

Does tobacco addiction relate to oral mucosal changes? An epidemiological study from North India

Santanu Chaudhuri¹ · Somnath Dey¹ · Ashish Awasthi¹ · Ram Chandra Bajpai^{1,2}

Received: 14 July 2016 / Accepted: 4 January 2017
© Springer-Verlag Berlin Heidelberg 2017

Abstract

Objective Tobacco use in both smokeless and smoked forms is a very common addiction in India, with high prevalence in northern India. The relationship between tobacco consumption and oral mucosal changes and ulceration is not well documented and studied in the literature. The aim of this study is to explore the extent of tobacco use and its relationship with the development of mouth ulcers.

Methods Cross-sectional health camps were organized through community outreach for a previously unscreened population in the Braj region in Uttar Pradesh, India. A total of 2053 individuals were screened for common health-related issues in 20 camps covering 4 districts. Multivariate logistic regression analysis was used to explore the independent factors related to tobacco use-related mucosal changes and oral ulceration.

Results The average age of the screened population was 43.5 years; the majority belonged to the 35–54-year-old age group. Any form of tobacco use was reported as 20.8% (95% CI: 19.2–22.7), and independently smoking and chewing were 11.3% and 13.1%, respectively. Prevalence of tobacco use

was significantly higher among males than females (34.9% vs. 6.1%; $p < 0.0001$). Increasing age and use of alcohol and betel nut were significantly associated with tobacco consumption. Further, age (34–54 years), use of either kind of tobacco as well as combined use of smoking, tobacco chewing and betel nut were significantly related to mouth ulcers and mucosal changes.

Conclusion A substantial population in the region, more so in the young age group, was using one of the forms of tobacco. Despite certain policy efforts, the prevalence of tobacco consumption has not decreased over time. Effective measures and proper advocacy need to be undertaken urgently to control the tobacco menace in India.

Keywords Tobacco use · Mouth ulcers · Association · Regression analysis · Uttar Pradesh · India

Introduction

Tobacco use alone is currently ranked fourth in the world in its contribution to years of life lost (Adejuwon 2009). Tobacco use (smoked or smokeless) is common in India, like in other developing countries in Asia. More than 15 percent (16.6%) of the global tobacco users live in India, i.e., 182 million (Shimkhada and Peabody 2003). The reported prevalence of tobacco use is higher among the older age group, the male population, and in rural areas and slums (Chaudhuri et al. 2017; 2016). It varies from 15 to 50% among men, and the percentage is less among women (4%). However, smoking among women is more common in the northeastern states, Jammu and Kashmir as well as Bihar (Jindal et al. 2006). According to global mortality estimates in 2000, tobacco-attributed deaths contributed about 18% of all deaths among men and 3% of all deaths among women in India (Ezzati and Lopez 2003). The total projected annual number of

✉ Santanu Chaudhuri
chaudhursantanu@hotmail.com

Somnath Dey
drdeysomnath@yahoo.co.in

Ashish Awasthi
ashish.awasthi15@outlook.com

Ram Chandra Bajpai
rambajpai@hotmail.com

¹ Nayati Healthcare and Research Centre, Mathura, UP 281003, India

² Present address: Centre for Population Health Sciences (CePHaS), Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore, Singapore

fatalities among men and women in India attributed to tobacco use was 1 million in the 2010s (Jha et al. 2008). It has already been reported that chewing tobacco products is a major risk factor for the development of oral precancerous lesions and oral cancers (Critchley and Unal 2003). However, there are limited data on the prevalence of tobacco addiction and its relation with oral mucosal changes, particularly in the western Uttar Pradesh region.

Similarly, one of the most common symptoms of the oral mucosa due to tobacco use is reported to be oral mucosal ulcerations. Nearly 4% of the world population is affected by oral ulcers, and 25% of them are affected by aphthous ulcers (Patil et al. 2014). The oral mucosal changes are multifactorial. Oral cancers and precancerous lesions, hematological disorders, connective tissue diseases, cutaneous diseases, HIV infections and drugs are the most common causal factors in the etiology of mouth ulcers (Scully 2006; Scully and Felix 2005; 2006; Scully et al. 2010). The oral mucosal changes may be associated with local trauma, stress, food hypersensitivity, hormonal changes, vitamin and trace element deficiencies and allergies (Patil et al. 2014; Safadi 2009).

The increasing use of various lifestyle-related addictive substances, especially tobacco (smoked or smokeless), has an adverse impact on health, affecting the quality of life and causing several health hazards. Therefore, it is important to know the prevalence of tobacco addiction in a previously unscreened population. Likewise, the occurrence of mouth ulcers depends on several factors; hence, it is necessary to explore the cause and effect phenomenon between tobacco usage and the development of oral ulceration and mucosal changes. Hence, this epidemiological study has tried to estimate the prevalence of tobacco-related addictions and their association with mouth ulcers among an unscreened population in northern India.

Materials and methods

Study design and participants

The data were retrieved from a cross-sectional study, conducted as community-based outreach health camps organized among an unscreened mixed population (sub-urban and rural) of the western part (Braj region) of Uttar Pradesh (UP) state in Northern India from June to August 2015 at 20 different places. Based on the local culture, geography and regional language, Uttar Pradesh has been divided into different regions, namely Awadh, Braj, Bundelkhand, Doab, Purvanchal and Rohilkhand. The participants were individuals (male and female) of all age groups who voluntarily came to the health camp for their screening on the day of the survey. There was no specific criterion for inclusion of individual participants. However, patients with severe health-related issues were excluded from the study. Hence, the individuals

who had given consent for a general checkup in the health camp were also included for oral screening as a part of their general health checkup.

Sample size calculation

The national estimate of the prevalence of consumption of tobacco in any form was reported to be 28.3% (IIPS 1999). A previous epidemiological study from Chennai (rural, semi-urban and urban) carried out in 2009–2011 reported a prevalence of 23.7% for a rural and 20.9% for a semi-urban population that consumed tobacco in any form (Chockalingam et al. 2013). We assumed that the maximum prevalence of tobacco use would be 25% with a 95% confidence interval, 10% allowable error and 15% non-participation rate. The sample size was calculated using the formula: $n = 4p(1 - p)/d^2$ (Machin et al. 2009), where ‘*n*’ is the estimated sample size, ‘*p*’ is the anticipated prevalence of tobacco use (25%), and ‘*d*’ is the absolute permissible error (10%). Therefore, the required operational sample size was approximated to 100 (75 was computed from the formula) per camp.

Data collection

The purpose of the community outreach health camps was to screen individuals for common health-related issues such as oral health, respiratory and gynecological problems, and so on. The study participants were screened by trained health workers who were sensitized and trained in primary cancer screening under the supervision of qualified medical graduates. The outreach team collected information using a pretested questionnaire on demographics: age and sex; addiction habits: tobacco use (smoked or smokeless), alcohol and betel nut; symptoms: mouth ulcers, difficulty opening the mouth, voice hoarseness, neck swellings, difficulty swallowing, earache/ear discharge or nasal bleeding.

The community-based health camps were organized in four districts of Uttar Pradesh, Mathura, Hathras, Firozabad and Shikohabad, at a sub-district level for general health check-ups among the previously unscreened population. Further, five camps per district were held at randomly selected places. Places with a minimum surrounding population of 1000 were shortlisted from the district table, and there was no preference in the selection process for any location. Therefore, nearly 500 samples were collected from each district.

Ethical statement

Individual verbal consents were taken before the screening of oral cavity lesions, and observations were made concerning different addictions (smoked or smokeless tobacco, alcohol consumption and betel nut).

Data analysis

Data collected from the screened individuals were analyzed to estimate the prevalence of tobacco use (smoked or smokeless) and its association with mouth ulcers. Chi-square or Fisher's test was applied to examine the association between tobacco use and background variables such as age group, gender, symptom types and other addictions (Pohjanpää et al. 1997). The risk of developing the habit of tobacco use among males and females in different age groups was estimated by risk ratios using stratified regression analysis with 95% confidence intervals (CI). Further bivariate and multivariable logistic regressions were used to assess the odds ratios with respect to the reference category for comparison and identification of factors associated with an increasing risk of developing mouth ulcers (Janghorbani et al. 2003). The data were analyzed using IBM SPSS statistics version 21.0 (Armonk, NY, USA). A *p* value less than 0.05 was considered statistically significant.

Results

Of the 2053 individuals who were examined, 1051 (51.2%) were male and 1002 (48.8%) female with mean age of 45.3 and 41.6 years, respectively. Commonly reported symptoms

were mouth ulcers (5.8%) followed by dysphagia or difficulty in swallowing (1.5%) and trismus or difficulty in mouth opening (0.5%). The overall proportions of tobacco smoking and chewing were 11.3% and 13.1%, respectively. Approximately three percent (2.7%) were addicted to betel nut, and a few (0.7%) had only alcohol addiction (Table 1). The average age, use of addictive substances and symptoms such as mouth ulcers and trismus among females were significantly less ($P < 0.05$) compared to males. However, the symptom dysphagia was significantly more ($P < 0.01$) among females compared to males.

The overall prevalence of tobacco use was 20.8% (95% CI: 19.2–22.7) (smoked or smokeless) among the screened population, and overall tobacco use (smoked or smokeless) increased with age. However, individually, tobacco smoking showed a consistent increase, whereas tobacco chewing decreased with older age (≥ 55 years). Nearly 50 percent (47.1%) of patients with mouth ulcers, 63.6% with trismus, 50% with ear discharge and 40% with voice hoarseness were using tobacco in either of its forms. All alcohol users and 50% of betel nut users consumed tobacco in some form. The forms of tobacco use were significantly different ($P < 0.05$) with age, gender, symptoms (mouth ulcers, dysphagia, trismus) and other addictions (alcohol consumption and betel nut chewing) (Table 2). Any form of tobacco use increased according to age up to 54 years and then started decreasing in both genders,

Table 1 Gender-wise distributions of background characteristics among screened individuals

Background characteristics	Category	Male (n = 1051) %	Female (n = 1002) %	Total (n = 2053) %
Age (years)	<25	9.8	9.6	9.7
	25–34	15.6	20.6	18.0
	35–44	21.6	26.9	24.2
	45–54	22.1	21.1	21.6
	55–64	17.6	15.3	16.5
	≥ 65	13.3	6.6	10.0
	Mean \pm SD	45.3 \pm 15.5	41.6 \pm 13.6	43.5 \pm 14.7
Symptoms	Mouth ulcers	8.1	3.4	5.8
	Dysphagia	0.5	2.5	1.5
	Trismus	1.0	0.1	0.5
	Ear discharge	0.3	0.3	0.3
	Hoarseness of voice	0.4	0.1	0.2
	Neck Swelling	0.1	0.1	0.1
	Nose bleeding	0.1	0.0	0.05
Addictions	Smoking	20.1	2.0	11.3
	Tobacco chewing	21.5	4.2	13.1
	Alcohol consumption	1.4	0.0	0.7
	Betel nut	5.0	0.3	2.7

Table 2 Prevalence of tobacco use and its association with demographic variables, other addictions and precancerous symptoms

Background characteristics	Total screened (N)	Prevalence of tobacco use (%)				<i>p</i> value*
		Tobacco smoking %	Tobacco chewing %	Any form of tobacco use (95% CI)		
Age (years)						
<25	199	5.0	10.6	13.6	8.8–18.3	<0.001
25–34	370	5.9	13.8	15.7	12.0–19.4	
35–44	497	11.5	14.1	21.7	18.1–25.4	
45–54	443	12.6	15.8	24.4	20.4–28.4	
55–64	338	14.8	11.5	23.7	19.1–28.2	
≥65	206	17.5	8.3	22.8	17.1–28.5	
Gender						
Male	1051	20.1	21.5	34.9	32.0–37.8	<0.001
Female	1002	2.0	4.2	6.1	4.6–7.6	
Symptoms						
Mouth ulcers	119	26.1	34.5	47.1	38.1–56.0	<0.001
Dysphagia	30	3.3	–	3.3	0.6–16.7	0.012
Trismus	11	18.2	63.6	63.6	35.4–84.8	<0.001
Ear discharge	6	16.7	33.3	50.0	18.8–81.2	0.109
Hoarseness of voice	5	20.0	40.0	40.0	11.8–76.9	0.280
Other addictions						
Alcohol use	15	86.7	66.7	100.0	79.6–100.0	<0.001
Betel nut	56	28.6	39.3	50.0	36.9–63.1	0.001
Total	2053	11.3	13.1	20.8	19.2–22.7	

*Age, gender, symptoms and other addictions were compared with any form of tobacco use

and peak use of tobacco (smoked or smokeless) was found to be in the 35–54-year age group (Fig. 1).

On stratification of risk among males and females for tobacco usage according to their age, males consistently showed a three-fold increase in usage from age group 35 and above (risk ratio: 3.2 for 35–44; 3.0 for 45–54; 3.3 for 55–64; 3.1 for ≥65 years). The risk of developing the habit of smokeless

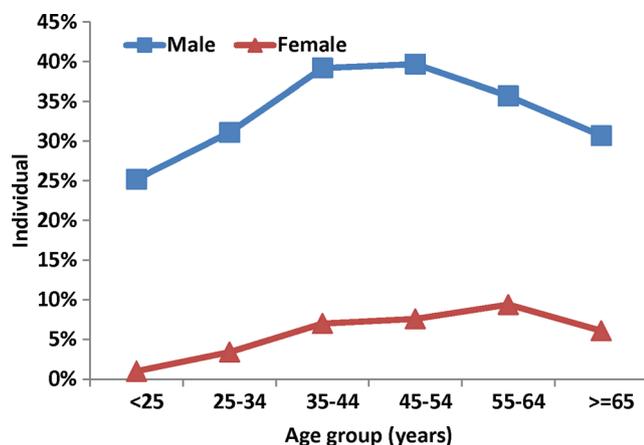


Fig. 1 Prevalence of any form of tobacco use (smoked or smokeless) among males and females according to study population age group

tobacco abuse was highest in the 25–34-year age group (risk ratio: 2.7; 95% CI 1.5–5.1) followed by 35–44 years (risk ratio: 2.4; 95% CI 1.3–4.1) and 45–54 years (risk ratio: 2.3; 95% CI 1.3–4.3) (Fig. 2). However, age was not found to have statistical significance for smoked or smokeless tobacco use in the female population (Appendix 1).

Alcohol users had a nearly 40 times greater risk of developing tobacco smoking (risk ratio: 38.9; 95% CI 8.4–181.2) and 13 times greater risk of initiation of tobacco chewing (risk ratio: 12.8; 95% CI 3.7–44.0), whereas the betel nut users showed a nearly three times greater likelihood of tobacco smoking (risk ratio: 2.6; 95% CI 1.3–5.0) and four times greater chances of the tobacco chewing habit (risk ratio: 4.2; 95% CI 2.4–7.5). Further, no significant association was found among common users of alcohol and betel nut with developing tobacco abuse.

Bivariate and multivariate logistic regression analyses were applied considering mouth ulcers as the dependent variable, and the low prevalence category in each predictor was considered as the reference group. Multivariable analysis confirmed that age 35–44 years [adjusted odds ratio (AOR)=2.8; 95% CI 1.2–6.9], 45–54 years (AOR=2.9; 95% CI 1.2–7.1), male sex (AOR=1.6; 95% CI 1.1–2.6), tobacco smoking (AOR=2.2; 95% CI 1.2–4.2), tobacco chewing (AOR=2.7; 95% CI 1.6–

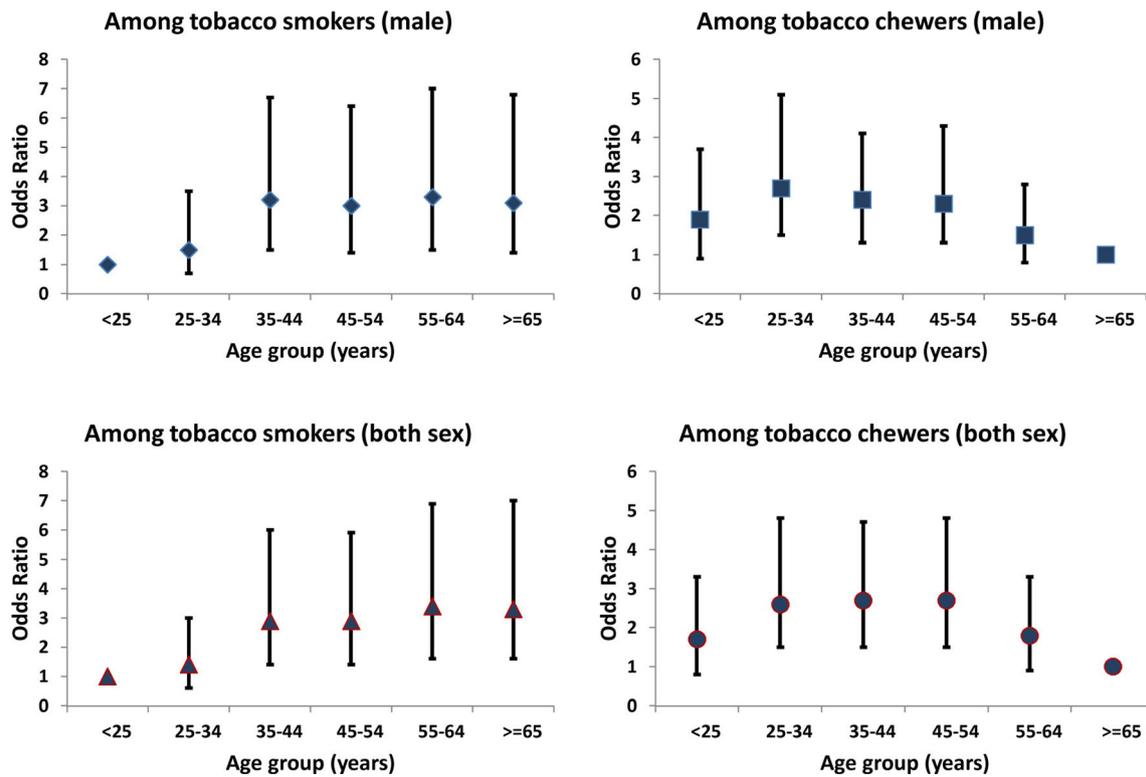


Fig. 2 Risk assessment for tobacco use (smoke and smokeless) in different age groups using logistic regression analysis

4.6) and tobacco use (smoke and smokeless) with betel nut (AOR =5.9; 95% CI 1.5–23.9)] were independently associated with the occurrence of mouth ulcers (Table 3).

Discussion

This study mainly concentrated on the unscreened population of western parts of Uttar Pradesh. We observed that the overall prevalence of tobacco use (any form) was 20.8%, similar to what was found in the earlier studies on India (Chockalingam et al. 2013; Neufeld et al. 2005; Subramanian et al. 2004). The proportion of used tobacco (in any form) in Uttar Pradesh as estimated in the latest national family health survey (NFHS-3) was estimated to be around 40%, higher than the present study particularly among males (IIPS 2007). Prevalence of tobacco use was also observed to be higher in rural areas in the national health survey. Further, the fact that tobacco use increased with age confirms the findings of earlier studies in India and elsewhere (Chockalingam et al. 2013; Giovino et al. 2012; Rani et al. 2003).

With respect to gender, tobacco usage (smoked or smokeless) among males (34.9%) was significantly higher compared to females (6.1%). These results are very similar to a study from southern parts of India (Chockalingam et al. 2013) and other studies on tobacco use in India (Giovino et al. 2012; Rani et al. 2003). A detailed comparison is given in Appendix 2. However, the estimated prevalence of tobacco usage was quite high for

Uttar Pradesh in NFHS-3 (64.3% for males and 12.1% for females) (Giovino et al. 2012). This fact also corroborates the finding of Rani et al. (2003), who reported tobacco use prevalence of 47% in men and 14% in women. Another study by Subramanian et al. (2004) reported a higher tobacco use prevalence of 50.2% for men and 15.5% for women. Moreover, our estimates are closer to those of a study done by Chockalingam et al. (2013) in the city of Chennai and its surroundings (39.6% for males and 5% for females) (Chockalingam et al. 2013). Although the prevalence of smokeless tobacco use in females was found to be relatively less in our study (4.2%), it supports the fact that a similar use of smokeless tobacco is present among women in other Asian countries (Giovino et al. 2012).

An interesting observation from this study showed that younger adults (aged <25 years) use smokeless tobacco twice (10.6% as much as tobacco smoking (5%). A study by Mishra et al. (2009) also reported an increase in the use of smokeless tobacco products among younger age groups (Misra et al. 2009). This may have occurred because it is less expensive and easily available, and smoking in the presence of elders is not socially acceptable. It is already well documented that tobacco use (smoked or smokeless) plays a vital role in the development and progression of cancers (Sarna et al. 2001). However, the overall proportion of tobacco use was low in younger adults, indicating an awareness about the detrimental effects of tobacco use (smoked or smokeless) (Fig. 1) (Chaly 2007).

Alcohol and tobacco are common addictive substances used in India (De Leon et al. 2007; Janghorbani et al. 2003;

Table 3 Factors associated with the occurrence of mouth ulcers using bivariate and multivariate logistic regression analysis

Risk factors	Prevalence of mouth ulcers (%)	Bivariate analysis		Multivariate analysis	
		OR	95% CI	AOR	95% CI
Age (years)					
<25	6.0	2.1	0.8–5.8		
25–34	5.7	2.0	0.8–5.1		
35–44	6.4	2.3	0.9–5.6	2.8e	1.2–6.9
45–54	7.0	2.5e	1.0–6.1	2.9e	1.2–7.1
55–64	5.0	1.8	0.7–4.6		
≥65	2.9	1		1	
Gender					
Male	8.1	2.5e	1.7–3.8	1.6e	1.1–2.6
Female	3.4	1		1	
Addiction habits					
Tobacco smoking	13.4	3.1f	1.9–4.7	2.2e	1.2–4.2
Tobacco chewing	15.3	3.9f	2.6–5.9	2.7f	1.6–4.6
Alcohol consumption	13.3	2.5	0.6–11.3		
Betel nut	19.6	4.3f	2.2–8.5	2.4	0.7–7.6
Joint addictions					
Tobacco smoking and tobacco chewing	22.5	5.3f	2.9–9.6	0.9	0.4–2.4
Tobacco smoking and alcohol consumption	15.4	2.9	0.6–13.6		
Tobacco smoking and betel nut	25.0	5.6f	1.8–17.5	0.7	0.1–3.5
Tobacco chewing and alcohol consumption	10.0	1.8	0.2–14.4		
Tobacco chewing and betel nut	31.8	8.0f	3.2–20.0	1.5	0.3–6.7
Alcohol consumption and betel nut	0	–			
Tobacco smoking, tobacco chewing and betel nut	30.0	7.1f	1.8–27.9	5.9e	1.5–23.9
Tobacco smoking, tobacco chewing and alcohol consumption	12.5	2.3	0.3–19.1		

OR odds ratio, AOR adjusted odds ratio; $e < 0.05$; $f < 0.01$

Katulanda et al. 2014). Simultaneously drinking alcohol and smoking tobacco occur commonly, and the association has been well established (De Leon et al. 2007; Gordon and Doyle 1986; Katulanda et al. 2014; Pohjanpää et al. 1997). In this study, we also documented the strong correlation between alcohol and tobacco use. Alcohol users are 38.9 times more at risk of developing smoking habits and 12.8 times more at risk of developing chewing habits, despite the small proportion of alcohol users in our data (0.7%). A larger data set might throw more light on this propensity. Like alcohol, using betel nut was also strongly associated with tobacco use (smoked or smokeless). Interestingly, betel nut users have almost double the risk of initiating the tobacco chewing habit (4.2 times) rather than the tobacco smoking (2.6 times).

Recent epidemiological studies have shown substantial variation in the prevalence of oral ulcers among different regions throughout the world. The prevalence of recurrent aphthous ulceration (RAU) has been documented from 5 to

66% among differing populations (Abdullah 2013). The result of the present study shows that 5.8% of the total screened population (119/2053) presented with mouth ulcers at the time of the interview. A large hospital-based study by Patil et al. (2014) showed 21.7% prevalence of the RAU, whereas Bhatnagar et al. (2013) reported a lower prevalence of 1.5% among patients visiting a dental health facility in northern India (Bhatnagar et al. 2013). Differences in the estimated prevalence may have occurred because of the place of data collection. The common site of oral ulceration was found to be the buccal mucosae (Fig. 1), as also reported by other studies (Abdullah 2013; Patil et al. 2014). In this study, the majority of symptoms occurred among tobacco users, and they hypothesized a cause and effect relation between tobacco use and oral cavity lesions.

In this study, the most commonly affected age group was those 35–54 old years (13.4%), and the prevalence decreased as the age increased. This result is confirmed by the

multivariable analysis and is in harmony with the findings of Patil et al. (2014) in India and Abdullah (2013) in Iraq (Abdullah 2013). For gender, males were found to be more affected by mouth ulcers. This finding is in line with Rivera-Hidalgo et al. (2004) and not in agreement with others (Abdullah 2013; Patil et al. 2014; Rivera-Hidalgo et al. 2004; Safadi 2009). This could be explained by variations in the data collection methods.

Similar to the findings of other studies, mouth ulcers were less common among tobacco smokers than among subjects with other addictions, indicating the antibacterial effect of smoking might be the reason (Atkin et al. 2002). In addition to smoking, tobacco chewing was also independently associated with the occurrence of mouth ulcers. However, betel nut use was only significantly related in the bivariate analysis. For joint addictions, various combinations of tobacco use (smoked or smokeless), alcohol consumption and betel nut use were analyzed in the regression model. The joint use of tobacco in any form and betel nut is identified as an independent predictor for oral ulcers. We did not find any study so far using regression analysis to correlate different addictions with mouth ulcers. Therefore, these results cannot be compared with the published literature. Moreover, these findings may be very useful in oral health management and policy making at the community level.

Other findings show that the majority of the individuals coming for screening belonged to lower socioeconomic strata and had never reported to a dentist or other health professionals for oral hygiene and ulcer problems because of their lack of awareness. This population subgroup was generally under the impression that oral mucosal changes and ulcerations were self-limiting and did not require any intervention, as also reported by Patil et al. (2014). There may be similar behavior in the unscreened population in India.

The results of this study reflect the prevalence of tobacco use (in any form) and its association with oral ulceration only in the individuals who attended the health camps at one point in time. However, there is no reason to believe that this group of individuals is different from those in other parts of northern India. Furthermore, understanding the prevalence and pattern of mouth ulcers among the Indian population will give an indication of the proportion of people who suffer from this condition and need oral health management. Studying the prevalence also provides an insight into the volume of the population suffering from oral ulcers and the possible related causal factors.

Conclusion

This study provides valuable information about tobacco use and its causal relationship with oral ulceration regarding its prevalence and associated factors among the unscreened

population of northern India. This study reflects the high prevalence of tobacco use (smoked or smokeless) and its association with oral ulceration. The study findings indicate that in many cases joint addictions (tobacco chewing and smoking, alcohol, betel nuts) were also witnessed. This was an important initiative to sensitize the rural community and health workers to detect and prevent oral cancer early. However, comparison of the present results with earlier published studies should be undertaken with care because of divergences in the study design, sample size and geographic location. Therefore, due to a lack of comparable studies in the region, no conclusion could be drawn regarding the precise prevalence of mouth ulcers and their correlates. Careful examination and identification of the underlying factors would be of great help in the management of such oral lesions. The early and correct diagnosis of oral ulcers will be helpful to healthcare providers in the dissemination of awareness regarding the causes and management of the health condition of the general population.

Acknowledgements The authors are grateful to Ms. Niira Radia and Dr. R.K. Mani for their support and valuable suggestions during the study. We also would like to acknowledge Mr. Akash Radia, Col Suresh Bhatt and Ms. Mamata Dasgupta and the outreach team for data collection and its compilation. The present study was based on screening camps funded by Nayati Healthcare and Research Center under their outreach program of the social responsibility program. However, the funders had no role in the writing and submission of the manuscript.

Compliance with ethical standards

Conflict of interest All authors declare they have no conflict of interest.

Appendix 1

Table 4 Risk assessment in different age groups of females for tobacco use (smoke and smokeless) using logistic regression analysis

Age at risk	N	Among tobacco smokers			Among tobacco chewers		
		%	Risk ratio	95% CI	%	Risk ratio	95% CI
Female							
<25	96	1.0	1		–		
25–34	206	0.5	0.5	0.03–7.5	2.9	1	
35–44	270	1.5	1.4	0.2–12.9	5.9	2.1	0.8–5.5
45–54	211	1.9	1.8	0.2–16.7	5.7	2.0	0.7–5.5
55–64	153	3.9	3.9	0.5–32.7	5.2	1.8	0.6–5.4
≥65	66	6.1	6.1	0.7–56.1	–		

Appendix 2

Table 5 Comparison of characteristics of this study with previously published study

Sl no.	Author	Year	Eligibility	Study size and location	Key findings
8	Narayan et al.	1996	All individuals aged 25–64 years	A total of 13,558 adults; Delhi	45% males and 7% were identified as current smokers
2	Gajalakshmi et al.	2003	Any death due to medical reason in 25 years or older age group	Urban (Chennai; 27,043 cases vs. 20,162 controls); rural (South Arcot; 15,998 cases vs. 15,128 controls); 26,197 deaths; Chennai and South Arcot	Overall 27% deaths were associated with tobacco smoking. At ages 25–69 years, 59.6% of the cases and 39% of controls in the urban area and 52.2% of the cases and 42.8% of controls in the rural study area were smokers
9	Gupta & Ray	2003	Review article	Eight rural locations in India	In prevalence surveys in eight rural areas of India, smokeless tobacco use was 3–53% among males and 3–49% among females. Also, in these areas 2–26% of males and 0–4% of females practiced both smoking and smokeless tobacco habits
11	Sinha et al.	2003	School children; <15 years of age	3,566; Patna, Bihar	Tobacco use among children was 6.5% of which 6.2% used tobacco in smokeless form and 0.3% were smokers
17	Rani et al.	2003	Individuals 15 years or older	315,598; National Family Health Survey-2 (1998–99)	47% males and 14% of females either smoked or chewed tobacco
3	Sinha et al.	2004	VIII-X grade school children; age range: 13–15	2636; Patna, Bihar	71.8% (76.5% boys, 57.2% girls) were ever tobacco users; of them 48.9% had used tobacco before 10 years of age
4	Sinha et al.	2004	School personnel (mostly teachers)	993; Uttar Pradesh	Current cigarette smoking, bidi smoking and current smokeless tobacco use was reported by 27.3%, 17.5% and 21.9%
5	Gindal et al.	2005	Adults over 15 years of age	73,605; Multicentric	15.6% of the surveyed population had ever had a smoking habit (28.5% of males and 2.1% of females)
6	Sorensen et al.	2005	All individuals 35 years or older who were listed on the electoral rolls	Male = 27,141; female = 54,696	Male current users (smokeless tobacco = 44.4%, cigarette smoker = 12.4%, bidi smoker = 14.5%); female current users (smokeless tobacco = 56.9%)
1	Reddy et al.	2006	VI-VIII grade school children; age range: 10–16 years	11642; New Delhi and Chennai	Overall, 1667 (14.7%) students had ever used tobacco; 1242 (10.8%) had chewed tobacco, 851 (7.4%) had smoked cigarettes, and 796 (7%) had smoked bidis
7	Pednekar et al.	2006	All individuals aged ≥35 years	A total of 99,958 adults, 40,071 males and 59,527 females, were recruited and surveyed. Mumbai	Low BMI (<18.5 kg/m ²). Male ever users (smoking = 25.2%, smokeless = 19.9%, mixed = 26.4%). Female ever users (smoking = 28.1%, smokeless = 23.3%, mixed = 35.1%). Normal BMI (<18.5 kg/m ²). Male ever users (smoking = 58.8%, smokeless = 62.1%, mixed = 59.5%). Female ever users (smoking = 54.1%, smokeless = 52.2%, mixed = 47.9%)
10	Gindal et al.	2006	All individuals aged 35 years or older	35,296	Overall smokers = 24.7%; cigarette = 6.8%; bidi = 17.2%
12	Kumari and Nath	2008	Undergraduate male medical students	250; Lucknow, Uttar Pradesh	Among the tobacco users (28.8%), smoking was found in 87.5% and tobacco chewing in 37.5%
15	Bhojani et al.	2009	Pre-university students in a college	300; Bangalore, India	The prevalence of 'ever use' of tobacco was 15.7% (95% CI 11.7–20.3) of which 5.3% (95% CI 3.1–8.7) were current users of tobacco
13	Prabhakar et al.	2012	Indian residents ≥15 years in 29 states and 2 Union Territories (UT)	69,030	Among males, the prevalence of tobacco use (current or past) was higher (54%) than among females (23%)
14	Chockalingam et al.	2013	All individuals aged ≥15 years	7510; Chennai city (urban), Ambattur (semi-urban) and Sriperumbudur (rural) taluk	The overall prevalence of tobacco use was significantly higher in the rural (23.7%) compared to semi-urban (20.9%) and urban (19.4%) areas. Tobacco smoking prevalence was 14.3%, 13.9% and 12.4% in rural, semi-urban and urban areas, respectively

Table 5 (continued)

Sl no.	Author	Year	Eligibility	Study size and location	Key findings
16	Singh & Ladusingh	2014	Indian residents ≥ 15 years in 29 states and 2 Union Territories (UT)	69,296	Urban population (smoking only = 14%, smokeless = 17.1%, dual use = 6.4%); rural population (smoking only = 15.5%, smokeless = 26.4%, dual use = 10.5%)

References

- Abdullah MJ (2013) Prevalence of recurrent aphthous ulceration experience in patients attending Piramird dental speciality in Sulaimani City. *J Clin Exp Dent* 5:e89
- Adejuwon G (2009) Tobacco use and second hand smoke as risk factors for diseases in Nigeria: implications for collaborative research and multilevel tobacco control strategies. *Afr J Med Med Sci* 38:21–29
- Atkin P, Xu X, Thornhill M (2002) Minor recurrent aphthous stomatitis and smoking: an epidemiological study measuring plasma cotinine. *Oral Dis* 8:173–176
- Bhatnagar P, Rai S, Bhatnagar G, Kaur M, Goel S, Prabhat M (2013) Prevalence study of oral mucosal lesions, mucosal variants, and treatment required for patients reporting to a dental school in North India: in accordance with WHO guidelines. *J Fam Community Med* 20:41
- Chaly PE (2007) Tobacco control in India Indian. *J Dent Res* 18:2
- Chaudhuri S, Dey S, Bajpai RC (2016) Prevalence of oral ulcers and its association with addictions in rural population of western Uttar Pradesh and eastern Rajasthan. *J Oral Biol Craniofac Res* 6:179–186. doi:10.1016/j.jobcr.2016.04.003
- Chaudhuri S, Dey S, Awasthi A (2017) Epidemiological hazards of tobacco and its manifestations in oral health of a screened population in Northern India. *J Cancer Policy* 12:1–6 doi: 10.1016/j.jcpo.2016.12.006
- Chockalingam K, Vedhachalam C, Rangasamy S, Sekar G, Adinarayanan S, Swaminathan S, Menon PA (2013) Prevalence of tobacco use in urban, semi urban and rural areas in and around Chennai city India. *PloS One* 8, e76005
- Critchley JA, Unal B (2003) Health effects associated with smokeless tobacco: a systematic review. *Thorax* 58:435–443
- De Leon J, Rendon DM, Baca-Garcia E, Aizpuru F, Gonzalez-Pinto A, Anitua C, Diaz FJ (2007) Association between smoking and alcohol use in the general population: stable and unstable odds ratios across two years in two different countries. *Alcohol Alcohol* 42:252–257
- Ezzati M, Lopez AD (2003) Estimates of global mortality attributable to smoking in 2000. *Lancet* 362:847–852
- Giovino GA et al (2012) Tobacco use in 3 billion individuals from 16 countries: an analysis of nationally representative cross-sectional household surveys. *Lancet* 380:668–679
- Gordon T, Doyle JT (1986) Alcohol consumption and its relationship to smoking, weight, blood pressure, and blood lipids: the Albany Study. *Arch Intern Med* 146:262–265
- IIPS (1999) National Family Health Survey (NFHS-2) 1998-99 Volume I vol I. International Institute for Population Sciences, Mumbai, India and Macro International Mumbai, India
- IIPS (2007) National Family Health Survey (NFHS-3) 2005-06 Volume I vol I. International Institute for Population Sciences, Mumbai, India and Macro International Mumbai, India
- Janghorbani M, Ho SY, Lam TH, Janus ED (2003) Prevalence and correlates of alcohol use: a population-based study in Hong Kong. *Addiction* 98:215–224
- Jha P et al (2008) A nationally representative case-control study of smoking and death in India. *N Engl J Med* 358:1137–1147
- Jindal S, Aggarwal A, Chaudhry K, Chhabra S, Gupta D (2006) Tobacco smoking in India: prevalence, quit-rates and respiratory morbidity. *Indian J Chest Dis Allied Sci* 48:37–42
- Katulanda P, Ranasinghe C, Rathnapala A, Karunaratne N, Sheriff R, Matthews D (2014) Prevalence, patterns and correlates of alcohol consumption and its association with tobacco smoking among Sri Lankan adults: a cross-sectional study. *BMC Public Health* 14:1
- Machin D, Campbell MJ, Tan S-B, Tan S-H (2009) Sample size tables for clinical studies, 3rd edn. Wiley-Blackwell, Oxford

- Misra V, Singh PA, Lal N, Agarwal P, Singh M (2009) Changing pattern of oral cavity lesions and personal habits over a decade: hospital based record analysis from Allahabad. *Indian J Community Med* 34:321
- Neufeld K, Peters D, Rani M, Bonu S, Brooner R (2005) Regular use of alcohol and tobacco in India and its association with age, gender, and poverty. *Drug Alcohol Depend* 77:283–291
- Patil S, Reddy SN, Maheshwari S, Khandelwal S, Shruthi D, Doni B (2014) Prevalence of recurrent aphthous ulceration in the Indian Population. *J Clin Exp Dent* 6:e36
- Pohjanpää A, Rimpelä A, Rimpelä M, Karvonen J (1997) Is the strong positive correlation between smoking and use of alcohol consistent over time? A study of Finnish adolescents from 1977 to 1993. *Health Educ Res* 12:25–36
- Rani M, Bonu S, Jha P, Nguyen S, Jamjoum L (2003) Tobacco use in India: prevalence and predictors of smoking and chewing in a national cross sectional household survey. *Tob Control* 12:e4
- Rivera-Hidalgo F, Shulman J, Beach M (2004) The association of tobacco and other factors with recurrent aphthous stomatitis in an US adult population. *Oral Dis* 10:335–345
- Safadi RA (2009) Prevalence of recurrent aphthous ulceration in Jordanian dental patients. *BMC Oral Health* 9:31
- Sarna L, Wewers ME, Brown JK, Lillington L, Brecht M-L (2001) Barriers to tobacco cessation in clinical practice: report from a national survey of oncology nurses. *Nurs Outlook* 49:166–172
- Scully C (2006) Aphthous ulceration. *N Engl J Med* 355:165–172
- Scully C, Felix D (2005) Oral medicine—update for the dental practitioner. Mouth ulcers of more serious connotation. *Br Dent J* 199:339–343
- Scully C, Felix D (2006) Oral medicine—Update for the dental practitioner. Orofacial pain. *Br Dent J* 200:75–83
- Scully C, Flint S, Porter SR, Moos K, Bagan J (2010) *Oral and maxillofacial diseases*, 4th edn. CRC Press, Florida
- Shimkhada R, Peabody JW (2003) Tobacco control in India. *Bull World Health Organ* 81:48–52
- Subramanian S, Nandy S, Kelly M, Gordon D, Smith GD (2004) Patterns and distribution of tobacco consumption in India: cross sectional multilevel evidence from the 1998-9 national family health survey. *BMJ (Clin Res Ed)* 328:801–806