	26.8
51-60	8531	10.8	SCs	12854	19.1
60+	7753	10.4	STs	12128	8.9
Sex			OBCs	27321	45.3
Female	40265	48.9	**Religion**		
Male	33772	51.1	Hindu	54015	80.3
Marital Status			Muslim	8785	14.2
Married	56984	70.1	Christian	7111	2.3
Unmarried	11951	23.0	others	4126	3.1
Widowed/Separated/Divorced	5102	6.9	**Wealth Quintile**		
Education			Poorest	15547	23.4
No formal Education	18473	26.4	Poorer	18685	26.3
<Primary completed	7510	9.2	Middle	11278	16.8
Primary completed	8858	11.3	Richer	14814	19.6
<Secondary completed	12109	16.9	Richest	13713	13.8
Secondary completed	10331	14.1	**Place of Residence**		
Higher Secondary completed	7959	11.2	Urban	26488	34.5
College/University completed	6096	7.8	Rural	47549	65.5
Post-graduate completed	2642	3.1	**Region**		
			North	17128	8.7
Occupation			Central	11518	29.1
Student	6134	11.9	East	9834	21.7
Government Employee	3355	2.7	Northeast	13574	3.7
Non-government Employee	6259	8.3	West	7901	15.0
Daily Wage/Casual Labourer	13749	21.2	South	14082	21.8
Self-employed	13955	19.4			
Homemaker	25833	30.1			
Retired	1679	2.1			
Unemployed able to work	1572	1.9			
Unemployed unable to work	1471	2.3			
Don't know or refused	30	0.0			

All *N* are unweighted

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Supplementary Table 2. Prevalence (in %) of Areca Nut Use in Different Forms across States & Union Territories of India, GATS 2016-17

States/UTs	*Pan Masala* without Tobacco	*Pan Masala* with Tobacco	Betel Quid without Tobacco	Betel Quid with Tobacco	Areca Nut of Any Type	*Gutka*, Areca Nut-Tobacco Lime Mixture, or *Mawa*
North						
Jammu & Kashmir	0.2	0.2	0.3	0.8	0.2	0.4
Himachal Pradesh	0.7	0.1	0.4	0.0	0.6	0.5
Punjab	0.5	0.2	0.3	0.4	0.4	2.3
Chandigarh	0.5	0.4	0.6	0.9	1.2	1.0
Uttarakhand	3.1	3.1	8.6	2.7	10.8	2.2
Haryana	1.3	0.4	0.5	1.1	1.4	2.5
Delhi	4.9	1.3	8.3	2.6	7.6	3.0
Central						
Rajasthan	3.5	4.6	1.4	4.0	6.1	9.0
Uttar Pradesh	7.0	7.2	12.8	10.2	7.6	11.5
Chhattisgarh	6.1	1.8	2.1	2.0	3.4	7.8
Madhya Pradesh	3.8	4.4	2.4	4.1	6.7	13.7
East						
West Bengal	4.8	2.2	5.7	6.4	11.6	2.9
Jharkhand	7.4	1.1	1.2	4.9	2.0	8.3
Odisha	11.1	8.6	4.9	8.6	5.5	9.4
Bihar	5.2	1.4	1.5	3.4	2.3	3.7
North-East						
Sikkim	4.7	0.5	5.4	2.6	7.0	1.2
Arunachal Pradesh	11.5	4.7	13.6	14.9	5.1	18.9
Nagaland	8.7	21.1	8.8	17.5	2.2	9.4
Manipur	7.9	4.2	23.1	38.6	1.1	2.7
Mizoram	4.0	0.8	55.1	4.3	5.9	4.0
Tripura	6.4	10.4	8.3	39.5	22.6	2.5
Meghalaya	10.7	2.5	64.9	12.0	3.8	2.4
Assam	10.9	2.9	46.6	19.0	11.9	8.2
West						
Gujarat	3.5	1.4	4.9	1.1	4.7	12.8
Maharashtra	6.6	1.7	6.7	3.7	17.0	8.6
Goa	7.2	1.3	9.6	2.7	11.0	2.6
South						
Andhra Pradesh	0.3	0.2	4.9	2.4	5.6	1.9
Telangana	2.9	1.1	3.1	3.9	8.0	2.9
Karnataka	4.7	0.7	27.8	9.4	8.3	5.9
Kerala	1.2	0.4	2.1	4.4	0.9	0.7
Tamil Nadu	0.2	0.1	18.6	6.0	19.1	0.7

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Puducherry	0.8	0.1	7.7	3.4	15.1	0.7
India	**4.8**	**2.8**	**8.7**	**5.8**	**8.0**	**6.8**

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Supplementary Table 3. Prevalence (in %) of Areca Nut Use in Different Forms Across States & Union Territories of India, GATS 2016-17

	Urban				Rural			
States/UTs	**Areca nut use without tobacco only**	**Areca nut use with tobacco only**	**Both Forms**	**Any Form**	**Areca nut use without tobacco only**	**Areca nut use with tobacco only**	**Both Forms**	**Any Form**
North								
Jammu & Kashmir	1.2	0.7	0.0	1.8	0.1	0.9	0.0	1.1
Himachal Pradesh	3.3	1.6	0.0	4.9	1.0	0.2	0.0	1.2
Punjab	1.3	3.7	0.3	5.3	0.8	0.8	0.1	1.7
Chandigarh	1.7	1.6	0.1	3.5	1.9	0.0	0.0	1.9
Uttarakhand	19.8	4.2	1.4	25.4	16.3	3.6	1.2	21.0
Haryana	3.0	4.7	0.4	8.2	2.3	0.8	0.1	3.3
Delhi	15.9	2.0	1.0	18.9	3.4	2.1	0.0	5.5
Central								
Rajasthan	9.1	8.8	1.2	19.0	7.0	5.6	1.4	14.0
Uttar Pradesh	26.0	9.2	3.2	38.4	15.7	13.5	3.5	32.7
Chhattisgarh	10.6	12.4	1.5	24.5	7.6	5.6	1.0	14.2
Madhya Pradesh	11.9	12.3	2.7	26.9	7.1	13.9	1.8	22.9
East								
West Bengal	8.2	2.4	2.8	13.4	16.3	5.1	4.3	25.7
Jharkhand	7.8	7.7	0.8	16.3	8.4	8.4	1.2	18.0
Odisha	13.5	13.3	1.6	28.4	10.8	11.1	5.5	27.4
Bihar	4.3	5.7	0.4	10.4	7.4	4.9	0.5	12.8
North-East								
Sikkim	13.3	1.3	0.3	15.0	10.7	1.6	0.9	13.2
Arunachal Pradesh	18.1	13.3	4.4	35.8	17.1	20.3	3.4	40.9
Nagaland	10.6	15.2	7.0	32.7	9.2	15.1	5.2	29.4
Manipur	27.0	18.7	4.2	49.9	21.7	22.4	7.1	51.2
Mizoram	51.5	0.3	6.0	57.8	54.7	1.3	2.3	58.4
Tripura	12.5	19.9	10.4	42.8	15.0	15.8	15.6	46.5
Meghalaya	52.6	1.9	4.4	58.9	66.3	1.5	6.4	74.2
Assam	37.5	11.1	8.5	57.1	47.2	11.5	11.0	69.7
West								
Gujarat	10.4	10.0	1.3	21.7	6.5	12.0	1.0	19.5
Maharashtra	22.0	7.6	3.2	32.8	17.5	6.3	2.6	26.4
Goa	16.2	1.3	0.6	18.1	19.3	1.3	2.2	22.7
South								
Andhra Pradesh	8.3	0.8	0.6	9.8	5.9	1.5	1.4	8.9
Telangana	10.7	2.8	2.5	16.0	7.3	2.8	1.6	11.8

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Karnataka	26.6	6.3	2.9	35.8	30.3	8.7	5.3	44.2
Kerala	2.4	1.8	0.5	4.7	3.7	3.5	0.4	7.6
Tamil Nadu	26.1	1.1	0.6	27.7	24.9	6.6	1.7	33.2
Puducherry	13.5	0.8	0.7	15.0	27.3	4.5	3.2	34.9
India	**15.7**	**6.1**	**2.0**	**23.8**	**13.5**	**7.9**	**2.7**	**24.1**

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Supplementary Table 4. Prevalence (in %) of Areca Nut Use in Different Forms Across States & Union Territories of India, GATS 2016-17

	Female				Male			
States/UTs	**Areca nut use without tobacco only**	**Areca nut use with tobacco only**	**Both Forms**	**Any Form**	**Areca nut use without tobacco only**	**Areca nut use with tobacco only**	**Both Forms**	**Any Form**
North								
Jammu & Kashmir	0.3	0.2	0.1	0.6	0.6	1.5	0.0	2.1
Himachal Pradesh	0.1	0.0	0.0	0.1	2.3	0.6	0.1	3.0
Punjab	1.1	0.1	0.1	1.2	0.9	3.7	0.2	4.8
Chandigarh	2.0	0.4	0.0	2.4	1.6	2.6	0.1	4.3
Uttarakhand	16.3	1.1	0.0	17.4	18.7	6.4	2.5	27.6
Haryana	2.3	0.6	0.1	3.0	2.9	3.9	0.4	7.2
Delhi	11.9	1.0	0.3	13.2	18.9	2.8	1.6	23.3
Central								
Rajasthan	4.9	2.4	0.1	7.4	10.1	10.4	2.5	23.0
Uttar Pradesh	14.3	4.8	1.5	20.6	21.9	19.5	5.3	46.7
Chhattisgarh	4.2	1.8	0.2	6.2	12.5	13.1	2.1	27.7
Madhya Pradesh	4.9	5.5	1.7	12.1	12.0	20.9	2.5	35.3
East								
West Bengal	13.9	3.5	5.8	23.2	13.0	4.7	1.8	19.4
Jharkhand	9.0	0.6	0.5	10.1	7.6	15.5	1.6	24.7
Odisha	9.1	4.7	5.9	19.6	13.5	18.4	3.7	35.6
Bihar	2.6	0.4	0.1	3.2	11.0	9.3	0.9	21.1
North-East								
Sikkim	13.1	0.5	0.5	14.1	10.1	2.5	0.9	13.5
Arunachal Pradesh	27.6	10.2	4.8	42.6	7.8	26.3	2.6	36.8
Nagaland	8.5	17.3	5.1	30.9	10.7	13.1	6.4	30.2
Manipur	22.3	27.4	4.8	54.5	25.0	14.7	7.3	46.9
Mizoram	47.4	1.4	6.7	55.5	58.4	0.2	2.1	60.6
Tripura	19.4	21.7	20.6	61.6	9.4	12.6	7.7	29.7
Meghalaya	60.3	1.7	10.4	72.4	66.2	1.4	1.5	69.1
Assam	45.6	13.3	11.1	69.9	45.6	9.7	10.1	65.4
West								
Gujarat	5.4	3.9	0.9	10.2	11.0	17.7	1.4	30.1
Maharashtra	23.3	2.4	3.0	28.6	16.2	11.2	2.8	30.2
Goa	20.9	0.4	1.4	22.6	13.8	2.1	0.9	16.8
South								
Andhra Pradesh	10.0	1.8	2.2	14.0	3.4	0.8	0.1	4.3
Telangana	5.8	3.1	2.8	11.6	11.7	2.6	1.2	15.5
Karnataka	38.9	2.4	4.8	46.2	18.7	12.8	3.7	35.3
Kerala	1.8	2.4	0.6	4.8	4.4	2.9	0.3	7.6

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Tamil Nadu	20.8	4.5	1.3	26.5	30.4	3.0	1.1	34.4
Puducherry	14.1	2.3	2.3	18.7	21.5	1.5	0.5	23.4
India	**13.2**	**3.4**	**2.3**	**18.9**	**15.2**	**11.0**	**2.6**	**28.8**

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	2	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	5	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	6	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	6	Present key elements of study design early in the paper	6-7
Setting	6	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	6	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-9*
Bias	8	Describe any efforts to address potential sources of bias	6
Study size	9	Explain how the study size was arrived at	6
Quantitative variables	8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	9-10	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	10-10
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	

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Results			**Page no**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	12-14
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-14
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N.A.
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-18
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Areca nut consumption with and without tobacco among the adult population: a nationally representative study from India

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Areca nut consumption with and without tobacco among the adult population: a nationally representative study from India

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Areca nut consumption with and without tobacco among the adult population: a nationally representative study from India

Abstract

Objective: Areca nut is one of the most widely consumed substances globally, after nicotine, ethanol and caffeine and classified as carcinogenic to humans. This study examines the disparity and determinants of areca nut consumption with and without tobacco in India.

Design: Nationally representative cross-sectional study.

Participants: We utilized the nationally representative Global Adult Tobacco Survey (GATS) 2016-17. The analytical sample size was 74,037 individual's aged 15 years and above with a response rate of 92.9%.

Measures: Current consumption of areca nut without tobacco and with tobacco.

Method: We examined determinants of areca nut consumption (without tobacco and with tobacco) using multinomial logistic regression, accounting for the survey design.

Results: About 23.9% (95%CI 23.1-24.8) of the adult population consume areca nut, i.e. approximately 223.79 million people in India; 9.7% (95%CI 9.1-10.4) the majority of users (14.2% 95%CI 13.5-14.9) consumed areca nut with tobacco. When compared to females, males were more likely to consume areca nut (with tobacco RR=2.02; 95%CI 1.85-2.21 and without tobacco RR=1.13; 95%CI 1.07-1.20). Age, marital status, education, occupation, caste, religion and region were significantly associated with areca nut consumption. However, the direction and magnitude of association differs with respect to the areca nut consumption with and without tobacco.

Conclusion: The on-going tobacco control efforts would not address the majority of areca nut users until greater attention to areca nut consumption without tobacco is reflected in health policies in India.

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Key words: Areca nut, smokeless tobacco, GATS, India

Strengths and Limitations of this study

- Using a nationally representative survey with a high response rate, this study disentangled the current prevalence of areca nut consumption with and without tobacco in India, which has significant policy implications.
- The study provided detailed information on socioeconomic determinants of areca nut consumption, with and without tobacco, and separately for men and women, which may further guide future policy
- The survey covers only people 15 years and older, whereas areca nut consumption often starts at younger age.
- The survey is cross-sectional and cannot provide insights into trends of Areca nut consumption over time.

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Introduction

Areca nut is one of the most widely consumed substances globally, after nicotine, ethanol and caffeine[1,2]. Owing to its addictive properties, areca nut is estimated to be consumed by hundreds of millions of people across various countries [3]. However, addiction to areca nut is primarily prevalent in many Asia-Pacific countries and by emigrants from these countries in other parts of world [3]. It is not only known by several, sometimes local names, but also consumed in several forms e.g. pan masala, gutkha, mawa, dohra, kharra, betel etc. with or without tobacco[4,5]. Some forms of consumption may also include other constituents, such as betel leaf, slaked lime and various spices.

The International Agency for Research on Cancer (IARC) classified area nut consumption with or without tobacco as carcinogenic to humans[6]. A meta-analysis based on 50 studies worldwide reported increased relative risks for cancer of the oral cavity and oropharynx for the Indian subcontinent and areca nut consumption with tobacco (Relative Risk 7.03; 95%CI, 4.68–10.56) and areca nut consumption without tobacco (Relative Risk 3.22; 95%CI, 2.11–4.92) [7]. A global systematic review based on 62 studies concluded that consumption of areca nut affects almost all organs of the human body, including the brain, heart, lungs, gastrointestinal tract and reproductive organs; and causes or aggravates pre-existing conditions such as neuronal injury, myocardial infarction, cardiac arrhythmias, hepatotoxicity, asthma, central obesity, type II diabetes, hyperlipidemia, metabolic syndrome[8]. It has harmful effects on the foetus when used during pregnancy[8]. Previous studies observed that areca nut dependency among users [9] and its withdrawal effects [10] were similar to those observed among nicotine users [10]. It is also a gateway product in children who start using different kinds of areca nut products at an early age [11].

Despite growing scientific evidence of high addictiveness and several ill effects(8-11) associated with areca nut consumption, research on areca nut has not received much

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attention[3]. The large global and national movement that addresses tobacco control under the ambit of the WHO Framework Convention on Tobacco Control (FCTC) has focused primarily on smoking and has been less effective in controlling smokeless tobacco (SLT) [12]. The regulatory framework for areca nut control has also remained limited to prescribing health warnings on areca nut products by the Food Safety and Standard Authority of India (FSSAI). Further, use of tobacco and nicotine as an ingredient in any food item is also prohibited under FSSA regulations, thereby restricting mixing of tobacco in areca nut products and vice-versa[1]. Although tobacco control policies are applicable to areca nut products which contain tobacco a considerable number of people now consume areca nut without tobacco, which poses greater public health challenges in controlling and regulating the substance [13].

A comprehensive search of the literature revealed that studies on areca nut use in India lack representativeness and published studies were restricted to a specific geographical area or population groups. None of the published studies have examined diverse habits of areca nut consumption, its disparity and determinants using a nationally representative survey. Also, a recent global review calls for more research to better understand the epidemiology of areca nut consumption across different populations and geographies [3].

India, with a population of over 1.30 billion, exhibits one of the highest socioeconomic and demographic heterogeneities ever experienced anywhere in the world at the regional level[14]. There is considerable evidence of marked regional inequities in tobacco use[15], health and healthcare [16]and mortality outcomes [17]in India. These differences are primarily the outcome of differences in community-level development, population composition, state health expenditure, poverty levels, status of women, and availability, accessibility and affordability of maternal and child health care services and their utilization [18–20].

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While India's share to overall areca nut production and consumption remains at the top in the world, no attempts have been made to explore the patterns and determinants of the consumption of areca nut based on large scale representative surveys. This study aims to examine the disparity and determinants of areca nut consumption, with and without tobacco using the nationally-representative Global Adult Tobacco Survey (GATS) conducted in 2016-17.

Methods and materials

Study Design and Participants

We utilized the nationally representative cross-sectional Global Adult Tobacco Survey (GATS) 2016-17, conducted in all 29 states and three Union Territories (UTs) of India [21]. The study included whole GATS sample of 74,037 adults aged 15 and above. A multi-stage sampling design separately for rural and urban areas was adopted to draw a representative sample considering the 2011 census population figures. The household response rate and person-level response rate were 96.7 percent and 96.0 percent respectively resulting in an overall response rate of 92.9 percent.

The sampling was done independently in each state/UT; and within the state/UT, it was done independently for urban and rural areas. In urban areas, a three stage sampling process was adopted. At the first level, the list of all the wards from all cities and towns of the state/ UT constituted the urban sampling frame, from which a required sample of wards (Primary Sampling Units - PSUs) was selected using probability proportional to size (PPS) sampling. At the second level, a list of all census enumeration blocks (CEBs) in each selected ward constituted the sampling frame from which one CEB was selected by PPS from each ward. At the third level, a list of all residential households in each selected CEB constituted the sampling frame, from which a sample of required number of households was selected.

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In rural areas, a two stage sampling process was adopted. At the first stage of sampling, all villages in the state/UT formed the sampling frame. All small villages having less than five households were removed from the sampling frame. Villages with five to 49 households as per Census of India, 2011 were linked with the neighbouring larger villages. The required number of PSUs (villages) within each stratum was selected according to PPS sampling. At the second stage, a list of all residential households in each selected village constituted the sampling frame, from which a sample of the required number of households was selected.

A household listing operation was carried out in each sample area. All large villages with 300 or more households were segmented into three or more segments (depending on village size) of almost equal proportions, each being about 100-200 households. From all the segments in each large village, two segments were selected by using PPS sampling. Thirty households (plus three more, accounting for non-response) were selected from the list of households by systematic random sampling. The 33 selected households in a PSU were divided into two groups: 1) households for interview of a male member, and 2) households for interview of a female member; this was in proportion to the total sample size of male and female interviews in a state. From the total number of male/ female members aged 15 or above in a household, one member was randomly selected for the interview.

Further details related to survey methodology, sampling design, household and individual selection, data collection, management and monitoring procedures have been described elsewhere[21].

Dependent variables

The outcome variable was current consumption of areca nut use, assessed based on the following questions covered in the GATS:

i. Do you consume *pan masala* without tobacco? (response options: yes, no and

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refused)

ii. Do you consume betel quid without tobacco? (response options: yes, no and refused)

iii. Do you consume areca nut of any type, plain, powdered or flavoured? (response options: yes, no and refused)

iv. Betel quid with tobacco? (response: on average, how many times a day do you use)

v. *Gutka*, areca nut-tobacco lime mixture, or *mawa*? (response: on average, how many times a day do you use)

vi. *Pan masala* with tobacco? (response: on average, how many times a day do you use)

Based on the above-mentioned questions asked in GATS, we constructed three sets of variables: (i) areca nut consumption only without tobacco, (ii) areca nut consumption only with tobacco and (iii) areca nut consumption with and without tobacco, dual use. Definition of specific products can be found with the GATS 2 national report[22].

Independent variables

A range of socioeconomic (education, occupation, caste, religious affiliation and wealth quintile), demographic (age, sex, marital status,), awareness related and contextual level variables included in this study which were found to be associated with areca nut consumption in previous studies [23–27]. These variables include age (categorised as 15-18, 19-23, 24-30, 31-40, 41-50, 51-60 and 60+) and sex as male and female. Individual's education was measured as: (i) no formal education, (ii) below primary, (iii) primary completed, (iv) below secondary, (v) secondary completed, (vi) completed higher secondary, (vii) completed college/university and (viii) completed post-graduate level. Individual's occupation on the other side was assessed based on self-reported information as (i) student, (ii) government sector, (iii) non-government sector, (iv) casual/ daily labourer, (v) self-employed, (vi) homemaker, (vii) retired and (viii) unemployed.

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A wealth index was calculated based on availability of electricity, flush toilet, radio, television, fixed telephone or cell phone, refrigerator, washing machine, moped/scooter/motorcycle and car using Principle Component Analysis (PCA) methodology[28]. There are various ways to assign weighting values to the indicator variables. Ad hoc weights, such as assigning "1" for a bicycle, "3" for a motorcycle, and "5" for a car or truck, work to a certain extent, but they are arbitrary and are difficult to assign when the wealth ordering is not readily apparent. For this reason, Filmer and Pritchett recommended using principal components analysis (PCA) to assign the indicator weights, the procedure that is used for the wealth index[29]. This procedure first standardizes the indicator variables (calculating z scores); then the factor coefficient scores (factor loadings) are calculated; and finally, for each household, the indicator values are multiplied by the loadings and summed to produce the household's index value. In this process, only the first of the factors produced is used to represent the wealth index. The resulting sum is itself a standardized score with a mean of zero and a standard deviation of one[28]. Individuals were divided into five wealth quintiles based on their household score ranges from 1 being poorest to 5 being wealthiest, with each category representing 20 percent of the score[28].

A composite knowledge variable which measures the poor health impact of smokeless tobacco use was constructed based on the following information asked in the survey: smokeless tobacco causes serious illness (yes/no), smokeless tobacco cause oral cancer (yes/no), smokeless tobacco cause dental diseases (yes/no), smokeless tobacco cause harm to fetus during pregnancy (yes/no), and do you think smokeless tobacco leads to addiction (yes/no). The new knowledge variable was categorised as: (i) 'no, to all five awareness' (ii) 'no, to at least one awareness' and (iii) 'yes, to all five awareness'.

Caste (social group) as categorised based on individual's self-reporting as Scheduled Castes (SCs), Scheduled Tribes (STs), Other Backward Classes (OBCs) and others. This broad

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categorization of caste is based on their socioeconomic disadvantage in education, health, nutrition, and employment by federal government. For instance, a study has shown that as compared to other caste, children (age 2-5 years) and adolescents (age 6-18 years) belonging to scheduled tribes had the greatest risk of mortality (OR = 1.94, 95% CI = 1.47, 2.57), followed by those from scheduled castes (OR = 1.35, 95% CI = 1.05, 1.74) and other backward classes (OR = 1.33, 95% CI = 1.05,1.67) [17]. Other studies have also shown lower enrolment and completion of education among scheduled castes and scheduled tribes due to various factors [30,31]. Religion captures self-reported follower/believer of Hinduism, Islam, Christianity and others (which mainly include Sikhs, Jains, Buddhists and non-believers). The study also considered place of residence as rural and urban as well as all 29 states and three UTs in the analysis.

Analytical strategy

At first, prevalence of areca nut consumption with and without tobacco at national and sub-national levels along with rural-urban and male-female differences was analyzed. Chi-squared (x^2) tests were performed to examine whether variations in areca nut consumption across independent variables were statistically significant. To examine the associated between areca nut consumption with various socioeconomic and demographic characteristics, multinomial logistic regression was used. In the multinomial logit regression, it is assumed that log odds of outcome/dependent variable either follow linear form or non-binary form; each outcome/dependent variable is modelled relative to the baseline group or outcome[32]. In this study, we have considered (i) 'non-areca nut user (baseline group)', (ii) 'areca nut consumption only with tobacco', (iii) areca nut consumption only without tobacco' and (iv) 'areca nut consumption with and without tobacco, dual use'. The study reported the relative risk ratio (RRR) along with 95% confidence intervals [33]. We calculated the population burden based on GATS weighted sample population figures, which were provided in the

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GATS India report[22]. The analysis was adjusted for sampling weights and multistage sampling design using *syv* command in STATA. Analysis was carried out in STATA, version 15 [34]

Ethics statement

The second round of GATS obtained ethical clearance from the Ethics Committee of Tata Institute of Social Sciences[22]. No ethics clearance was required for this study, as we used secondary analysis using publicly available data.

Patient and public involvement

No patients were involved in the development of the research question, the outcome measures or the design of the study.

Results

Descriptive statistics

Of the 74037 respondents, 40265 (48.9%) were women and 33772 (51.1%) were men, and 47549 (65.5%) individuals resided in rural areas. One out of four respondents had no formal education and nearly 78% were aware about the adverse health effects of SLT consumption (**Supplementary table 1**).

We found that overall, betel quid without tobacco (8.7%; 95%CI 6.7-10.2) was consumed largely, followed by areca nut of any type (8%; 95%CI 5.9-10.3) at the national level (**Table 1**). Among men, the prevalence of *gutka,* areca nut-tobacco lime mixture or *mawa* was consumed the most (17.8%; 95%CI 15.1-20.2), whereas, among women, betel quid without tobacco was largely consumed (9.0%; 95%CI 6.1-11.9). In urban areas, both betel quid without tobacco and areca nut of any type were largely consumed, while in the rural areas it was mainly betel quid without tobacco. Regional pattern suggests that betel quid with tobacco

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were predominately consumed in many north-eastern states, while betel quid without tobacco was mainly used in south (**Supplementary table 2**).

Regional disparity in areca nut consumption

We found 23.9 (95%CI 23.1-24.8) adults were consuming areca nut at national level and 14.2% (95%CI 13.6-14.9) were consuming areca nut without tobacco (**Table 2**). **Figure 1** shows considerable variations in areca nut consumption across states and UTs of India. In many states areca nut consumption in any form was over 40% among men (like, Uttar Pradesh, Assam Meghalaya, Mizoram, and Manipur) and women (like, Karnataka, and all north-eastern states except Nagaland). Areca nut consumption without tobacco was largely being consumed across north-eastern states, apart from other bigger states like Karnataka (28.8%; 95%CI 25.6-32.1), Tamil Nadu (25.5%; 95%CI 21.9-29.5) and Maharashtra (20%; 95%CI 17.0-22.5). Nearly 223.4 million people out of the total 932,488,000 population aged 15 and above consume areca nut in India (**Table 3**). The distribution of areca nut users both in terms of population and proportion across states were as follows: Uttar Pradesh with 49.9 million users contributes to nearly 22% of all areca nut users, followed by Maharashtra with 26.7 million users (12%), Karnataka with 19.8 million (9%) and Tamil Nadu with 17.7 million users (8%). Together, these four states share nearly 51% of all areca nut users in the country. Not much difference exists between urban and rural areas in areca nut usage patterns (**Supplementary table 3**). In 18 states/UTs, however, areca nut consumption was higher in urban areas than rural counterparts. In 13 states/UTs, the opposite pattern was evident.

Demographic and socioeconomic differences in areca nut consumption

Consumption of areca nut in any form was higher among males as compared to females both at national level as well as in a majority of states (**Supplementary table 4**). All forms of areca nut consumption were higher in the age group 31-50 years (**Table 4**) as compared with

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other age categories. 28.8% men (95%CI 27.7-30.0) and 27.1% widowed/separated/divorced (95%CI 25.3-29.1) were consuming areca nut. Individuals who had completed below the primary level of schooling consumed higher proportion of areca nut. Areca nut consumption was highest among daily wage labourers (30.2%; 95%CI 28.7-31.7). We found that a high percentage of Scheduled Tribes (25.6%; 95%CI 23.0-27.5) and Muslims (30.8%; 95%CI 28.4-33.2) were consuming areca nut.

Determinants of areca nut consumption: regression analysis

Regression results suggest that as compared to 15-18 age group, the likelihood of areca nut consumption with tobacco and dual use was higher in higher age groups (**Table 5**); except that areca nut consumption without tobacco was lower among the age group 51 and above, as compared to the 15-18 age groups. Probability of areca nut consumption was higher among males as compared to females for all three forms. The likelihood of areca nut consumption without tobacco was higher across all the educational categories as compared to those who had no formal education. However, the probability of areca nut consumption with tobacco and in dual-form was declining with increase in the education level of respondents. The likelihood of areca nut consumption with tobacco and dual-use was significantly higher among Schedules Castes than Other castes. Probability of all the three forms of areca nut consumption was higher among Muslims as compared to Hindus.

Discussion

The findings of the study revealed that nearly one out of every four adults in India consumes areca nut, that is, almost 223.79 million users, making areca nut consumption a bigger public health challenge than use of smokeless tobacco (199 million users) in dealing with substance use and addiction in the country. The large number of users of areca nut, a known carcinogen presents a huge public health challenge for the country. Moreover, nearly 10% consume areca

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nut with tobacco. Thus, considering the wide range of adverse health impacts, effective implementation on banning of tobacco as an ingredient with areca nut products under regulation 2.3.4 of the Food Safety and Standards Regulation, 2011 and ban on manufacture and sale of areca nut products, as implemented in some of the states, is urgently needed [1].

We found considerable regional and socioeconomic differences in the consumption of areca nut. In four states, Meghalaya, Assam, Mizoram and Manipur, over half of the population consume areca nut. Further, Karnataka, Uttar Pradesh, Tamil Nadu, Maharashtra and Odisha, constitute nearly 55% of the country's areca nut users. As far as other determinants are concerned, the findings confirmed that age, gender, marital status, education, occupation, castes and religion are significantly associated with areca nut consumption. However, the direction of association differs with respect to areca nut consumption with and without tobacco. Cheaper and abundant availability, due to large scale domestic production of areca nut could be one of the key reasons for such high prevalence in the country.

We found protective effect of secondary and above level education in the case of areca nut consumption with tobacco and in both forms. A study from Pakistan also observed that the consumption of areca nut users increased by grade among school children aged 4 to 16 years [27]. Areca nut consumption were higher among male than among female, a finding that is consistent with other studies conducted in Tamil Nadu and Assam in India [26,35] and countries like Thailand and Taiwan [13]. It may be because areca nut consumption results in staining of teethe which may not be liked by young and adult females. The age-wise pattern suggests that areca nut consumption without tobacco began to decline from age 51 onwards. But in the case of areca nut consumption with tobacco and in both forms, it increased with age.

Similar to other studies from India and other neighbouring countries [24,36], we also observed higher consumption of areca nut with tobacco among daily wage/casual labourers.

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This study further adds that areca nut consumption without tobacco too was largely consumed by daily wage/casual labourers, followed by non-government sector. Evidences suggests that many misconceptions including consuming areca nut improves concentration, pleasure, helps in anxiety and muscle relaxation and suppresses appetite increases the likelihood of consumption among those who are engaged in casual labour and have long working hours [23,37,38]. We found higher consumption of areca nut among STs and SCs than other caste groups. Further, Muslims were more likely to consume all three forms of areca nut as compared with Hindus. Previous studies documented higher consumption of tobacco including SLT, among SCs/STs and Muslims [25,39].

Urban-rural differences by state suggest that in 18 states, areca nut consumption was higher in urban areas than in rural areas. Regression results also revealed higher consumption of areca nut without tobacco in urban areas than rural counterparts. This is likely due to higher awareness about harms related to tobacco use in urban areas than rural counterparts. Studies from India and Pakistan documented that *pan masala* and *gutka* are very popular even in urban areas due to aggressive advertising, targeting middle class and adolescents, which improved sale many tobacco and related products including areca nut [40].

Our study had some limitations. Information related to areca nut consumption in different forms in the GATS was based on respondents self-reporting. Thus, the study cannot rule out social desirability bias – a tendency among some people to respond to questions in a way which they deem to be more acceptable than would be their 'correct' answer [41]. The nomenclature of various areca nut products in geographically diverse country like India could be a source of concern, which is difficult to capture in the large scale surveys. Considering the cross-sectional design of the survey, we did not examine the cause and effect relationship between socioeconomic charecterstics and areca nut consumption. Similarly, the available data did not allow us to estimate trends of areca nut usage over time, but future analyses of

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repeated GATS may inform on important trends. Another limitation is that the study is based on 15 years and older population, whereas the areca nut habits often start at younger age. The future Global Youth Tobacco Survey (GYTS) should have areca nut related questions similar to GATS so that detailed usage pattern of areca nut could be examined among younger population of the country.

Conclusion

It is now well established that areca nut consumption in any form is highly addictive, a well-known risk factor for oral, pharynx and oesophageal cancers and is associated with many adverse health effects. This study adds to the existing knowledge that areca nut consumption in India was much higher than the overall smokeless tobacco. Moreover, a significant proportion of areca nut was consumed along with tobacco, which elevates the adverse health impacts and co-morbidities further. Thus, it calls for urgent policy intervention to prevent both new generations from taking up areca nut consumption habit and helping current users to quit. Such policy efforts to control areca nut consumption should be guided by the huge differences in its consumption across states, gender and socioeconomic groups in India. Unlike tobacco, for which the WHO FCTC provides evidence-based policies, no global policy exists for the regulation and control of areca nut consumption and its cessation. Also, there is a need for further research and population-based interventions to find treatment for areca nut dependence. In addition, research is needed to examine the intention to quit among areca nut users, separately for all three categories - those who consumption areca nut with tobacco, without tobacco and those who consume in both the forms, to develop an appropriate intervention model for cessation. This information may be collected within the GATS survey by adding a few additional questions on areca nut for future analysis. Given that areca nut consumption follows a complex pattern by SES and regional trajectories, separately for with and without tobacco, future research is needed to explore the various

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intersections between SES and areca nut consumption in different regions of India to gain better clarity.

Contributorship statement

PKS conceived the study. PKS and LS performed the statistical analysis. PKS and LS analyzed and interpreted the data. PKS and AY drafted the manuscript. SM, DNS, KS and SS provided comments and contributed to the development of the final draft of the manuscript. All authors have supervised and approved the manuscript.

Competing Interest

None declared.

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Data sharing statement

Data utilized by the study is available by emailing prashants.geo@gmail.com.

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Figure 1: Geographical variation in areca nut use among adult men and women in India

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Table 1. Prevalence (in %) and Number of Users of Different Types of Areca Nut in India, GATS 2016-17

Tobacco Products	Total		Men		Women		p-value of difference between men and women (*Chi²test)*	Urban		Rural		p-value of difference between urban and rural areas (*Chi²test)*
	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)		% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)	Users (in 000)
Pan masala without tobacco	4.8 (3.2-5.6)	44759	6.2 (4.1-8.3)	57814	3.2 (1.9-5.1)	29840	<0.001	5.2 (3.1-7.7)	48489	4.5 (2.2-6.8)	41962	>0.005
Pan masala with Tobacco	2.8 (1.6-3.8)	26110	4.5 (2.8-5.7)	41962	1.1 (0.6-2.1)	10257	<0.001	2.3 (1.1-3.8)	21447	3.1 (1.2-5.2)	28907	>0.005
Betel Quid without Tobacco	8.7 (6.7-10.2)	81126	8.4 (5.9-10.8)	78329	9.0 (6.1-11.9)	83924	<0.001	9.1 (6.8-12.6)	84856	8.4 (5.7-10.8)	78329	>0.005
Betel Quid with Tobacco	5.8 (3.8-7.2)	54084	7.1 (5.2-9.3)	66207	5.5 (3.2-7.8)	51287	<0.001	4.3 (2.8-6.3)	40097	6.6 (4.2-8.3)	61544	<0.005
Areca Nut of Any Type	8.0 (5.9-10.3)	74599	8.3 (5.8-11.2)	77397	7.7 (5.1-9.2)	71802	<0.001	9.1 (6.5-13.1)	84856	7.5 (4.8-9.8)	69937	>0.005
Gutka, Areca Nut-Tobacco Lime Mixture, or *Mawa*	6.8 (5.7-8.6)	63409	17.8 (15.1-20.2)	100709	2.7 (1.2-4.1)	25177	<0.001	6.3 (3.1-8.7)	58747	7.1 (4.5-9.8)	66207	<0.005

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Table 2. Prevalence (in %) of Areca Nut Use in Different Forms across States & Union Territories of India, GATS 2016-17

States/UTs	Areca nut use without tobacco only		Areca nut use with tobacco only		Dual use		Any Form	
North region								
Jammu & Kashmir	0.5	[0.2,1.2]	0.9	[0.5,1.5]	0.0	[0.0,0.1]	1.4	[0.8,2.1]
Himachal Pradesh	1.2	[0.8,1.9]	0.3	[0.1,0.8]	0.0	[0.0,0.2]	1.5	[1.1,2.3]
Punjab	1.0	[0.6,1.6]	2.0	[0.9,4.2]	0.1	[0.0,0.6]	3.1	[1.8,5.2]
Chandigarh	1.7	[1.1,2.7]	1.6	[0.9,3.0]	0.1	[0.0,0.3]	3.4	[2.3,5.1]
Uttarakhand	17.5	[14.0,21.6]	3.8	[2.9,4.8]	1.3	[0.7,2.1]	22.6	[18.5,27.1]
Haryana	2.6	[1.7,4.0]	2.4	[1.0,5.3]	0.2	[0.1,0.6]	5.2	[3.3,8.1]
Delhi	15.7	[13.0,18.7]	2.0	[1.3,2.9]	1.0	[0.6,1.7]	18.7	[15.6,22.0]
Central region								
Rajasthan	7.5	[6.3,9.1]	6.5	[5.3,7.9]	1.4	[0.7,2.5]	15.4	[13.4,17.6]
Uttar Pradesh	18.3	[16.4,20.3]	12.4	[11.0,14.0]	3.5	[2.7,4.4]	34.2	[31.9,36.5]
Chhattisgarh	8.4	[6.4,10.8]	7.4	[5.9,9.3]	1.2	[0.7,1.8]	17.0	[14.2,20.1]
Madhya Pradesh	8.6	[7.2,10.2]	13.4	[11.3,15.9]	2.1	[1.4,3.0]	24.1	[21.2,27.2]
East region								
West Bengal	13.4	[10.7,16.7]	4.1	[3.0,5.5]	3.7	[2.8,5.0]	21.2	[18.2,24.6]
Jharkhand	8.3	[6.6,10.3]	8.2	[6.4,10.5]	1.1	[0.6,2.0]	17.6	[14.3,21.4]
Odisha	11.3	[8.6,14.6]	11.5	[9.6,13.8]	4.8	[3.4,6.6]	27.6	[23.1,32.6]
Bihar	7.0	[5.4,9.1]	5.0	[4.0,6.3]	0.5	[0.3,0.9]	12.5	[10.5,14.8]
Northeast region								
Sikkim	11.5	[8.9,14.9]	1.5	[0.9,2.6]	0.7	[0.4,1.2]	13.7	[10.8,17.4]
Arunachal Pradesh	17.4	[14.4,20.8]	18.6	[13.0,25.8]	3.7	[2.6,5.2]	39.7	[32.6,47.0]
Nagaland	9.6	[7.6,12.2]	15.1	[12.7,17.8]	5.8	[4.3,7.8]	30.5	[27.3,34.0]
Manipur	23.7	[20.2,27.5]	21.0	[18.3,24.0]	6.0	[4.6,7.8]	50.7	[47.0,54.4]
Mizoram	52.9	[48.3,57.5]	0.8	[0.4,1.7]	4.4	[3.2,5.9]	58.1	[53.0,62.9]
Tripura	14.3	[11.6,17.4]	17.0	[14.0,20.6]	14.0	[11.0,17.7]	45.3	[42.0,48.7]
Meghalaya	63.2	[57.5,68.5]	1.6	[0.9,2.8]	6.0	[4.3,8.2]	70.8	[65.4,75.5]
Assam	45.6	[42.8,48.4]	11.4	[9.9,13.2]	10.6	[9.2,12.2]	67.6	[64.7,70.5]
West region								
Gujarat	8.3	[6.5,10.5]	11.1	[8.8,13.9]	1.1	[0.8,1.7]	20.5	[17.8,23.5]
Maharashtra	19.6	[17.0,22.5]	6.9	[5.5,8.8]	2.9	[2.0,4.2]	29.4	[25.3,34.0]
Goa	17.3	[14.6,20.4]	1.3	[0.7,2.2]	1.1	[0.7,1.9]	19.7	[16.7,23.1]
South region								
Andhra Pradesh	6.7	[5.2,8.7]	1.3	[0.7,2.4]	1.2	[0.6,2.4]	9.2	[7.1,11.7]
Telangana	8.7	[6.9,11.0]	2.8	[1.8,4.3]	2.0	[1.2,3.3]	13.5	[11.3,16.2]
Karnataka	28.8	[25.6,32.1]	7.7	[6.2,9.4]	4.3	[3.4,5.3]	40.8	[36.3,45.2]
Kerala	3.1	[2.2,4.3]	2.6	[1.9,3.6]	0.4	[0.2,1.0]	6.1	[4.7,7.9]
Tamil Nadu	25.5	[21.9,29.5]	3.7	[2.5,5.6]	1.2	[0.8,1.7]	30.4	[27.1,34.0]
Puducherry	17.7	[14.7,21.1]	1.9	[1.0,3.4]	1.4	[0.9,2.1]	21.0	[17.6,24.9]
India	**14.2**	**[13.6,14.9]**	**7.3**	**[6.9,7.7]**	**2.4**	**[2.2,2.7]**	**23.9**	**[23.1,24.8]**

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Table 3. Population and Share of Areca Nut Use by States & Union Territories (UT) of India, GATS 2016-17

States/UTs	Population	Share (in%)
Chandigarh	33,040	0.0
Sikkim	68,448	0.0
Himachal Pradesh	88,112	0.0
Jammu & Kashmir	1,21,264	0.1
Puducherry	2,11,680	0.1
Goa	2,37,779	0.1
Arunachal Pradesh	4,15,800	0.2
Nagaland	4,59,940	0.2
Mizoram	4,88,040	0.2
Punjab	6,99,081	0.3
Haryana	10,48,632	0.5
Manipur	11,31,624	0.5
Tripura	13,16,418	0.6
Meghalaya	14,93,184	0.7
Kerala	16,50,843	0.7
Uttarakhand	17,56,575	0.8
Delhi	27,61,914	1.2
Chhattisgarh	32,62,714	1.5
Andhra Pradesh	36,54,056	1.6
Telangana	38,09,088	1.7
Jharkhand	42,61,840	1.9
Rajasthan	79,00,200	3.5
Odisha	89,84,904	4.0
Bihar	90,95,000	4.1
Gujarat	98,13,760	4.4
Madhya Pradesh	1,31,45,827	5.9
West Bengal	1,54,75,728	6.9
Assam	1,58,33,272	7.1
Tamil Nadu	1,77,53,296	7.9
Karnataka	1,98,34,738	8.9
Maharashtra	2,67,53,412	12.0
Uttar Pradesh	4,99,32,289	22.3
India	22,37,97,120	100.0

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Table 4. Areca Nut Use Pattern by Demographic and Socioeconomic Characteristics, GATS 2016-17

Background Variables	Areca nut use without tobacco only		Areca nut use with tobacco only		Dual use		Any Forms	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Age	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
15-18	15.7	[13.9,17.6]	1.9	[1.4,2.5]	0.7	[0.5,1.2]	18.3	[16.5,20.3]
19-23	14.8	[13.3,16.4]	5.4	[4.5,6.4]	1.3	[0.9,1.9]	21.5	[19.8,23.3]
24-30	14.1	[13.1,15.2]	8.2	[7.3,9.1]	2.4	[2.0,2.9]	24.7	[23.3,26.1]
31-40	14.6	[13.6,15.6]	9.3	[8.6,10.1]	2.7	[2.4,3.2]	26.7	[25.4,28.0]
41-50	15.2	[14.1,16.3]	8.1	[7.3,9.0]	3.1	[2.6,3.7]	26.4	[25.0,27.9]
51-60	13.5	[12.2,14.8]	8	[7.0,9.0]	3.2	[2.6,3.9]	24.6	[23.1,26.3]
60+	11.1	[9.9,12.3]	7.8	[6.6,9.0]	3.2	[2.6,4.0]	22.0	[20.2,23.9]
Sex	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
Female	13.2	[12.5,14.0]	3.4	[3.0,3.8]	2.3	[2.0,2.6]	18.9	[18.0,19.9]
Male	15.2	[14.4,16.1]	11	[10.4,11.8]	2.6	[2.3,2.9]	28.8	[27.7,30.0]
Marital Status	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
Married	13.7	[13.1,14.4]	8.1	[7.6,8.6]	2.7	[2.4,3.0]	24.5	[23.6,25.4]
Unmarried	15.8	[14.6,17.1]	4.6	[3.9,5.3]	1	[0.8,1.4]	21.4	[20.0,22.9]
Widowed/Separated/Divorced	14.3	[12.8,15.9]	8.3	[7.1,9.7]	4.5	[3.7,5.5]	27.1	[25.3,29.1]
Education	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
No formal education	11.2	[10.3,12.1]	8.7	[8.0,9.6]	3.7	[3.2,4.2]	23.6	[22.4,25.0]
<Primary completed	14.7	[13.4,16.1]	9.7	[8.6,10.9]	2.9	[2.4,3.6]	27.4	[25.6,29.2]
Primary completed	15.4	[14.1,16.9]	10.0	[8.9,11.2]	2.5	[2.0,3.0]	27.9	[26.2,29.7]
<Secondary completed	16	[14.7,17.3]	8.5	[7.6,9.5]	2.4	[1.9,2.9]	26.8	[25.3,28.3]
Secondary completed	15.1	[13.8,16.5]	5.1	[4.4,5.8]	1.7	[1.3,2.4]	21.9	[20.5,23.5]
Higher Secondary completed	15.6	[14.0,17.3]	4.4	[3.6,5.3]	1.4	[0.9,2.1]	21.4	[19.7,23.3]
College/University completed	15.5	[13.9,17.3]	3.0	[2.3,3.8]	1.1	[0.7,1.7]	19.6	[17.8,21.5]
Post-graduate completed	12.8	[10.7,15.2]	2.8	[1.6,4.6]	0.9	[0.4,2.4]	16.5	[14.0,19.3]
Occupation	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
Student	14.8	[13.2,16.6]	0.8	[0.5,1.2]	0.3	[0.2,0.6]	15.8	[14.2,17.6]
Government Employee	17.4	[14.9,20.3]	6.7	[5.1,8.8]	1.9	[1.1,3.4]	26.1	[23.2,29.2]
Non-government Employee	16.9	[15.3,18.6]	10.4	[8.7,12.3]	2.7	[2.0,3.8]	30.0	[27.7,32.5]
Daily Wage/Casual Labourer	15.3	[14.2,16.5]	11.4	[10.4,12.4]	3.5	[3.0,4.1]	30.2	[28.7,31.7]
Self-employed	14.9	[13.8,16.2]	11.7	[10.7,12.7]	3.1	[2.7,3.7]	29.7	[28.2,31.4]
Homemaker	12.4	[11.6,13.3]	3.5	[3.1,4.1]	1.9	[1.6,2.3]	17.9	[16.9,18.9]
Retired	9.1	[7.2,11.6]	6.3	[4.1,9.5]	2.6	[1.2,5.7]	18.0	[14.7,22.0]
Unemployed able to work	14.6	[11.9,17.8]	6.5	[4.6,9.2]	2.8	[1.7,4.6]	23.9	[20.3,28.0]
Unemployed unable to work	10.7	[8.5,13.2]	7	[5.2,9.4]	3.4	[2.1,5.4]	21.1	[18.2,24.4]
Knowledge of adverse health impact of SLT use	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
No	11.5	[8.3,15.7]	7.7	[5.6,10.4]	3.7	[2.2,6.1]	22.9	[18.6,27.8]
Partial	15.2	[14.1,16.3]	9	[8.2,9.9]	3.4	[2.9,3.9]	27.5	[26.1,29.0]
Full	14	[13.4,14.8]	6.8	[6.4,7.3]	2.2	[2.0,2.4]	23.1	[22.2,24.0]

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Caste								
Others	14.2	[13.2,15.2]	6.1	[5.5,6.9]	2.6	[2.2,3.0]	22.9	[21.6,24.3]
Scheduled Castes	12.3	[11.1,13.5]	8.4	[7.5,9.3]	2.6	[2.2,3.0]	23.2	[21.8,24.6]
Scheduled Tribes	14.3	[12.7,16.0]	8.5	[7.2,9.5]	2.8	[2.1,3.3]	25.6	[23.0,27.5]
Oother Backward Castes	15.1	[14.2,16.1]	7.3	[6.8,7.9]	2.3	[2.0,2.6]	24.7	[23.5,25.9]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Religion	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
Hindu	13.6	[12.9,14.3]	7.3	[6.9,7.8]	2.3	[2.1,2.6]	23.2	[22.3,24.1]
Muslim	19	[17.2,20.9]	8.5	[7.3,9.9]	3.3	[2.8,4.0]	30.8	[28.4,33.2]
Christian	16.2	[13.6,19.1]	3.5	[2.8,4.4]	2.3	[1.4,3.7]	21.9	[18.9,25.3]
Others	8.4	[6.5,10.7]	4.1	[2.7,6.0]	1.7	[1.0,3.1]	14.1	[11.4,17.4]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Wealth Quintile	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
Poorest	12.1	[11.1,13.1]	9.6	[8.8,10.4]	3.1	[2.7,3.6]	24.7	[23.4,26.2]
Poorer	13.7	[12.8,14.8]	8.6	[7.8,9.4]	2.9	[2.5,3.4]	25.2	[23.9,26.6]
Middle	14.6	[13.5,15.8]	8.2	[7.3,9.2]	2.4	[1.9,2.9]	25.2	[23.7,26.8]
Richer	16.1	[14.8,17.5]	5.4	[4.7,6.1]	2.0	[1.5,2.6]	23.4	[21.9,25.0]
Richest	15.7	[14.3,17.3]	2.7	[2.2,3.3]	1.1	[0.8,1.6]	19.5	[18.0,21.1]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Place of Residence	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
Urban	15.7	[14.6,16.9]	6.1	[5.4,6.8]	2.0	[1.7,2.4]	23.8	[22.3,25.4]
Rural	13.5	[12.7,14.2]	7.9	[7.4,8.5]	2.7	[2.4,3.0]	24.1	[23.1,25.0]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Region	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
North	5.6	[4.9,6.4]	2.0	[1.4,2.8]	0.4	[0.3,0.6]	8.0	[7.0,9.1]
Central	13.6	[12.5,14.8]	11.1	[10.2,12.1]	2.6	[2.2,3.2]	27.3	[25.9,28.8]
East	10.1	[8.9,11.6]	6.1	[5.4,6.9]	2.4	[2.0,3.0]	18.7	[17.1,20.4]
Northeast	39.9	[37.8,42.0]	11.9	[10.8,13.2]	9.6	[8.6,10.7]	61.4	[59.3,63.5]
West	15.7	[13.8,17.8]	8.3	[7.0,9.8]	2.3	[1.6,3.2]	26.3	[23.3,29.5]
South	17.3	[15.8,18.8]	3.9	[3.3,4.6]	1.9	[1.6,2.3]	23.1	[21.4,24.9]

Chi² p-value <0.001

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Table 5. Multinomial Regression Analysis showing Determinants of Areca Nut Use, India GATS 2016-17

Background Variables	Areca nut use without tobacco only				Areca nut use with tobacco only				Dual use			
	RRR	95%CI		p-value	RRR	95%CI		p-value	RRR	95%CI		p-value
Age												
15-18 (ref.)	1.00				1.00				1.00			
19-23	0.91	0.81	1.02	0.106	1.73	1.33	2.25	<0.001	1.53	1.03	2.26	0.034
24-30	0.92	0.81	1.04	0.202	2.37	1.83	3.08	<0.001	2.26	1.54	3.33	<0.001
31-40	0.92	0.81	1.04	0.191	2.71	2.08	3.52	<0.001	2.72	1.84	4.03	<0.001
41-50	0.91	0.80	1.04	0.159	2.42	1.85	3.16	<0.001	2.59	1.74	3.86	<0.001
51-60	0.77	0.67	0.89	<0.001	2.14	1.62	2.81	<0.001	2.53	1.68	3.80	<0.001
60+	0.65	0.56	0.75	<0.001	2.04	1.54	2.70	<0.001	2.36	1.55	3.58	<0.001
Sex												
Female (ref.)	1.00				1.00				1.00			
Male	1.13	1.07	1.20	<0.001	2.02	1.85	2.21	<0.001	1.81	1.72	1.92	0.001
Marital Status												
Married (ref.)	1.00				1.00				1.00			
Unmarried	0.94	0.86	1.02	0.16	1.06	0.93	1.20	0.382	1.12	0.92	1.36	0.273
Widowed/Separated/Divorced	1.37	1.24	1.50	<0.001	1.62	1.42	1.83	<0.001	1.59	1.35	1.88	<0.001
Education												
No formal education (ref.)	1.00				1.00				1.00			
<Primary completed	1.23	1.14	1.34	<0.001	1.01	0.91	1.12	0.867	0.93	0.80	1.08	0.318
Primary completed	1.20	1.11	1.30	<0.001	1.06	0.96	1.17	0.264	0.82	0.70	0.96	0.016
<Secondary completed	1.37	1.27	1.48	<0.001	0.99	0.89	1.09	0.774	0.90	0.77	1.05	0.177
Secondary completed	1.23	1.13	1.34	<0.001	0.79	0.70	0.89	<0.001	0.75	0.62	0.91	0.003
Higher Secondary completed	1.23	1.11	1.35	<0.001	0.74	0.64	0.86	<0.001	0.74	0.59	0.93	0.011
College/University completed	1.18	1.06	1.31	0.003	0.53	0.44	0.63	<0.001	0.53	0.40	0.71	<0.001
Post-graduate completed	1.18	1.02	1.36	0.023	0.35	0.25	0.48	<0.001	0.43	0.27	0.68	<0.001
Occupation												
Student (ref.)	1.00				1.00				1.00			
Government Employee	1.15	0.99	1.34	0.06	3.43	2.49	4.73	<0.001	2.56	1.63	4.00	<0.001
Non-government Employee	1.59	1.39	1.81	<0.001	4.87	3.64	6.53	<0.001	4.17	2.75	6.30	<0.001
Daily Wage/Casual Labourer	1.65	1.46	1.87	<0.001	4.51	3.40	5.99	<0.001	3.95	2.66	5.87	<0.001
Self-employed	1.30	1.15	1.47	<0.001	4.34	3.27	5.75	<0.001	2.87	1.94	4.27	<0.001

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Homemaker	1.26	1.11	1.42	<0.001	2.61	1.95	3.49	<0.001	2.11	1.42	3.13	<0.001
Retired	0.95	0.77	1.17	0.604	2.28	1.56	3.33	<0.001	2.21	1.29	3.77	0.004
Unemployed able to work	0.91	0.76	1.08	0.287	2.91	2.09	4.05	<0.001	2.04	1.28	3.25	0.003
Unemployed unable to work	1.24	1.01	1.52	0.039	2.56	1.79	3.67	<0.001	2.49	1.51	4.09	<0.001
Knowledge of adverse health impact of SLT use												
No (ref.)	1.00				1.00				1.00			
Partial	1.37	1.13	1.66	0.001	1.36	1.06	1.76	0.017	1.60	1.12	2.28	0.009
Full	1.22	1.01	1.48	0.056	1.04	0.81	1.34	0.759	1.23	0.87	1.74	0.249
Caste												
Others (ref.)	1.00				1.00				1.00			
Scheduled Castes	1.05	0.97	1.13	0.197	1.17	1.05	1.29	0.004	1.25	1.07	1.46	0.005
Scheduled Tribes	1.11	1.02	1.20	0.016	0.96	0.85	1.08	0.459	0.91	0.77	1.08	0.295
Oother Backward Castes	0.95	0.89	1.01	0.087	0.96	0.88	1.05	0.346	0.80	0.70	0.92	0.001
Religion												
Hindu (ref.)	1.00				1.00				1.00			
Muslim	1.35	1.26	1.45	<0.001	1.22	1.11	1.35	<0.001	1.41	1.22	1.63	<0.001
Christian	0.83	0.77	0.91	<0.001	0.59	0.52	0.68	<0.001	0.58	0.49	0.69	<0.001
others	0.61	0.55	0.68	<0.001	0.50	0.42	0.60	<0.001	0.36	0.27	0.47	<0.001
Wealth Quintile												
Poorest (ref.)	1.00				1.00				1.00			
Poorer	0.94	0.88	1.00	0.062	0.96	0.88	1.04	0.321	1.11	0.98	1.25	0.097
Middle	1.02	0.95	1.11	0.573	0.97	0.88	1.08	0.628	1.00	0.85	1.17	0.964
Richer	1.03	0.96	1.12	0.403	0.79	0.70	0.89	<0.001	0.79	0.66	0.95	0.01
Richest	1.04	0.94	1.15	0.305	0.54	0.46	0.63	<0.001	0.83	0.67	1.03	0.096
Place of Residence												
Urban (ref.)	1.00				1.00				1.00			
Rural	0.94	0.90	0.99	0.024	0.94	0.87	1.01	0.092	1.07	0.95	1.20	0.262
Region												
North (ref.)	1.00				1.00				1.00			
Central	2.28	2.07	2.51	<0.001	6.08	5.26	7.04	<0.001	6.45	4.78	8.71	<0.001
East	2.01	1.82	2.22	<0.001	3.38	2.90	3.95	<0.001	6.25	4.64	8.44	<0.001
Northeast	11.85	10.84	12.95	<0.001	14.81	12.77	17.18	<0.001	51.51	38.90	68.23	<0.001
West	3.40	3.10	3.73	<0.001	4.84	4.14	5.65	<0.001	5.85	4.26	8.03	<0.001
South	3.67	3.37	4.01	<0.001	2.29	1.95	2.68	<0.001	6.14	4.57	8.25	<0.001

Note: Ref- Reference

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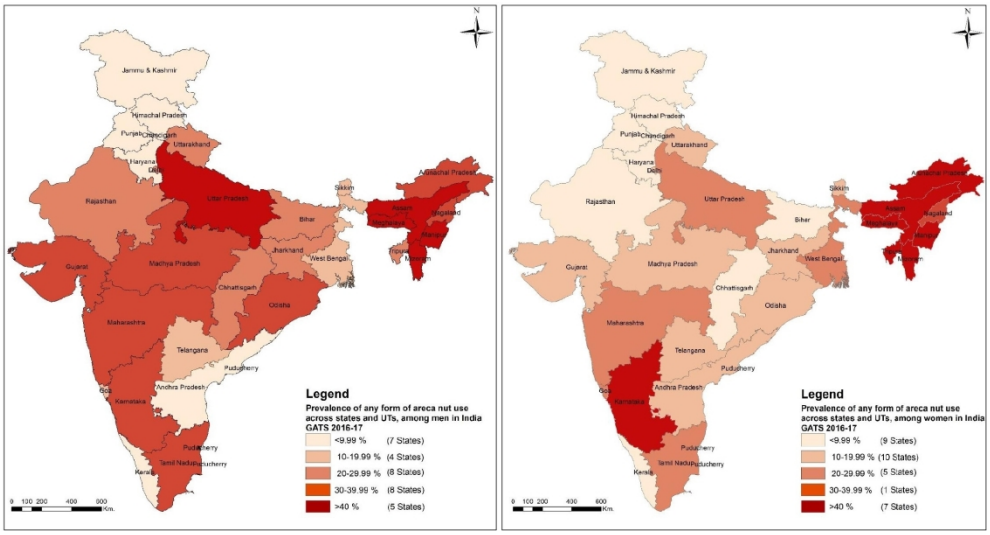

Figure 1: Geographical variation in areca nut use among adult men and women in India

591x312mm (96 x 96 DPI)

Supplementary Table 1. Sample Description of the Study Population

Background Variables	*N*	%	Background Variables	*N*	%
Age			**Knowledge of Adverse Health Impact of Smokeless Tobacco Use**		
15-18	4641	10.5	No	1051	1.4
19-23	7161	13.8	Partial	14459	20.5
24-30	13867	18.2	Full	58527	78.1
31-40	18839	21.0	**Caste**		
41-50	13245	15.3	Others	21734	26.8
51-60	8531	10.8	SCs	12854	19.1
60+	7753	10.4	STs	12128	8.9
Sex			OBCs	27321	45.3
Female	40265	48.9	**Religion**		
Male	33772	51.1	Hindu	54015	80.3
Marital Status			Muslim	8785	14.2
Married	56984	70.1	Christian	7111	2.3
Unmarried	11951	23.0	others	4126	3.1
Widowed/Separated/Divorced	5102	6.9	**Wealth Quintile**		
Education			Poorest	15547	23.4
No formal Education	18473	26.4	Poorer	18685	26.3
<Primary completed	7510	9.2	Middle	11278	16.8
Primary completed	8858	11.3	Richer	14814	19.6
<Secondary completed	12109	16.9	Richest	13713	13.8
Secondary completed	10331	14.1	**Place of Residence**		
Higher Secondary completed	7959	11.2	Urban	26488	34.5
College/University completed	6096	7.8	Rural	47549	65.5
Post-graduate completed	2642	3.1	**Region**		
			North	17128	8.7
Occupation			Central	11518	29.1
Student	6134	11.9	East	9834	21.7
Government Employee	3355	2.7	Northeast	13574	3.7
Non-government Employee	6259	8.3	West	7901	15.0
Daily Wage/Casual Labourer	13749	21.2	South	14082	21.8
Self-employed	13955	19.4			
Homemaker	25833	30.1			
Retired	1679	2.1			
Unemployed able to work	1572	1.9			
Unemployed unable to work	1471	2.3			
Don't know or refused	30	0.0			

All *N* are unweighted

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Supplementary Table 2. Prevalence (in %) of Areca Nut Use in Different Forms across States & Union Territories of India, GATS 2016-17

States/UTs	*Pan Masala* without Tobacco	*Pan Masala* with Tobacco	Betel Quid without Tobacco	Betel Quid with Tobacco	*Gutka*, Areca Nut-Tobacco Lime Mixture, or *Mawa*	Areca Nut of Any Type
North						
Jammu & Kashmir	0.2	0.2	0.3	0.8	0.4	0.2
Himachal Pradesh	0.7	0.1	0.4	0.0	0.5	0.6
Punjab	0.5	0.2	0.3	0.4	2.3	0.4
Chandigarh	0.5	0.4	0.6	0.9	1.0	1.2
Uttarakhand	3.1	3.1	8.6	2.7	2.2	10.8
Haryana	1.3	0.4	0.5	1.1	2.5	1.4
Delhi	4.9	1.3	8.3	2.6	3.0	7.6
Central						
Rajasthan	3.5	4.6	1.4	4.0	9.0	6.1
Uttar Pradesh	7.0	7.2	12.8	10.2	11.5	7.6
Chhattisgarh	6.1	1.8	2.1	2.0	7.8	3.4
Madhya Pradesh	3.8	4.4	2.4	4.1	13.7	6.7
East						
West Bengal	4.8	2.2	5.7	6.4	2.9	11.6
Jharkhand	7.4	1.1	1.2	4.9	8.3	2.0
Odisha	11.1	8.6	4.9	8.6	9.4	5.5
Bihar	5.2	1.4	1.5	3.4	3.7	2.3
North-East						
Sikkim	4.7	0.5	5.4	2.6	1.2	7.0
Arunachal Pradesh	11.5	4.7	13.6	14.9	18.9	5.1
Nagaland	8.7	21.1	8.8	17.5	9.4	2.2
Manipur	7.9	4.2	23.1	38.6	2.7	1.1
Mizoram	4.0	0.8	55.1	4.3	4.0	5.9
Tripura	6.4	10.4	8.3	39.5	2.5	22.6
Meghalaya	10.7	2.5	64.9	12.0	2.4	3.8
Assam	10.9	2.9	46.6	19.0	8.2	11.9
West						
Gujarat	3.5	1.4	4.9	1.1	12.8	4.7
Maharashtra	6.6	1.7	6.7	3.7	8.6	17.0
Goa	7.2	1.3	9.6	2.7	2.6	11.0
South						
Andhra Pradesh	0.3	0.2	4.9	2.4	1.9	5.6
Telangana	2.9	1.1	3.1	3.9	2.9	8.0
Karnataka	4.7	0.7	27.8	9.4	5.9	8.3

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Kerala	1.2	0.4	2.1	4.4	0.7	0.9
Tamil Nadu	0.2	0.1	18.6	6.0	0.7	19.1
Puducherry	0.8	0.1	7.7	3.4	0.7	15.1
India	**4.8**	**2.8**	**8.7**	**5.8**	**6.8**	**8.0**

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Supplementary Table 3. Prevalence (in %) of Areca Nut Use in Different Forms by Urban and Rural area Across States & Union Territories of India, GATS 2016-17

	Urban				Rural			
States/UTs	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**
North								
Jammu & Kashmir	1.2	0.7	0.0	1.8	0.1	0.9	0.0	1.1
Himachal Pradesh	3.3	1.6	0.0	4.9	1.0	0.2	0.0	1.2
Punjab	1.3	3.7	0.3	5.3	0.8	0.8	0.1	1.7
Chandigarh	1.7	1.6	0.1	3.5	1.9	0.0	0.0	1.9
Uttarakhand	19.8	4.2	1.4	25.4	16.3	3.6	1.2	21.0
Haryana	3.0	4.7	0.4	8.2	2.3	0.8	0.1	3.3
Delhi	15.9	2.0	1.0	18.9	3.4	2.1	0.0	5.5
Central								
Rajasthan	9.1	8.8	1.2	19.0	7.0	5.6	1.4	14.0
Uttar Pradesh	26.0	9.2	3.2	38.4	15.7	13.5	3.5	32.7
Chhattisgarh	10.6	12.4	1.5	24.5	7.6	5.6	1.0	14.2
Madhya Pradesh	11.9	12.3	2.7	26.9	7.1	13.9	1.8	22.9
East								
West Bengal	8.2	2.4	2.8	13.4	16.3	5.1	4.3	25.7
Jharkhand	7.8	7.7	0.8	16.3	8.4	8.4	1.2	18.0
Odisha	13.5	13.3	1.6	28.4	10.8	11.1	5.5	27.4
Bihar	4.3	5.7	0.4	10.4	7.4	4.9	0.5	12.8
North-East								
Sikkim	13.3	1.3	0.3	15.0	10.7	1.6	0.9	13.2
Arunachal Pradesh	18.1	13.3	4.4	35.8	17.1	20.3	3.4	40.9
Nagaland	10.6	15.2	7.0	32.7	9.2	15.1	5.2	29.4
Manipur	27.0	18.7	4.2	49.9	21.7	22.4	7.1	51.2
Mizoram	51.5	0.3	6.0	57.8	54.7	1.3	2.3	58.4
Tripura	12.5	19.9	10.4	42.8	15.0	15.8	15.6	46.5
Meghalaya	52.6	1.9	4.4	58.9	66.3	1.5	6.4	74.2
Assam	37.5	11.1	8.5	57.1	47.2	11.5	11.0	69.7
West								
Gujarat	10.4	10.0	1.3	21.7	6.5	12.0	1.0	19.5
Maharashtra	22.0	7.6	3.2	32.8	17.5	6.3	2.6	26.4
Goa	16.2	1.3	0.6	18.1	19.3	1.3	2.2	22.7
South								
Andhra Pradesh	8.3	0.8	0.6	9.8	5.9	1.5	1.4	8.9
Telangana	10.7	2.8	2.5	16.0	7.3	2.8	1.6	11.8
Karnataka	26.6	6.3	2.9	35.8	30.3	8.7	5.3	44.2
Kerala	2.4	1.8	0.5	4.7	3.7	3.5	0.4	7.6
Tamil Nadu	26.1	1.1	0.6	27.7	24.9	6.6	1.7	33.2
Puducherry	13.5	0.8	0.7	15.0	27.3	4.5	3.2	34.9

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India	**15.7**	**6.1**	**2.0**	**23.8**	**13.5**	**7.9**	**2.7**	**24.1**

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Supplementary Table 4. Prevalence (in %) of Areca Nut Use in Different Forms by sex Across States & Union Territories of India, GATS 2016-17

	Female				Male			
States/UTs	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**
North								
Jammu & Kashmir	0.3	0.2	0.1	0.6	0.6	1.5	0.0	2.1
Himachal Pradesh	0.1	0.0	0.0	0.1	2.3	0.6	0.1	3.0
Punjab	1.1	0.1	0.1	1.2	0.9	3.7	0.2	4.8
Chandigarh	2.0	0.4	0.0	2.4	1.6	2.6	0.1	4.3
Uttarakhand	16.3	1.1	0.0	17.4	18.7	6.4	2.5	27.6
Haryana	2.3	0.6	0.1	3.0	2.9	3.9	0.4	7.2
Delhi	11.9	1.0	0.3	13.2	18.9	2.8	1.6	23.3
Central								
Rajasthan	4.9	2.4	0.1	7.4	10.1	10.4	2.5	23.0
Uttar Pradesh	14.3	4.8	1.5	20.6	21.9	19.5	5.3	46.7
Chhattisgarh	4.2	1.8	0.2	6.2	12.5	13.1	2.1	27.7
Madhya Pradesh	4.9	5.5	1.7	12.1	12.0	20.9	2.5	35.3
East								
West Bengal	13.9	3.5	5.8	23.2	13.0	4.7	1.8	19.4
Jharkhand	9.0	0.6	0.5	10.1	7.6	15.5	1.6	24.7
Odisha	9.1	4.7	5.9	19.6	13.5	18.4	3.7	35.6
Bihar	2.6	0.4	0.1	3.2	11.0	9.3	0.9	21.1
North-East								
Sikkim	13.1	0.5	0.5	14.1	10.1	2.5	0.9	13.5
Arunachal Pradesh	27.6	10.2	4.8	42.6	7.8	26.3	2.6	36.8
Nagaland	8.5	17.3	5.1	30.9	10.7	13.1	6.4	30.2
Manipur	22.3	27.4	4.8	54.5	25.0	14.7	7.3	46.9
Mizoram	47.4	1.4	6.7	55.5	58.4	0.2	2.1	60.6
Tripura	19.4	21.7	20.6	61.6	9.4	12.6	7.7	29.7
Meghalaya	60.3	1.7	10.4	72.4	66.2	1.4	1.5	69.1
Assam	45.6	13.3	11.1	69.9	45.6	9.7	10.1	65.4
West								
Gujarat	5.4	3.9	0.9	10.2	11.0	17.7	1.4	30.1
Maharashtra	23.3	2.4	3.0	28.6	16.2	11.2	2.8	30.2
Goa	20.9	0.4	1.4	22.6	13.8	2.1	0.9	16.8
South								
Andhra Pradesh	10.0	1.8	2.2	14.0	3.4	0.8	0.1	4.3
Telangana	5.8	3.1	2.8	11.6	11.7	2.6	1.2	15.5
Karnataka	38.9	2.4	4.8	46.2	18.7	12.8	3.7	35.3
Kerala	1.8	2.4	0.6	4.8	4.4	2.9	0.3	7.6
Tamil Nadu	20.8	4.5	1.3	26.5	30.4	3.0	1.1	34.4
Puducherry	14.1	2.3	2.3	18.7	21.5	1.5	0.5	23.4
India	**13.2**	**3.4**	**2.3**	**18.9**	**15.2**	**11.0**	**2.6**	**28.8**

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	2	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	5	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	6	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	6	Present key elements of study design early in the paper	6-7
Setting	6	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	6	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-9*
Bias	8	Describe any efforts to address potential sources of bias	6
Study size	9	Explain how the study size was arrived at	6
Quantitative variables	8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	9-10	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	10-10
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	

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Results			**Page no**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	12-14
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-14
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N.A.
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-18
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Areca nut consumption with and without tobacco among the adult population: a nationally representative study from India

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Areca nut consumption with and without tobacco among the adult population: a nationally representative study from India

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Areca nut consumption with and without tobacco among the adult population: a nationally representative study from India

Abstract

Objective: Areca nut is one of the most widely consumed substances globally, after nicotine, ethanol and caffeine and classified as carcinogenic to humans. This study examines the disparity and determinants of areca nut consumption with and without tobacco in India.

Design: Nationally representative cross-sectional study.

Participants: We utilized the nationally representative Global Adult Tobacco Survey (GATS) 2016-17. The analytical sample size was 74,037 individual's aged 15 years and above with a response rate of 92.9%.

Measures: Current consumption of areca nut without tobacco and with tobacco.

Method: We examined determinants of areca nut consumption (without tobacco and with tobacco) using multinomial logistic regression, accounting for the survey design.

Results: About 23.9% (95%CI 23.1-24.8) of the adult population consume areca nut, i.e. approximately 223.79 million people in India; majority of users (14.2% 95%CI 13.5-14.9) consumed areca nut with tobacco. When compared to females, males were more likely to consume areca nut (with tobacco RR=2.02; 95%CI 1.85-2.21 and without tobacco RR=1.13; 95%CI 1.07-1.20). Age, marital status, education, occupation, caste, religion and region were significantly associated with areca nut consumption. However, the direction and magnitude of association differs with respect to the areca nut consumption with and without tobacco.

Conclusion: The on-going tobacco control efforts would not address the majority of areca nut users until greater attention to areca nut consumption with and without tobacco is reflected in health policies in India.

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Key words: Areca nut, smokeless tobacco, GATS, India

Strengths and Limitations of this study

- Using a nationally representative survey with a high response rate, this study disentangled the current prevalence of areca nut consumption with and without tobacco in India, which has significant policy implications.
- The study provided detailed information on socioeconomic determinants of areca nut consumption, with and without tobacco, and separately for men and women, which may further guide future policy
- The survey covers only people 15 years and older, whereas areca nut consumption often starts at younger age.
- The survey cannot provide insights into trends of Areca nut consumption over time.

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Introduction

Areca nut is one of the most widely consumed substances globally, after nicotine, ethanol and caffeine[1,2]. Owing to its addictive properties, areca nut is estimated to be consumed by hundreds of millions of people across various countries [3]. However, addiction to areca nut is primarily prevalent in many Asia-Pacific countries and by emigrants from these countries in other parts of world [3]. It is not only known by several, sometimes local names, but also consumed in several forms e.g. pan masala, gutkha, mawa, dohra, kharra, betel etc. with or without tobacco[4,5]. Some forms of consumption may also include other constituents, such as betel leaf, slaked lime and various spices.

The International Agency for Research on Cancer (IARC) classified area nut consumption with or without tobacco as carcinogenic to humans[6]. A meta-analysis based on 50 studies worldwide reported increased relative risks for cancer of the oral cavity and oropharynx for the Indian subcontinent and areca nut consumption with tobacco (Relative Risk 7.03; 95%CI, 4.68–10.56) and areca nut consumption without tobacco (Relative Risk 3.22; 95%CI, 2.11–4.92) [7]. A global systematic review based on 62 studies concluded that consumption of areca nut affects almost all organs of the human body, including the brain, heart, lungs, gastrointestinal tract and reproductive organs; and causes or aggravates pre-existing conditions such as neuronal injury, myocardial infarction, cardiac arrhythmias, hepatotoxicity, asthma, central obesity, type II diabetes, hyperlipidemia, metabolic syndrome[8]. It has harmful effects on the foetus when used during pregnancy[8]. Previous studies observed that areca nut dependency among users [9] and its withdrawal effects [10] were similar to those observed among nicotine users [10]. It is also a gateway product in children who start using different kinds of areca nut products at an early age [11].

Despite growing scientific evidence of high addictiveness and several ill effects(8-11) associated with areca nut consumption, research on areca nut has not received much

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attention[3]. The large global and national movement that addresses tobacco control under the ambit of the WHO Framework Convention on Tobacco Control (FCTC) has focused primarily on smoking and has been less effective in controlling smokeless tobacco (SLT) [12]. The regulatory framework for areca nut control has also remained limited to prescribing health warnings on areca nut products by the Food Safety and Standard Authority of India (FSSAI). Further, use of tobacco and nicotine as an ingredient in any food item is also prohibited under FSSA regulations, thereby restricting mixing of tobacco in areca nut products and vice-versa[1]. Although tobacco control policies are applicable to areca nut products which contain tobacco a considerable number of people now consume areca nut without tobacco, which poses greater public health challenges in controlling and regulating the substance [13].

A comprehensive search of the literature revealed that studies on areca nut use in India lack representativeness and published studies were restricted to a specific geographical area or population groups. None of the published studies have examined diverse habits of areca nut consumption, its disparity and determinants using a nationally representative survey. Also, a recent global review calls for more research to better understand the epidemiology of areca nut consumption across different populations and geographies [3].

India, with a population of over 1.30 billion, exhibits one of the highest socioeconomic and demographic heterogeneities ever experienced anywhere in the world at the regional level[14]. There is considerable evidence of marked regional inequities in tobacco use[15], health and healthcare [16]and mortality outcomes [17]in India. These differences are primarily the outcome of differences in community-level development, population composition, state health expenditure, poverty levels, status of women, and availability, accessibility and affordability of maternal and child health care services and their utilization [18–20].

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While India's share to overall areca nut production and consumption remains at the top in the world, no attempts have been made to explore the patterns and determinants of the consumption of areca nut based on large scale representative surveys. This study aims to examine the disparity and determinants of areca nut consumption, with and without tobacco using the nationally-representative Global Adult Tobacco Survey (GATS) conducted in 2016-17.

Methods and materials

Study Design and Participants

We utilized the nationally representative cross-sectional Global Adult Tobacco Survey (GATS) 2016-17, conducted in all 29 states and three Union Territories (UTs) of India [21]. The study included whole GATS sample of 74,037 adults aged 15 and above. A multi-stage sampling design separately for rural and urban areas was adopted to draw a representative sample considering the 2011 census population figures. The person level response rate was 96.0 percent (95.6% in urban areas and 96.3% in rural areas). The overall response rate, calculated as the product of response rates at the household and person level, was 92.9 percent.

The sampling was done independently in each state/UT; and within the state/UT, it was done independently for urban and rural areas. In urban areas, a three stage sampling process was adopted. At the first level, the list of all the wards from all cities and towns of the state/ UT constituted the urban sampling frame, from which a required sample of wards (Primary Sampling Units - PSUs) was selected using probability proportional to size (PPS) sampling. At the second level, a list of all census enumeration blocks (CEBs) in each selected ward constituted the sampling frame from which one CEB was selected by PPS from each ward. At

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the third level, a list of all residential households in each selected CEB constituted the sampling frame, from which a sample of required number of households was selected.

In rural areas, a two stage sampling process was adopted. At the first stage of sampling, all villages in the state/UT formed the sampling frame. All small villages having less than five households were removed from the sampling frame. Villages with five to 49 households as per Census of India, 2011 were linked with the neighbouring larger villages. The required number of PSUs (villages) within each stratum was selected according to PPS sampling. At the second stage, a list of all residential households in each selected village constituted the sampling frame, from which a sample of the required number of households was selected.

A household listing operation was carried out in each sample area. All large villages with 300 or more households were segmented into three or more segments (depending on village size) of almost equal proportions, each being about 100-200 households. From all the segments in each large village, two segments were selected by using PPS sampling. Thirty households (plus three more, accounting for non-response) were selected from the list of households by systematic random sampling. The 33 selected households in a PSU were divided into two groups: 1) households for interview of a male member, and 2) households for interview of a female member; this was in proportion to the total sample size of male and female interviews in a state. From the total number of male/ female members aged 15 or above in a household, one member was randomly selected for the interview.

Further details related to survey methodology, sampling design, household and individual selection, data collection, management and monitoring procedures have been described elsewhere[21].

Dependent variables

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The outcome variable was current consumption of areca nut use, assessed based on the following questions covered in the GATS:

i. Do you consume *pan masala* without tobacco? (response options: yes, no and refused)
ii. Do you consume betel quid without tobacco? (response options: yes, no and refused)
iii. Do you consume areca nut of any type, plain, powdered or flavoured? (response options: yes, no and refused)
iv. Betel quid with tobacco? (response: on average, how many times a day do you use)
v. *Gutka*, areca nut-tobacco lime mixture, or *mawa*? (response: on average, how many times a day do you use)
vi. *Pan masala* with tobacco? (response: on average, how many times a day do you use)

Based on the above-mentioned questions asked in GATS, we constructed three sets of variables: (i) areca nut consumption only without tobacco, (ii) areca nut consumption only with tobacco and (iii) areca nut consumption with and without tobacco, dual use. Definition of specific products can be found with the GATS 2 national report[22].

Independent variables

A range of socioeconomic (education, occupation, caste, religious affiliation and wealth quintile), demographic (age, sex, marital status,), awareness related and contextual level variables included in this study which were found to be associated with areca nut consumption in previous studies [23–27]. These variables include age (categorised as 15-18, 19-23, 24-30, 31-40, 41-50, 51-60 and 60+) and sex as male and female. Individual's education was measured as: (i) no formal education, (ii) below primary, (iii) primary completed, (iv) below secondary, (v) secondary completed, (vi) completed higher secondary, (vii) completed college/university and (viii) completed post-graduate level. Individual's

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occupation on the other side was assessed based on self-reported information as (i) student, (ii) government sector, (iii) non-government sector, (iv) casual/ daily labourer, (v) self-employed, (vi) homemaker, (vii) retired and (viii) unemployed.

A wealth index was calculated based on availability of electricity, flush toilet, radio, television, fixed telephone or cell phone, refrigerator, washing machine, moped/scooter/motorcycle and car using Principle Component Analysis (PCA) methodology[28]. There are various ways to assign weighting values to the indicator variables. Ad hoc weights, such as assigning "1" for a bicycle, "3" for a motorcycle, and "5" for a car or truck, work to a certain extent, but they are arbitrary and are difficult to assign when the wealth ordering is not readily apparent. For this reason, Filmer and Pritchett recommended using principal components analysis (PCA) to assign the indicator weights, the procedure that is used for the wealth index[29]. This procedure first standardizes the indicator variables (calculating z scores); then the factor coefficient scores (factor loadings) are calculated; and finally, for each household, the indicator values are multiplied by the loadings and summed to produce the household's index value. In this process, only the first of the factors produced is used to represent the wealth index. The resulting sum is itself a standardized score with a mean of zero and a standard deviation of one[28]. Individuals were divided into five wealth quintiles based on their household score ranges from 1 being poorest to 5 being wealthiest, with each category representing 20 percent of the score[28].

A composite knowledge variable which measures the poor health impact of smokeless tobacco use was constructed based on the following information asked in the survey: smokeless tobacco causes serious illness (yes/no), smokeless tobacco cause oral cancer (yes/no), smokeless tobacco cause dental diseases (yes/no), smokeless tobacco cause harm to fetus during pregnancy (yes/no), and do you think smokeless tobacco leads to addiction (yes/no). The new knowledge variable was categorised as: (i) 'no, to all five awareness' (ii)

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'no, to at least one awareness' and (iii) 'yes, to all five awareness'.

Caste (social group) as categorised based on individual's self-reporting as Scheduled Castes (SCs), Scheduled Tribes (STs), Other Backward Classes (OBCs) and others. This broad categorization of caste is based on their socioeconomic disadvantage in education, health, nutrition, and employment by federal government. For instance, a study has shown that as compared to other caste, children (age 2-5 years) and adolescents (age 6-18 years) belonging to scheduled tribes had the greatest risk of mortality (OR = 1.94, 95% CI = 1.47, 2.57), followed by those from scheduled castes (OR = 1.35, 95% CI = 1.05, 1.74) and other backward classes (OR = 1.33, 95% CI = 1.05,1.67) [17]. Other studies have also shown lower enrolment and completion of education among scheduled castes and scheduled tribes due to various factors [30,31]. Religion captures self-reported follower/believer of Hinduism, Islam, Christianity and others (which mainly include Sikhs, Jains, Buddhists and non-believers). The study also considered place of residence as rural and urban as well as all 29 states and three UTs in the analysis.

Analytical strategy

At first, prevalence of areca nut consumption with and without tobacco at national and sub-national levels along with rural-urban and male-female differences was analyzed. Chi-squared (x^2) tests were performed to examine whether variations in areca nut consumption across independent variables were statistically significant. To examine the associated between areca nut consumption with various socioeconomic and demographic characteristics, multinomial logistic regression was used. In the multinomial logit regression, it is assumed that log odds of outcome/dependent variable either follow linear form or non-binary form; each outcome/dependent variable is modelled relative to the baseline group or outcome[32]. In this study, we have considered (i) 'non-areca nut user (baseline group)', (ii) 'areca nut consumption only with tobacco', (iii) areca nut consumption only without tobacco' and (iv)

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'areca nut consumption with and without tobacco, dual use'. The study reported the relative risk ratio (RRR) along with 95% confidence intervals [33]. We calculated the population burden based on GATS weighted sample population figures, which were provided in the GATS India report[22]. The analysis was adjusted for sampling weights and multistage sampling design using *syv* command in STATA. Analysis was carried out in STATA, version 15 [34]

Ethics statement

The second round of GATS obtained ethical clearance from the Ethics Committee of Tata Institute of Social Sciences[22]. No ethics clearance was required for this study, as we performed a secondary analysis using publicly available data.

Patient and public involvement

No patients were involved in the development of the research question, the outcome measures or the design of the study.

Results

Descriptive statistics

Of the 74037 respondents, 40265 (48.9%) were women and 33772 (51.1%) were men, and 47549 (65.5%) individuals resided in rural areas. One out of four respondents had no formal education and nearly 78% were aware about the adverse health effects of SLT consumption (**Supplementary table 1**).

We found that overall, betel quid without tobacco (8.7%; 95%CI 6.7-10.2) was consumed largely, followed by areca nut of any type (8%; 95%CI 5.9-10.3) at the national level (**Table 1**). Among men, the prevalence of *gutka,* areca nut-tobacco lime mixture or *mawa* was consumed the most (17.8%; 95%CI 15.1-20.2), whereas, among women, betel quid without tobacco was largely consumed (9.0%; 95%CI 6.1-11.9). In urban areas, both betel quid

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without tobacco and areca nut of any type were largely consumed, while in the rural areas it was mainly betel quid without tobacco. Regional pattern suggests that betel quid with tobacco were predominately consumed in many north-eastern states, while betel quid without tobacco was mainly used in south (**Supplementary table 2**).

Regional disparity in areca nut consumption

We found 23.9 (95%CI 23.1-24.8) adults were consuming areca nut at national level and 14.2% (95%CI 13.6-14.9) were consuming areca nut without tobacco (**Table 2**). **Figure 1** shows considerable variations in areca nut consumption across states and UTs of India. In many states areca nut consumption in any form was over 40% among men (like, Uttar Pradesh, Assam Meghalaya, Mizoram, and Manipur) and women (like, Karnataka, and all north-eastern states except Nagaland). Areca nut consumption without tobacco was largely being consumed across north-eastern states, apart from other bigger states like Karnataka (28.8%; 95%CI 25.6-32.1), Tamil Nadu (25.5%; 95%CI 21.9-29.5) and Maharashtra (20%; 95%CI 17.0-22.5). Nearly 223.4 million people out of the total 932,488,000 population aged 15 and above consume areca nut in India (**Table 3**). The distribution of areca nut users both in terms of population and proportion across states were as follows: Uttar Pradesh with 49.9 million users contributes to nearly 22% of all areca nut users, followed by Maharashtra with 26.7 million users (12%), Karnataka with 19.8 million (9%) and Tamil Nadu with 17.7 million users (8%). Together, these four states share nearly 51% of all areca nut users in the country. Not much difference exists between urban and rural areas in areca nut usage patterns (**Supplementary table 3**). In 18 states/UTs, however, areca nut consumption was higher in urban areas than rural counterparts. In 13 states/UTs, the opposite pattern was evident.

Demographic and socioeconomic differences in areca nut consumption

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Consumption of areca nut in any form was higher among males as compared to females both at national level as well as in a majority of states (**Supplementary table 4**). All forms of areca nut consumption were higher in the age group 31-50 years (**Table 4**) as compared with other age categories. 28.8% men (95%CI 27.7-30.0) and 27.1% widowed/separated/divorced (95%CI 25.3-29.1) were consuming areca nut. Individuals who had completed below the primary level of schooling consumed higher proportion of areca nut. Areca nut consumption was highest among daily wage labourers (30.2%; 95%CI 28.7-31.7). We found that a high percentage of Scheduled Tribes (25.6%; 95%CI 23.0-27.5) and Muslims (30.8%; 95%CI 28.4-33.2) were consuming areca nut.

Determinants of areca nut consumption: regression analysis

Regression results suggest that as compared to 15-18 age group, the likelihood of areca nut consumption with tobacco and dual use was higher in higher age groups (**Table 5**); except that areca nut consumption without tobacco was lower among the age group 51 and above, as compared to the 15-18 age groups. Probability of areca nut consumption was higher among males as compared to females for all three forms. The likelihood of areca nut consumption without tobacco was higher across all the educational categories as compared to those who had no formal education. However, the probability of areca nut consumption with tobacco and in dual-form was declining with increase in the education level of respondents. The likelihood of areca nut consumption with tobacco and dual-use was significantly higher among Schedules Castes than Other castes. Probability of all the three forms of areca nut consumption was higher among Muslims as compared to Hindus.

Discussion

The findings of the study revealed that nearly one out of every four adults in India consumes areca nut, that is, almost 223.79 million users, making areca nut consumption a bigger public

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health challenge than use of smokeless tobacco (199 million users) in dealing with substance use and addiction in the country. The large number of users of areca nut, a known carcinogen presents a huge public health challenge for the country. Moreover, nearly 10% consume areca nut with tobacco. Thus, considering the wide range of adverse health impacts, effective implementation on banning of tobacco as an ingredient with areca nut products under regulation 2.3.4 of the Food Safety and Standards Regulation, 2011 and ban on manufacture and sale of areca nut products, as implemented in some of the states, is urgently needed [1].

We found considerable regional and socioeconomic differences in the consumption of areca nut. In four states, Meghalaya, Assam, Mizoram and Manipur, over half of the population consume areca nut. Further, Karnataka, Uttar Pradesh, Tamil Nadu, Maharashtra and Odisha, constitute nearly 55% of the country's areca nut users. As far as other determinants are concerned, the findings confirmed that age, gender, marital status, education, occupation, castes and religion are significantly associated with areca nut consumption. However, the direction of association differs with respect to areca nut consumption with and without tobacco. Cheaper and abundant availability, due to large scale domestic production of areca nut could be one of the key reasons for such high prevalence in the country.

We found protective effect of secondary and above level education in the case of areca nut consumption with and without tobacco. A study from Pakistan also observed that the consumption of areca nut users increased by grade among school children aged 4 to 16 years [27]. Areca nut consumption were higher among male than among female, a finding that is consistent with other studies conducted in Tamil Nadu and Assam in India [26,35] and countries like Thailand and Taiwan [13]. It may be because areca nut consumption results in staining of teethe which may not be liked by young and adult females. The age-wise pattern suggests that areca nut consumption without tobacco began to decline from age 51 onwards.

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But in the case of areca nut consumption with tobacco and in both forms, it increased with age.

Similar to other studies from India and other neighbouring countries [24,36], we also observed higher consumption of areca nut with tobacco among daily wage/casual labourers. This study further adds that areca nut consumption without tobacco too was largely consumed by daily wage/casual labourers, followed by non-government sector. Evidences suggests that many misconceptions including consuming areca nut improves concentration, pleasure, helps in anxiety and muscle relaxation and suppresses appetite increases the likelihood of consumption among those who are engaged in casual labour and have long working hours [23,37,38]. We found higher consumption of areca nut among STs and SCs than other caste groups. Further, Muslims were more likely to consume all three forms of areca nut as compared with Hindus. Previous studies documented higher consumption of tobacco including SLT, among SCs/STs and Muslims [25,39].

Urban-rural differences by state suggest that in 18 states, areca nut consumption was higher in urban areas than in rural areas. Regression results also revealed higher consumption of areca nut without tobacco in urban areas than rural counterparts. This is likely due to higher awareness about harms related to tobacco use in urban areas than rural counterparts. Studies from India and Pakistan documented that *pan masala* and *gutka* are very popular even in urban areas due to aggressive advertising, targeting middle class and adolescents, which improved sale many tobacco and related products including areca nut [40].

Our study had some limitations. Information related to areca nut consumption in different forms in the GATS was based on respondents self-reporting. Thus, the study cannot rule out social desirability bias – a tendency among some people to respond to questions in a way which they deem to be more acceptable than would be their 'correct' answer [41]. The nomenclature of various areca nut products in geographically diverse country like India could

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be a source of concern, which is difficult to capture in the large scale surveys. Considering the cross-sectional design of the survey, we did not examine the cause and effect relationship between socioeconomic charecterstics and areca nut consumption. Similarly, the available data did not allow us to estimate trends of areca nut usage over time, but future analyses of repeated GATS may inform on important trends. Another limitation is that the study is based on 15 years and older population, whereas the areca nut habits often start at younger age. The future Global Youth Tobacco Survey (GYTS) should have areca nut related questions similar to GATS so that detailed usage pattern of areca nut could be examined among younger population of the country.

Conclusion

It is now well established that areca nut consumption in any form is highly addictive, a well-known risk factor for oral, pharynx and oesophageal cancers and is associated with many adverse health effects. This study adds to the existing knowledge that areca nut consumption in India was much higher than the overall smokeless tobacco. Moreover, a significant proportion of areca nut was consumed along with tobacco, which elevates the adverse health impacts and co-morbidities further. Thus, it calls for urgent policy intervention to prevent both new generations from taking up areca nut consumption habit and helping current users to quit. Such policy efforts to control areca nut consumption should be guided by the huge differences in its consumption across states, gender and socioeconomic groups in India. Unlike tobacco, for which the WHO FCTC provides evidence-based policies, no global policy exists for the regulation and control of areca nut consumption and its cessation. Also, there is a need for further research and population-based interventions to find treatment for areca nut dependence. In addition, research is needed to examine the intention to quit among areca nut users, separately for all three categories - those who consumption areca nut with tobacco, without tobacco and those who consume in both the forms, to develop an

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appropriate intervention model for cessation. This information may be collected within the GATS survey by adding a few additional questions on areca nut for future analysis. Given that areca nut consumption follows a complex pattern by SES and regional trajectories, separately for with and without tobacco, future research is needed to explore the various intersections between SES and areca nut consumption in different regions of India to gain better clarity.

Contributorship statement

PKS conceived the study. PKS and LS performed the statistical analysis. PKS and LS analyzed and interpreted the data. PKS and AY drafted the manuscript. SM, DNS, KS and SS provided comments and contributed to the development of the final draft of the manuscript. All authors have supervised and approved the manuscript.

Competing Interest

None declared.

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Data sharing statement

Data utilized by the study is available by emailing prashants.geo@gmail.com.

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Figure 1: Geographical variation in areca nut use among adult men and women in India

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Table 1. Prevalence (in %) and Number of Users of Different Types of Areca Nut in India, GATS 2016-17

Tobacco Products	Total		Men		Women		p-value of difference between men and women (*Chi²test)*	Urban		Rural		p-value of difference between urban and rural areas (*Chi²test)*
	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)		% (95%CI)	Users (in 000)	% (95%CI)	Users (in 000)	Users (in 000)
Pan masala without tobacco	4.8 (3.2-5.6)	44759	6.2 (4.1-8.3)	57814	3.2 (1.9-5.1)	29840	<0.001	5.2 (3.1-7.7)	48489	4.5 (2.2-6.8)	41962	>0.005
Pan masala with Tobacco	2.8 (1.6-3.8)	26110	4.5 (2.8-5.7)	41962	1.1 (0.6-2.1)	10257	<0.001	2.3 (1.1-3.8)	21447	3.1 (1.2-5.2)	28907	>0.005
Betel Quid without Tobacco	8.7 (6.7-10.2)	81126	8.4 (5.9-10.8)	78329	9.0 (6.1-11.9)	83924	<0.001	9.1 (6.8-12.6)	84856	8.4 (5.7-10.8)	78329	>0.005
Betel Quid with Tobacco	5.8 (3.8-7.2)	54084	7.1 (5.2-9.3)	66207	5.5 (3.2-7.8)	51287	<0.001	4.3 (2.8-6.3)	40097	6.6 (4.2-8.3)	61544	<0.005
Areca Nut of Any Type	8.0 (5.9-10.3)	74599	8.3 (5.8-11.2)	77397	7.7 (5.1-9.2)	71802	<0.001	9.1 (6.5-13.1)	84856	7.5 (4.8-9.8)	69937	>0.005
Gutka, Areca Nut-Tobacco Lime Mixture, or *Mawa*	6.8 (5.7-8.6)	63409	17.8 (15.1-20.2)	100709	2.7 (1.2-4.1)	25177	<0.001	6.3 (3.1-8.7)	58747	7.1 (4.5-9.8)	66207	<0.005

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Table 2. Prevalence (in %) of Areca Nut Use in Different Forms across States & Union Territories of India, GATS 2016-17

States/UTs	Areca nut use without tobacco only		Areca nut use with tobacco only		Dual use		Any Form	
North region								
Jammu & Kashmir	0.5	[0.2,1.2]	0.9	[0.5,1.5]	0.0	[0.0,0.1]	1.4	[0.8,2.1]
Himachal Pradesh	1.2	[0.8,1.9]	0.3	[0.1,0.8]	0.0	[0.0,0.2]	1.5	[1.1,2.3]
Punjab	1.0	[0.6,1.6]	2.0	[0.9,4.2]	0.1	[0.0,0.6]	3.1	[1.8,5.2]
Chandigarh	1.7	[1.1,2.7]	1.6	[0.9,3.0]	0.1	[0.0,0.3]	3.4	[2.3,5.1]
Uttarakhand	17.5	[14.0,21.6]	3.8	[2.9,4.8]	1.3	[0.7,2.1]	22.6	[18.5,27.1]
Haryana	2.6	[1.7,4.0]	2.4	[1.0,5.3]	0.2	[0.1,0.6]	5.2	[3.3,8.1]
Delhi	15.7	[13.0,18.7]	2.0	[1.3,2.9]	1.0	[0.6,1.7]	18.7	[15.6,22.0]
Central region								
Rajasthan	7.5	[6.3,9.1]	6.5	[5.3,7.9]	1.4	[0.7,2.5]	15.4	[13.4,17.6]
Uttar Pradesh	18.3	[16.4,20.3]	12.4	[11.0,14.0]	3.5	[2.7,4.4]	34.2	[31.9,36.5]
Chhattisgarh	8.4	[6.4,10.8]	7.4	[5.9,9.3]	1.2	[0.7,1.8]	17.0	[14.2,20.1]
Madhya Pradesh	8.6	[7.2,10.2]	13.4	[11.3,15.9]	2.1	[1.4,3.0]	24.1	[21.2,27.2]
East region								
West Bengal	13.4	[10.7,16.7]	4.1	[3.0,5.5]	3.7	[2.8,5.0]	21.2	[18.2,24.6]
Jharkhand	8.3	[6.6,10.3]	8.2	[6.4,10.5]	1.1	[0.6,2.0]	17.6	[14.3,21.4]
Odisha	11.3	[8.6,14.6]	11.5	[9.6,13.8]	4.8	[3.4,6.6]	27.6	[23.1,32.6]
Bihar	7.0	[5.4,9.1]	5.0	[4.0,6.3]	0.5	[0.3,0.9]	12.5	[10.5,14.8]
Northeast region								
Sikkim	11.5	[8.9,14.9]	1.5	[0.9,2.6]	0.7	[0.4,1.2]	13.7	[10.8,17.4]
Arunachal Pradesh	17.4	[14.4,20.8]	18.6	[13.0,25.8]	3.7	[2.6,5.2]	39.7	[32.6,47.0]
Nagaland	9.6	[7.6,12.2]	15.1	[12.7,17.8]	5.8	[4.3,7.8]	30.5	[27.3,34.0]
Manipur	23.7	[20.2,27.5]	21.0	[18.3,24.0]	6.0	[4.6,7.8]	50.7	[47.0,54.4]
Mizoram	52.9	[48.3,57.5]	0.8	[0.4,1.7]	4.4	[3.2,5.9]	58.1	[53.0,62.9]
Tripura	14.3	[11.6,17.4]	17.0	[14.0,20.6]	14.0	[11.0,17.7]	45.3	[42.0,48.7]
Meghalaya	63.2	[57.5,68.5]	1.6	[0.9,2.8]	6.0	[4.3,8.2]	70.8	[65.4,75.5]
Assam	45.6	[42.8,48.4]	11.4	[9.9,13.2]	10.6	[9.2,12.2]	67.6	[64.7,70.5]
West region								
Gujarat	8.3	[6.5,10.5]	11.1	[8.8,13.9]	1.1	[0.8,1.7]	20.5	[17.8,23.5]
Maharashtra	19.6	[17.0,22.5]	6.9	[5.5,8.8]	2.9	[2.0,4.2]	29.4	[25.3,34.0]
Goa	17.3	[14.6,20.4]	1.3	[0.7,2.2]	1.1	[0.7,1.9]	19.7	[16.7,23.1]
South region								
Andhra Pradesh	6.7	[5.2,8.7]	1.3	[0.7,2.4]	1.2	[0.6,2.4]	9.2	[7.1,11.7]
Telangana	8.7	[6.9,11.0]	2.8	[1.8,4.3]	2.0	[1.2,3.3]	13.5	[11.3,16.2]
Karnataka	28.8	[25.6,32.1]	7.7	[6.2,9.4]	4.3	[3.4,5.3]	40.8	[36.3,45.2]
Kerala	3.1	[2.2,4.3]	2.6	[1.9,3.6]	0.4	[0.2,1.0]	6.1	[4.7,7.9]
Tamil Nadu	25.5	[21.9,29.5]	3.7	[2.5,5.6]	1.2	[0.8,1.7]	30.4	[27.1,34.0]
Puducherry	17.7	[14.7,21.1]	1.9	[1.0,3.4]	1.4	[0.9,2.1]	21.0	[17.6,24.9]
India	**14.2**	**[13.6,14.9]**	**7.3**	**[6.9,7.7]**	**2.4**	**[2.2,2.7]**	**23.9**	**[23.1,24.8]**

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Table 3. Population and Share of Areca Nut Use by States & Union Territories (UT) of India, GATS 2016-17

States/UTs	Population	Share (in%)
Chandigarh	33,040	0.0
Sikkim	68,448	0.0
Himachal Pradesh	88,112	0.0
Jammu & Kashmir	1,21,264	0.1
Puducherry	2,11,680	0.1
Goa	2,37,779	0.1
Arunachal Pradesh	4,15,800	0.2
Nagaland	4,59,940	0.2
Mizoram	4,88,040	0.2
Punjab	6,99,081	0.3
Haryana	10,48,632	0.5
Manipur	11,31,624	0.5
Tripura	13,16,418	0.6
Meghalaya	14,93,184	0.7
Kerala	16,50,843	0.7
Uttarakhand	17,56,575	0.8
Delhi	27,61,914	1.2
Chhattisgarh	32,62,714	1.5
Andhra Pradesh	36,54,056	1.6
Telangana	38,09,088	1.7
Jharkhand	42,61,840	1.9
Rajasthan	79,00,200	3.5
Odisha	89,84,904	4.0
Bihar	90,95,000	4.1
Gujarat	98,13,760	4.4
Madhya Pradesh	1,31,45,827	5.9
West Bengal	1,54,75,728	6.9
Assam	1,58,33,272	7.1
Tamil Nadu	1,77,53,296	7.9
Karnataka	1,98,34,738	8.9
Maharashtra	2,67,53,412	12.0
Uttar Pradesh	4,99,32,289	22.3
India	22,37,97,120	100.0

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Table 4. Areca Nut Use Pattern by Demographic and Socioeconomic Characteristics, GATS 2016-17

Background Variables	Areca nut use without tobacco only		Areca nut use with tobacco only		Dual use		Any Forms	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Age	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
15-18	15.7	[13.9,17.6]	1.9	[1.4,2.5]	0.7	[0.5,1.2]	18.3	[16.5,20.3]
19-23	14.8	[13.3,16.4]	5.4	[4.5,6.4]	1.3	[0.9,1.9]	21.5	[19.8,23.3]
24-30	14.1	[13.1,15.2]	8.2	[7.3,9.1]	2.4	[2.0,2.9]	24.7	[23.3,26.1]
31-40	14.6	[13.6,15.6]	9.3	[8.6,10.1]	2.7	[2.4,3.2]	26.7	[25.4,28.0]
41-50	15.2	[14.1,16.3]	8.1	[7.3,9.0]	3.1	[2.6,3.7]	26.4	[25.0,27.9]
51-60	13.5	[12.2,14.8]	8	[7.0,9.0]	3.2	[2.6,3.9]	24.6	[23.1,26.3]
60+	11.1	[9.9,12.3]	7.8	[6.6,9.0]	3.2	[2.6,4.0]	22.0	[20.2,23.9]
Sex	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
Female	13.2	[12.5,14.0]	3.4	[3.0,3.8]	2.3	[2.0,2.6]	18.9	[18.0,19.9]
Male	15.2	[14.4,16.1]	11	[10.4,11.8]	2.6	[2.3,2.9]	28.8	[27.7,30.0]
Marital Status	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
Married	13.7	[13.1,14.4]	8.1	[7.6,8.6]	2.7	[2.4,3.0]	24.5	[23.6,25.4]
Unmarried	15.8	[14.6,17.1]	4.6	[3.9,5.3]	1	[0.8,1.4]	21.4	[20.0,22.9]
Widowed/Separated/Divorced	14.3	[12.8,15.9]	8.3	[7.1,9.7]	4.5	[3.7,5.5]	27.1	[25.3,29.1]
Education	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
No formal education	11.2	[10.3,12.1]	8.7	[8.0,9.6]	3.7	[3.2,4.2]	23.6	[22.4,25.0]
<Primary completed	14.7	[13.4,16.1]	9.7	[8.6,10.9]	2.9	[2.4,3.6]	27.4	[25.6,29.2]
Primary completed	15.4	[14.1,16.9]	10.0	[8.9,11.2]	2.5	[2.0,3.0]	27.9	[26.2,29.7]
<Secondary completed	16	[14.7,17.3]	8.5	[7.6,9.5]	2.4	[1.9,2.9]	26.8	[25.3,28.3]
Secondary completed	15.1	[13.8,16.5]	5.1	[4.4,5.8]	1.7	[1.3,2.4]	21.9	[20.5,23.5]
Higher Secondary completed	15.6	[14.0,17.3]	4.4	[3.6,5.3]	1.4	[0.9,2.1]	21.4	[19.7,23.3]
College/University completed	15.5	[13.9,17.3]	3.0	[2.3,3.8]	1.1	[0.7,1.7]	19.6	[17.8,21.5]
Post-graduate completed	12.8	[10.7,15.2]	2.8	[1.6,4.6]	0.9	[0.4,2.4]	16.5	[14.0,19.3]
Occupation	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
Student	14.8	[13.2,16.6]	0.8	[0.5,1.2]	0.3	[0.2,0.6]	15.8	[14.2,17.6]
Government Employee	17.4	[14.9,20.3]	6.7	[5.1,8.8]	1.9	[1.1,3.4]	26.1	[23.2,29.2]
Non-government Employee	16.9	[15.3,18.6]	10.4	[8.7,12.3]	2.7	[2.0,3.8]	30.0	[27.7,32.5]
Daily Wage/Casual Labourer	15.3	[14.2,16.5]	11.4	[10.4,12.4]	3.5	[3.0,4.1]	30.2	[28.7,31.7]
Self-employed	14.9	[13.8,16.2]	11.7	[10.7,12.7]	3.1	[2.7,3.7]	29.7	[28.2,31.4]
Homemaker	12.4	[11.6,13.3]	3.5	[3.1,4.1]	1.9	[1.6,2.3]	17.9	[16.9,18.9]
Retired	9.1	[7.2,11.6]	6.3	[4.1,9.5]	2.6	[1.2,5.7]	18.0	[14.7,22.0]
Unemployed able to work	14.6	[11.9,17.8]	6.5	[4.6,9.2]	2.8	[1.7,4.6]	23.9	[20.3,28.0]
Unemployed unable to work	10.7	[8.5,13.2]	7	[5.2,9.4]	3.4	[2.1,5.4]	21.1	[18.2,24.4]
Knowledge of adverse health impact of SLT use	(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*		(*Chi² p-value <0.001)*	
No	11.5	[8.3,15.7]	7.7	[5.6,10.4]	3.7	[2.2,6.1]	22.9	[18.6,27.8]
Partial	15.2	[14.1,16.3]	9	[8.2,9.9]	3.4	[2.9,3.9]	27.5	[26.1,29.0]
Full	14	[13.4,14.8]	6.8	[6.4,7.3]	2.2	[2.0,2.4]	23.1	[22.2,24.0]

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Caste								
Others	14.2	[13.2,15.2]	6.1	[5.5,6.9]	2.6	[2.2,3.0]	22.9	[21.6,24.3]
Scheduled Castes	12.3	[11.1,13.5]	8.4	[7.5,9.3]	2.6	[2.2,3.0]	23.2	[21.8,24.6]
Scheduled Tribes	14.3	[12.7,16.0]	8.5	[7.2,9.5]	2.8	[2.1,3.3]	25.6	[23.0,27.5]
Oother Backward Castes	15.1	[14.2,16.1]	7.3	[6.8,7.9]	2.3	[2.0,2.6]	24.7	[23.5,25.9]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Religion	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
Hindu	13.6	[12.9,14.3]	7.3	[6.9,7.8]	2.3	[2.1,2.6]	23.2	[22.3,24.1]
Muslim	19	[17.2,20.9]	8.5	[7.3,9.9]	3.3	[2.8,4.0]	30.8	[28.4,33.2]
Christian	16.2	[13.6,19.1]	3.5	[2.8,4.4]	2.3	[1.4,3.7]	21.9	[18.9,25.3]
Others	8.4	[6.5,10.7]	4.1	[2.7,6.0]	1.7	[1.0,3.1]	14.1	[11.4,17.4]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Wealth Quintile	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
Poorest	12.1	[11.1,13.1]	9.6	[8.8,10.4]	3.1	[2.7,3.6]	24.7	[23.4,26.2]
Poorer	13.7	[12.8,14.8]	8.6	[7.8,9.4]	2.9	[2.5,3.4]	25.2	[23.9,26.6]
Middle	14.6	[13.5,15.8]	8.2	[7.3,9.2]	2.4	[1.9,2.9]	25.2	[23.7,26.8]
Richer	16.1	[14.8,17.5]	5.4	[4.7,6.1]	2.0	[1.5,2.6]	23.4	[21.9,25.0]
Richest	15.7	[14.3,17.3]	2.7	[2.2,3.3]	1.1	[0.8,1.6]	19.5	[18.0,21.1]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Place of Residence	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
Urban	15.7	[14.6,16.9]	6.1	[5.4,6.8]	2.0	[1.7,2.4]	23.8	[22.3,25.4]
Rural	13.5	[12.7,14.2]	7.9	[7.4,8.5]	2.7	[2.4,3.0]	24.1	[23.1,25.0]
	(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*		(*Chi² p-value*	
Region	*<0.001)*		*<0.001)*		*<0.001)*		*<0.001)*	
North	5.6	[4.9,6.4]	2.0	[1.4,2.8]	0.4	[0.3,0.6]	8.0	[7.0,9.1]
Central	13.6	[12.5,14.8]	11.1	[10.2,12.1]	2.6	[2.2,3.2]	27.3	[25.9,28.8]
East	10.1	[8.9,11.6]	6.1	[5.4,6.9]	2.4	[2.0,3.0]	18.7	[17.1,20.4]
Northeast	39.9	[37.8,42.0]	11.9	[10.8,13.2]	9.6	[8.6,10.7]	61.4	[59.3,63.5]
West	15.7	[13.8,17.8]	8.3	[7.0,9.8]	2.3	[1.6,3.2]	26.3	[23.3,29.5]
South	17.3	[15.8,18.8]	3.9	[3.3,4.6]	1.9	[1.6,2.3]	23.1	[21.4,24.9]

Chi² p-value <0.001

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Table 5. Multinomial Regression Analysis showing Determinants of Areca Nut Use, India GATS 2016-17

Background Variables	Areca nut use without tobacco only				Areca nut use with tobacco only				Dual use			
	RRR	95%CI		p-value	RRR	95%CI		p-value	RRR	95%CI		p-value
Age												
15-18 (ref.)	1.00				1.00				1.00			
19-23	0.91	0.81	1.02	0.106	1.73	1.33	2.25	<0.001	1.53	1.03	2.26	0.034
24-30	0.92	0.81	1.04	0.202	2.37	1.83	3.08	<0.001	2.26	1.54	3.33	<0.001
31-40	0.92	0.81	1.04	0.191	2.71	2.08	3.52	<0.001	2.72	1.84	4.03	<0.001
41-50	0.91	0.80	1.04	0.159	2.42	1.85	3.16	<0.001	2.59	1.74	3.86	<0.001
51-60	0.77	0.67	0.89	<0.001	2.14	1.62	2.81	<0.001	2.53	1.68	3.80	<0.001
60+	0.65	0.56	0.75	<0.001	2.04	1.54	2.70	<0.001	2.36	1.55	3.58	<0.001
Sex												
Female (ref.)	1.00				1.00				1.00			
Male	1.13	1.07	1.20	<0.001	2.02	1.85	2.21	<0.001	1.81	1.72	1.92	0.001
Marital Status												
Married (ref.)	1.00				1.00				1.00			
Unmarried	0.94	0.86	1.02	0.16	1.06	0.93	1.20	0.382	1.12	0.92	1.36	0.273
Widowed/Separated/Divorced	1.37	1.24	1.50	<0.001	1.62	1.42	1.83	<0.001	1.59	1.35	1.88	<0.001
Education												
No formal education (ref.)	1.00				1.00				1.00			
<Primary completed	1.23	1.14	1.34	<0.001	1.01	0.91	1.12	0.867	0.93	0.80	1.08	0.318
Primary completed	1.20	1.11	1.30	<0.001	1.06	0.96	1.17	0.264	0.82	0.70	0.96	0.016
<Secondary completed	1.37	1.27	1.48	<0.001	0.99	0.89	1.09	0.774	0.90	0.77	1.05	0.177
Secondary completed	1.23	1.13	1.34	<0.001	0.79	0.70	0.89	<0.001	0.75	0.62	0.91	0.003
Higher Secondary completed	1.23	1.11	1.35	<0.001	0.74	0.64	0.86	<0.001	0.74	0.59	0.93	0.011
College/University completed	1.18	1.06	1.31	0.003	0.53	0.44	0.63	<0.001	0.53	0.40	0.71	<0.001
Post-graduate completed	1.18	1.02	1.36	0.023	0.35	0.25	0.48	<0.001	0.43	0.27	0.68	<0.001
Occupation												
Student (ref.)	1.00				1.00				1.00			
Government Employee	1.15	0.99	1.34	0.06	3.43	2.49	4.73	<0.001	2.56	1.63	4.00	<0.001
Non-government Employee	1.59	1.39	1.81	<0.001	4.87	3.64	6.53	<0.001	4.17	2.75	6.30	<0.001
Daily Wage/Casual Labourer	1.65	1.46	1.87	<0.001	4.51	3.40	5.99	<0.001	3.95	2.66	5.87	<0.001
Self-employed	1.30	1.15	1.47	<0.001	4.34	3.27	5.75	<0.001	2.87	1.94	4.27	<0.001

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Homemaker	1.26	1.11	1.42	<0.001	2.61	1.95	3.49	<0.001	2.11	1.42	3.13	<0.001
Retired	0.95	0.77	1.17	0.604	2.28	1.56	3.33	<0.001	2.21	1.29	3.77	0.004
Unemployed able to work	0.91	0.76	1.08	0.287	2.91	2.09	4.05	<0.001	2.04	1.28	3.25	0.003
Unemployed unable to work	1.24	1.01	1.52	0.039	2.56	1.79	3.67	<0.001	2.49	1.51	4.09	<0.001
Knowledge of adverse health impact of SLT use												
No (ref.)	1.00				1.00				1.00			
Partial	1.37	1.13	1.66	0.001	1.36	1.06	1.76	0.017	1.60	1.12	2.28	0.009
Full	1.22	1.01	1.48	0.056	1.04	0.81	1.34	0.759	1.23	0.87	1.74	0.249
Caste												
Others (ref.)	1.00				1.00				1.00			
Scheduled Castes	1.05	0.97	1.13	0.197	1.17	1.05	1.29	0.004	1.25	1.07	1.46	0.005
Scheduled Tribes	1.11	1.02	1.20	0.016	0.96	0.85	1.08	0.459	0.91	0.77	1.08	0.295
Oother Backward Castes	0.95	0.89	1.01	0.087	0.96	0.88	1.05	0.346	0.80	0.70	0.92	0.001
Religion												
Hindu (ref.)	1.00				1.00				1.00			
Muslim	1.35	1.26	1.45	<0.001	1.22	1.11	1.35	<0.001	1.41	1.22	1.63	<0.001
Christian	0.83	0.77	0.91	<0.001	0.59	0.52	0.68	<0.001	0.58	0.49	0.69	<0.001
others	0.61	0.55	0.68	<0.001	0.50	0.42	0.60	<0.001	0.36	0.27	0.47	<0.001
Wealth Quintile												
Poorest (ref.)	1.00				1.00				1.00			
Poorer	0.94	0.88	1.00	0.062	0.96	0.88	1.04	0.321	1.11	0.98	1.25	0.097
Middle	1.02	0.95	1.11	0.573	0.97	0.88	1.08	0.628	1.00	0.85	1.17	0.964
Richer	1.03	0.96	1.12	0.403	0.79	0.70	0.89	<0.001	0.79	0.66	0.95	0.01
Richest	1.04	0.94	1.15	0.305	0.54	0.46	0.63	<0.001	0.83	0.67	1.03	0.096
Place of Residence												
Urban (ref.)	1.00				1.00				1.00			
Rural	0.94	0.90	0.99	0.024	0.94	0.87	1.01	0.092	1.07	0.95	1.20	0.262
Region												
North (ref.)	1.00				1.00				1.00			
Central	2.28	2.07	2.51	<0.001	6.08	5.26	7.04	<0.001	6.45	4.78	8.71	<0.001
East	2.01	1.82	2.22	<0.001	3.38	2.90	3.95	<0.001	6.25	4.64	8.44	<0.001
Northeast	11.85	10.84	12.95	<0.001	14.81	12.77	17.18	<0.001	51.51	38.90	68.23	<0.001
West	3.40	3.10	3.73	<0.001	4.84	4.14	5.65	<0.001	5.85	4.26	8.03	<0.001
South	3.67	3.37	4.01	<0.001	2.29	1.95	2.68	<0.001	6.14	4.57	8.25	<0.001

Note: Ref- Reference

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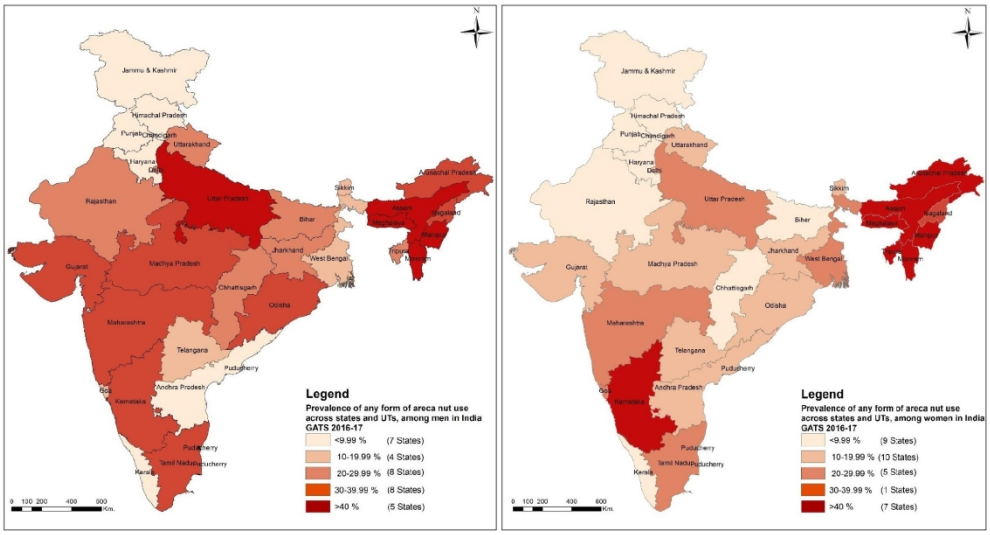

Figure 1: Geographical variation in areca nut use among adult men and women in India

591x312mm (96 x 96 DPI)

Supplementary Table 1. Sample Description of the Study Population

Background Variables	*N*	%	Background Variables	*N*	%
Age			**Knowledge of Adverse Health Impact of Smokeless Tobacco Use**		
15-18	4641	10.5	No	1051	1.4
19-23	7161	13.8	Partial	14459	20.5
24-30	13867	18.2	Full	58527	78.1
31-40	18839	21.0	**Caste**		
41-50	13245	15.3	Others	21734	26.8
51-60	8531	10.8	SCs	12854	19.1
60+	7753	10.4	STs	12128	8.9
Sex			OBCs	27321	45.3
Female	40265	48.9	**Religion**		
Male	33772	51.1	Hindu	54015	80.3
Marital Status			Muslim	8785	14.2
Married	56984	70.1	Christian	7111	2.3
Unmarried	11951	23.0	others	4126	3.1
Widowed/Separated/Divorced	5102	6.9	**Wealth Quintile**		
Education			Poorest	15547	23.4
No formal Education	18473	26.4	Poorer	18685	26.3
<Primary completed	7510	9.2	Middle	11278	16.8
Primary completed	8858	11.3	Richer	14814	19.6
<Secondary completed	12109	16.9	Richest	13713	13.8
Secondary completed	10331	14.1	**Place of Residence**		
Higher Secondary completed	7959	11.2	Urban	26488	34.5
College/University completed	6096	7.8	Rural	47549	65.5
Post-graduate completed	2642	3.1	**Region**		
			North	17128	8.7
Occupation			Central	11518	29.1
Student	6134	11.9	East	9834	21.7
Government Employee	3355	2.7	Northeast	13574	3.7
Non-government Employee	6259	8.3	West	7901	15.0
Daily Wage/Casual Labourer	13749	21.2	South	14082	21.8
Self-employed	13955	19.4			
Homemaker	25833	30.1			
Retired	1679	2.1			
Unemployed able to work	1572	1.9			
Unemployed unable to work	1471	2.3			
Don't know or refused	30	0.0			

All *N* are unweighted

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Supplementary Table 2. Prevalence (in %) of Areca Nut Use in Different Forms across States & Union Territories of India, GATS 2016-17

States/UTs	*Pan Masala* without Tobacco	*Pan Masala* with Tobacco	Betel Quid without Tobacco	Betel Quid with Tobacco	*Gutka*, Areca Nut-Tobacco Lime Mixture, or *Mawa*	Areca Nut of Any Type
North						
Jammu & Kashmir	0.2	0.2	0.3	0.8	0.4	0.2
Himachal Pradesh	0.7	0.1	0.4	0.0	0.5	0.6
Punjab	0.5	0.2	0.3	0.4	2.3	0.4
Chandigarh	0.5	0.4	0.6	0.9	1.0	1.2
Uttarakhand	3.1	3.1	8.6	2.7	2.2	10.8
Haryana	1.3	0.4	0.5	1.1	2.5	1.4
Delhi	4.9	1.3	8.3	2.6	3.0	7.6
Central						
Rajasthan	3.5	4.6	1.4	4.0	9.0	6.1
Uttar Pradesh	7.0	7.2	12.8	10.2	11.5	7.6
Chhattisgarh	6.1	1.8	2.1	2.0	7.8	3.4
Madhya Pradesh	3.8	4.4	2.4	4.1	13.7	6.7
East						
West Bengal	4.8	2.2	5.7	6.4	2.9	11.6
Jharkhand	7.4	1.1	1.2	4.9	8.3	2.0
Odisha	11.1	8.6	4.9	8.6	9.4	5.5
Bihar	5.2	1.4	1.5	3.4	3.7	2.3
North-East						
Sikkim	4.7	0.5	5.4	2.6	1.2	7.0
Arunachal Pradesh	11.5	4.7	13.6	14.9	18.9	5.1
Nagaland	8.7	21.1	8.8	17.5	9.4	2.2
Manipur	7.9	4.2	23.1	38.6	2.7	1.1
Mizoram	4.0	0.8	55.1	4.3	4.0	5.9
Tripura	6.4	10.4	8.3	39.5	2.5	22.6
Meghalaya	10.7	2.5	64.9	12.0	2.4	3.8
Assam	10.9	2.9	46.6	19.0	8.2	11.9
West						
Gujarat	3.5	1.4	4.9	1.1	12.8	4.7
Maharashtra	6.6	1.7	6.7	3.7	8.6	17.0
Goa	7.2	1.3	9.6	2.7	2.6	11.0
South						
Andhra Pradesh	0.3	0.2	4.9	2.4	1.9	5.6
Telangana	2.9	1.1	3.1	3.9	2.9	8.0
Karnataka	4.7	0.7	27.8	9.4	5.9	8.3

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Kerala	1.2	0.4	2.1	4.4	0.7	0.9
Tamil Nadu	0.2	0.1	18.6	6.0	0.7	19.1
Puducherry	0.8	0.1	7.7	3.4	0.7	15.1
India	**4.8**	**2.8**	**8.7**	**5.8**	**6.8**	**8.0**

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Supplementary Table 3. Prevalence (in %) of Areca Nut Use in Different Forms by Urban and Rural area Across States & Union Territories of India, GATS 2016-17

	Urban				Rural			
States/UTs	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**
North								
Jammu & Kashmir	1.2	0.7	0.0	1.8	0.1	0.9	0.0	1.1
Himachal Pradesh	3.3	1.6	0.0	4.9	1.0	0.2	0.0	1.2
Punjab	1.3	3.7	0.3	5.3	0.8	0.8	0.1	1.7
Chandigarh	1.7	1.6	0.1	3.5	1.9	0.0	0.0	1.9
Uttarakhand	19.8	4.2	1.4	25.4	16.3	3.6	1.2	21.0
Haryana	3.0	4.7	0.4	8.2	2.3	0.8	0.1	3.3
Delhi	15.9	2.0	1.0	18.9	3.4	2.1	0.0	5.5
Central								
Rajasthan	9.1	8.8	1.2	19.0	7.0	5.6	1.4	14.0
Uttar Pradesh	26.0	9.2	3.2	38.4	15.7	13.5	3.5	32.7
Chhattisgarh	10.6	12.4	1.5	24.5	7.6	5.6	1.0	14.2
Madhya Pradesh	11.9	12.3	2.7	26.9	7.1	13.9	1.8	22.9
East								
West Bengal	8.2	2.4	2.8	13.4	16.3	5.1	4.3	25.7
Jharkhand	7.8	7.7	0.8	16.3	8.4	8.4	1.2	18.0
Odisha	13.5	13.3	1.6	28.4	10.8	11.1	5.5	27.4
Bihar	4.3	5.7	0.4	10.4	7.4	4.9	0.5	12.8
North-East								
Sikkim	13.3	1.3	0.3	15.0	10.7	1.6	0.9	13.2
Arunachal Pradesh	18.1	13.3	4.4	35.8	17.1	20.3	3.4	40.9
Nagaland	10.6	15.2	7.0	32.7	9.2	15.1	5.2	29.4
Manipur	27.0	18.7	4.2	49.9	21.7	22.4	7.1	51.2
Mizoram	51.5	0.3	6.0	57.8	54.7	1.3	2.3	58.4
Tripura	12.5	19.9	10.4	42.8	15.0	15.8	15.6	46.5
Meghalaya	52.6	1.9	4.4	58.9	66.3	1.5	6.4	74.2
Assam	37.5	11.1	8.5	57.1	47.2	11.5	11.0	69.7
West								
Gujarat	10.4	10.0	1.3	21.7	6.5	12.0	1.0	19.5
Maharashtra	22.0	7.6	3.2	32.8	17.5	6.3	2.6	26.4
Goa	16.2	1.3	0.6	18.1	19.3	1.3	2.2	22.7
South								
Andhra Pradesh	8.3	0.8	0.6	9.8	5.9	1.5	1.4	8.9
Telangana	10.7	2.8	2.5	16.0	7.3	2.8	1.6	11.8
Karnataka	26.6	6.3	2.9	35.8	30.3	8.7	5.3	44.2
Kerala	2.4	1.8	0.5	4.7	3.7	3.5	0.4	7.6
Tamil Nadu	26.1	1.1	0.6	27.7	24.9	6.6	1.7	33.2
Puducherry	13.5	0.8	0.7	15.0	27.3	4.5	3.2	34.9

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India	**15.7**	**6.1**	**2.0**	**23.8**	**13.5**	**7.9**	**2.7**	**24.1**

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Supplementary Table 4. Prevalence (in %) of Areca Nut Use in Different Forms by sex Across States & Union Territories of India, GATS 2016-17

	Female				Male			
States/UTs	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**	**Areca nut use only without tobacco**	**Areca nut use only with tobacco**	**Dual use**	**Any form**
North								
Jammu & Kashmir	0.3	0.2	0.1	0.6	0.6	1.5	0.0	2.1
Himachal Pradesh	0.1	0.0	0.0	0.1	2.3	0.6	0.1	3.0
Punjab	1.1	0.1	0.1	1.2	0.9	3.7	0.2	4.8
Chandigarh	2.0	0.4	0.0	2.4	1.6	2.6	0.1	4.3
Uttarakhand	16.3	1.1	0.0	17.4	18.7	6.4	2.5	27.6
Haryana	2.3	0.6	0.1	3.0	2.9	3.9	0.4	7.2
Delhi	11.9	1.0	0.3	13.2	18.9	2.8	1.6	23.3
Central								
Rajasthan	4.9	2.4	0.1	7.4	10.1	10.4	2.5	23.0
Uttar Pradesh	14.3	4.8	1.5	20.6	21.9	19.5	5.3	46.7
Chhattisgarh	4.2	1.8	0.2	6.2	12.5	13.1	2.1	27.7
Madhya Pradesh	4.9	5.5	1.7	12.1	12.0	20.9	2.5	35.3
East								
West Bengal	13.9	3.5	5.8	23.2	13.0	4.7	1.8	19.4
Jharkhand	9.0	0.6	0.5	10.1	7.6	15.5	1.6	24.7
Odisha	9.1	4.7	5.9	19.6	13.5	18.4	3.7	35.6
Bihar	2.6	0.4	0.1	3.2	11.0	9.3	0.9	21.1
North-East								
Sikkim	13.1	0.5	0.5	14.1	10.1	2.5	0.9	13.5
Arunachal Pradesh	27.6	10.2	4.8	42.6	7.8	26.3	2.6	36.8
Nagaland	8.5	17.3	5.1	30.9	10.7	13.1	6.4	30.2
Manipur	22.3	27.4	4.8	54.5	25.0	14.7	7.3	46.9
Mizoram	47.4	1.4	6.7	55.5	58.4	0.2	2.1	60.6
Tripura	19.4	21.7	20.6	61.6	9.4	12.6	7.7	29.7
Meghalaya	60.3	1.7	10.4	72.4	66.2	1.4	1.5	69.1
Assam	45.6	13.3	11.1	69.9	45.6	9.7	10.1	65.4
West								
Gujarat	5.4	3.9	0.9	10.2	11.0	17.7	1.4	30.1
Maharashtra	23.3	2.4	3.0	28.6	16.2	11.2	2.8	30.2
Goa	20.9	0.4	1.4	22.6	13.8	2.1	0.9	16.8
South								
Andhra Pradesh	10.0	1.8	2.2	14.0	3.4	0.8	0.1	4.3
Telangana	5.8	3.1	2.8	11.6	11.7	2.6	1.2	15.5
Karnataka	38.9	2.4	4.8	46.2	18.7	12.8	3.7	35.3
Kerala	1.8	2.4	0.6	4.8	4.4	2.9	0.3	7.6
Tamil Nadu	20.8	4.5	1.3	26.5	30.4	3.0	1.1	34.4
Puducherry	14.1	2.3	2.3	18.7	21.5	1.5	0.5	23.4
India	**13.2**	**3.4**	**2.3**	**18.9**	**15.2**	**11.0**	**2.6**	**28.8**

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	2	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	5	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	6	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	6	Present key elements of study design early in the paper	6-7
Setting	6	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	6	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-9*
Bias	8	Describe any efforts to address potential sources of bias	6
Study size	9	Explain how the study size was arrived at	6
Quantitative variables	8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	9-10	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	10-10
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	

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Results			**Page no**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	12-14
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-14
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N.A.
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-18
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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