

Pattern of hookah smoking and oral mucosal lesions in Indian population

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Abstract

Objectives: 1. To find out association of characteristics, frequency, duration and quantity of hookah (water-pipe) smoking with oral-mucosal lesions (OMLs) in Indian population. 2. To estimate prevalence of OMLs among hookah smokers.

Methods: A cross-sectional study was done at Jhajjar district, Haryana, India from January to June 2017. Sample size of 900 was calculated based on 30% prevalence of OMLs in pilot study. Participants were selected using multistage sampling and current hookah smokers (smoked hookah in past 30days) were included in study.

Data regarding pattern of hookah smoking was collected through face to face interview using a 37-item pre-tested questionnaire in Hindi. OMLs were recorded using WHO basic oral health survey 2013. 1% toluidine blue staining with punch biopsy of positive lesions were performed.

Chi-square test ($p < 0.05$) and binary logistic regression were used to analyze association of hookah smoking and presence of OMLs.

Results: Study population comprised of 900 hookah smokers among which 98.3% were males (Mean age=52.65±15.6 years). 85.8% subjects were daily hookah smokers. Median time spent per day on smoking was 70 minutes. Mean years spent on smoking hookah in lifetime was 30.39±17.53 years. Mean age of initiation was 22.25±9.94 years.

Prevalence of OMLs was 83.0%. Subjects with duration of smoking ≥ 21 years (OR=2.478; $p=0.000$) and moderate smokers i.e. Smoking Index=101-300, (OR=4.949; $p=0.044$) had more odd's of developing OMLs. Smoker's palate was the commonest lesion. 9.2% leukoplakia, out of which, 58.2% were toluidine blue positive and 2 cases of carcinoma of palate were also detected.

Conclusion: Hookah smoking may be potential risk factor for oral cancer and potentially malignant disorders which was significantly associated with quantity and duration of smoking. Creating awareness is paramount necessity as cognitive dissonance regarding harm caused by hookah is immense.

Keywords: Hookah, waterpipe, tobacco, smoking, prevalence

Introduction

Tobacco is a known carcinogenic to humans as declared by the International Agency for Research on Cancer (IARC).¹ It can cause a wide spectrum of oral mucosal alterations or lesions including oral pre-malignant disorders and oral cancer. Along with causing oral cancer, tobacco products also affect oral health, particularly causing a wide range of problems such as halitosis, hyperpigmentation, periodontitis and increased susceptibility to infections.² Among various forms of tobacco used, smoking tobacco particularly, has a very high annual cancer transformation rate.³ Type of tobacco used for smoking, the way in which it is smoked and the frequency and duration of use determine the type and location of the alteration/lesion in oral mucosa.⁴

Currently tobacco is used by more than a billion people worldwide in various forms, and about 80% are from middle- and low-income countries.⁵ Commonly used smoked forms include cigarette, bidis, cigar, pipe and hookah.^{6,7} The use of tobacco in India has witnessed varied patterns since ancient times, which include smoking, chewing, applying, sucking, gargling, and so on and each of these patterns of consumption is governed by the geographic area, economic status, sociocultural, and religious influences.⁸ Presently, India has more than 26.7 crore tobacco consumers out of which 10 crore smoke tobacco

in some form.⁹ Also at the same time in India oral cancer accounts for over 30% of all cancers which is more than any other country in the world.¹⁰

Hookah is a form of smoking tobacco which is thought to have originated in Central Asia. It consists of an apparatus that has a container for water and a chamber where tobacco is placed; a pipe is connected through a tube and placed in the mouth to smoke the tobacco. It is very common in the Asian continent, in countries like India, Pakistan, Bangladesh, and also in the Arabian Peninsula.¹¹

Hookah users have a common misconception that hookah is not as harmful as cigarettes, thus further promoting the use. However, tobacco used in hookah contains many of the same substances as cigarettes including nicotine, tar, and heavy metals. It also contains the byproducts from the charcoal used to heat the tobacco. When comparing cigarettes and hookah, the World Health Organization (2005)¹² reported that a single-hour session of hookah use is approximately the equivalent to the smoke inhaled by smoking 100 or more cigarettes, which clearly reflects the severity and magnitude of health effects it can cause.¹³

Studies have also indicated that hookah smokers absorb high levels of toxins and carcinogens which acts as a risk factor for cardiovascular

diseases, respiratory diseases and lung cancer, oesophageal cancer and adverse pregnancy outcomes.¹⁴ Thus, the composition of tobacco and heated charcoal used for hookah smoking has potential carcinogens and high temperatures which can manifest oral mucosal changes. In addition to systemic issues, risks of acquiring infectious diseases such as tuberculosis, herpes simplex virus, and hepatitis from sharing mouthpieces due to the social nature of this practice, is also a matter of concern.¹³ Large quantity of second hand smoke produced from hookah is also a health hazard. It contains smoke from the tobacco and smoke from the heat source (e.g., charcoal) used in the hookah.¹⁵⁻¹⁷

Hookah smoking is now considered a public health threat and the American Lung Association has recently called it the ‘emerging deadly trend’.¹⁸ However, very few epidemiological studies have documented the full spectrum of adverse oral health consequences of hookah smoking. There is also paucity of data specifically pertaining to prevalence of oral mucosal lesions (OMLs) particularly among hookah smokers.^{19,20} Hence the current study was undertaken. The objective of this study is to find out oral-mucosal lesions among hookah smokers and its association with pattern of hookah smoking in Jhajjar district, Haryana.

Material and methods

A cross sectional study was carried out from January to April, 2017 to evaluate oral mucosal lesions (OMLs) among hookah smokers of Beri Tehsil, Jhajjar district.

Multistage sampling method was used. The state of Haryana is divided into 4 administrative blocks- Ambala, Gurgaon, Hisar and Rohtak. Among these Rohtak administrative block was selected. Under Rohtak block there are 5 districts- Jhajjar, Karnal, Panipat, Rohtak and Sonapat. Among these Jhajjar was selected. Under Jhajjar district there are 4 tehsils- Jhajjar, Matanhail, Beri and Bahadurgarh. Among these Beri was selected. Out of 77 villages in Beri, 22 villages were selected randomly through simple random sampling procedure. Approximately 80% of the study subjects were selected from the villages accounting to at least 15 study subjects from each village. Proportional to the village population, every ‘nth’ house was selected to achieve desired sample size. If consent is not obtained from the selected house or there is no study subject present, next house will be selected. Similarly 20% were recruited from urban areas of Beri town.

A sample size, of 897 which is rounded to 900 was calculated at 30% prevalence obtained from pilot study, 95% confidence interval and 10% margin of error.

Subjects included in this study subject were adults more than 18 years of age who were current hookah smokers i.e. have smoked hookah at least once in past 30 days and gave consent to participate. Subjects who had alcohol habit or those with serious systemic disorders were excluded from the study. This study was approved by the Institutional Ethical Committee (PGIDS/IEC/2016/66) and informed consent was taken from all participants prior to data collection and oral examination.

Data collection included a combination of questionnaire administration and clinical examination for the assessment of OMLs. A structured questionnaire in Hindi language was developed for the study. A pilot study was done to assess feasibility of study and reliability of the questionnaire. Test retest of the questionnaire was done at two weeks interval among 20 hookah smokers at General Hospital, Beri. Reliability was assessed using the intra-class correlation coefficient (ICC) which was found to be 0.83.

The main domains of the questionnaire were pattern of hookah smoking (i.e. frequency, duration, income spent, age and reason

for initiation) and characteristics pertaining to practice of hookah smoking (i.e. mixed tobacco habits, company for smoking and family members smoking hookah).

For the purpose of quantification, “Hours of smoking in lifetime” variable was generated. The product of frequency of hookah smoking per day and hours of smoking per day was multiplied to the number of years the subject has been smoking hookah.

To quantify further, a 20minutes session of hookah was considered equivalent to 25 cigarettes.²¹ One pack year is defined as one pack of cigarette (i.e. equal to 20 cigarettes) smoked daily for one year i.e. 7300 cigarettes \approx 1 Pack year. Smoking Index is defined as the number of cigarettes smoked per day multiplied by the number of years smoked.

Based upon Smoking Index(SI) and Pack Years(PY), subjects were categorized into the following groups: Light smokers [SI=1-100, PY=1-5], Moderate smokers [SI=101-300, PY=6-15] and Heavy smokers [SI \geq 301, PY \geq 16].

Hookah smoking sessions in terms of **Cigarettes/day** = Number of 20 minutes sessions/day \times 25

Pack years of study subjects = Cigarettes/day \times Years of smoking hookah
20

Smoking Index = Cigarettes/day \times Years of smoking hookah

A single examiner conducted the oral examination. The training and calibration of investigator was done prior to the pilot study in the Department of Public health Dentistry, Post graduate Institute of Dental Sciences Rohtak. Oral examination was done using CPI probe and plain mouth mirror. A modified WHO 2013 format was used.²² OMLs were assessed based on WHO criteria.²³ Toluidine blue staining²⁴ was done to assess dysplastic changes in OMLs.

All participants after examination were assessed on stage of change model and were given a brief advice; tailored health education material informing them about health risks associated with hookah smoking. The data was analyzed using SPSS 21 (Statistical Package for Social Sciences) package for relevant statistical comparison. Significance of the variables has been assessed through chi-square test. $P \leq 0.05$ is considered as the level of significance throughout the study.

Results

As per Table 1; in this study 98.3%(885) of the hookah smokers were males and 1.7%(15) were females. The mean age of the study population was 52.65 \pm 15.6 years. 20%(180) were illiterate and farming was the major occupation with approximately 75% subjects being farmers. According to BG Prasad scale²⁵ used for socio-economic classification of the subjects, most of them i.e. 49.7%(447) belong to Class IV(Lower middle class) while 20.2%(182) belong to Class V(Lower class).

It was found that 85.3%(768) of the study subjects smoke hookah daily, 12.6%(113) smoke hookah once in 2-3 days while around 2.1%(19) subjects smoke hookah occasionally i.e. once in a week. The duration of session varied from less than 10 minutes (34.3%(309)) to more than 1hour (14.4%(130)). It was found that 21.4%(193) subjects had tried quitting hookah in past. Also 53.4%(481) reported that they are exclusively hookah smokers while 45.6%(411) subjects reported that they smoke bidi along with hookah.

Among 900 study subjects, 17.0%(153) subjects had no oral mucosal lesion. 60.4%(544) subjects smokers’ palate, 21.5%(194) subjects melanosis, 31%(279) had thermal burns and 9.2% had leukoplakia.

Other lesions found in study subjects were candidiasis, leukedema, hyperkeratosis, ulceration and vascular lesions in 4.5%(41), 5.6%(51), 1.4%(13), 0.9%(8) and 0.6(6) subjects respectively. 0.2%(2) prevalence of malignant tumor was seen in the study population with both the subjects having lesion on the hard/soft palate area.

Toluidine blue staining was done for dysplastic lesions upon which 58.2%(46) lesions stained positive with toluidine blue stain while 41.8%(33) stained negative. (Figure 1)

Table I Socio-demographic details and pattern of hookah smoking

CHARACTERISTICS	FREQUENCY	PERCENTAGE (%)
GENDER		
MALE	885	98.3
FEMALE	15	1.7
AGE (in years)		
18-39 YEARS	178	19.8
40-59 YEARS	388	43.1
≥60 YEARS	334	37.1
MARITAL STATUS		
MARRIED	847	94.1
UNMARRIED/WIDOWED/SEPARATED	53	5.8
EDUCATIONAL STATUS		
ILLITERATE	180	20
PRIMARY SCHOOL EDUCATION	105	11.7
MIDDLE SCHOOL EDUCATION	152	16.9
HIGH SCHOOL EDUCATION	282	31.3
INTERMEDIATE	114	12.7
GRADUATE	63	7
POSTGRADUATE	4	0.4
OCCUPATIONAL STATUS		
UNEMPLOYED	76	8.4
FARMER	675	75
UNSKILLED WORKER	32	3.6
SEMI-SKILLED WORKER	24	2.7
SKILLED WORKER	38	4.2
CLERK/ SHOPOWNER	42	4.7
SEMI-PROFESSION	4	0.4
PROFESSION	9	1
SOCIO-ECONOMIC STATUS (B.G.PRASAD SCALE)		
CLASS I (UPPER)	7	0.8
CLASS II (UPPER MIDDLE)	62	6.9
CLASS III (MIDDLE)	202	22.4
CLASS IV (LOWER MIDDLE)	447	49.7
CLASS V (LOWER)	182	20.2
FREQUENCY OF SMOKING HOOKAH		
EVERYDAY	768	85.3
ONCE IN 2-3 DAYS	113	12.6
WEEKLY	19	2.1
LENGTH OF HOOKAH SMOKING SESSION (past 30 days)		
0-10 MINUTES	309	34.3
11-30 MINUTES	398	44.2
31-60 MINUTES	63	7
>60 MINUTES	130	14.4
CONSUMPTION OF TOBACCO IN ANY OTHER FORM with HOOKAH		
BIDI	411	45.6
CIGARETTE	22	2.4
CHEWING TOBACCO	2	0.2
NONE (exclusively hookah smokers)	481	53.4
PREVIOUS QUIT ATTEMPTS (to quit hookah smoking)		
YES	193	21.4
NO	707	78.6

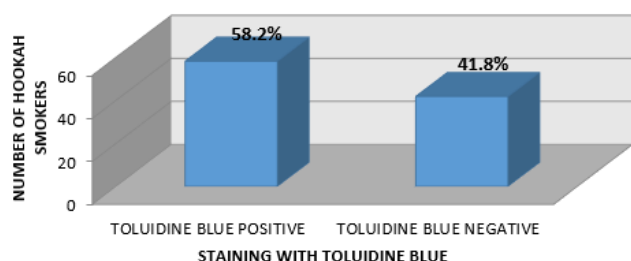


Figure 1 Lesions (leukoplakia & malignant lesions) which stained positive with toluidine blue stain.

As per location (Table 2) it was found that 60.4%(544) subjects had

Table 2 Prevalence of oral mucosal lesions in hookah smokers as per location

ORAL MUCOSAL LESION	COMMISSURES	LIPS	SULCI	BUCCAL MUCOSA	HARD/ SOFT PALATE	ALVEOLAR RIDGES/ GINGIVA	TOTAL
SMOKER'S PALATE	0	0	0	0	544 (60.4)	0	544 (60.4)
MELANOSIS	0	6 (0.6)	0	187 (20.7)	0	1 (0.1)	194 (21.5)
LEUKEDEMA	0	1 (0.1)	0	50 (5.5)	0	0	51 (5.6)
LEUKOPLAKIA	0	27 (3.0)	0	54 (6.0)	1 (0.1)	1 (0.1)	83 (9.2)
CANDIDIASIS	9 (1.0)	4 (0.4)	0	24 (2.6)	3 (0.3)	1 (0.1)	41 (4.5)
ULCERATION	1 (0.1)	2 (0.2)	1 (0.1)	3 (0.3)	0	1 (0.1)	8 (0.9)
MALIGNANT TUMOR	0	0	0	0	2 (0.1)	0	2 (0.2)
ABSCCESS	0	0	0	0	1 (0.1)	0	1 (0.1)
THERMAL BURNS	0	276 (30.6)	0	3 (0.3)	0	0	279 (31.0)
VASCULAR LESION	1 (0.1)	0	0	5 (0.5)	0	0	6 (0.6)
HYPERKERATOSIS	0	0	0	13 (1.4)	0	0	13 (1.4)
TOTAL	11	316	1	339	551	4	1222
	-1.2	-35.1	-0.1	-37.6	-61.1	-0.4	

Table 3 Distribution of oral mucosal lesions in hookah smokers as per years of smoking

ORAL MUCOSAL LESION	≤10 YEARS	11-20 YEARS	≤21 YEARS	TOTAL	p value
SMOKER'S PALATE	78 (8.6)	68 (7.5)	398 (44.2)	544 (60.4)	0
MELANOSIS	24 (2.6)	19 (2.1)	136 (15.1)	179 (19.9)	0.024
LEUKEDEMA	10 (1.1)	19 (2.1)	22 (2.4)	51 (5.6)	0.532
LEUKOPLAKIA	7 (0.7)	6 (0.6)	38 (4.2)	78 (8.7)	0.026
CANDIDIASIS	4 (0.4)	4 (0.4)	31 (3.4)	39 (4.3)	0.248
ULCERATION	2 (0.2)	0	6 (0.6)	8 (0.9)	0.498
MALIGNANT TUMOR	0	0	2 (0.2)	2 (0.2)	-
ABSCCESS	1 (0.1)	0	0	1 (0.1)	-
THERMAL BURNS	34 (3.7)	41 (4.5)	206 (22.8)	278 (31.0)	0.006

lesion smokers' palate affecting either hard or soft palate. Around 20.7%(187) subjects had melanosis affecting buccal mucosa while 0.6%(6) subjects had melanosis affecting lips/labial mucosa. 6%(54) had leukoplakia in buccal mucosa while 3%(27) had leukoplakia involving lips/labial mucosa, 2.6%(24) subjects had candidiasis involving buccal mucosa. Most of the subjects having thermal burns i.e. around 30.6%(276) had lesion in the lower lip/labial mucosa. Most of the cases of vascular lesions and hyperkeratosis involved buccal mucosa i.e. 0.5%(5) and 1.4%(13) of all study subjects respectively. Fordyce's granules were also found in buccal mucosa of 11%(99) subjects while it also involved lips/labial mucosa of around 1.6%(15) subjects. As shown in Table 3, lesions like smokers' palate, leukoplakia, melanosis and thermal burns increased significantly years of smoking i.e. smoking more than 20 years.

After quantification of hookah smoking, values were highly skewed for all four quantification variables; hence median values for smokers belonging to different age group have been reported in table 4. It was observed that older individuals were having higher values for all four variables suggestive of heavy smoking. Median value of number of hours of lifetime hookah smoking, cigarettes/day, smoking index and pack year for subjects older than 60 years was 22508.33 (136.27-168812.50), 106.25 (0.8-468.5), 4625 (28-34687.50) and 231 (1.40-1734.38) respectively.

As depicted in table 5, among subjects who were illiterate 84.4%(152) had some oral mucosal lesion; 88.6%(93) of those with primary school education had lesion and 86.2%(131) of those having middle school education had some oral mucosal lesion (p=0.004). It was found that subjects with mixed habits i.e those who consume tobacco in any other form along with hookah, had significantly more OMLs (p= 0.041).

We found that 87.6%(532) of those who have smoked hookah for more than 20 years had some oral mucosal lesion. 74%(94) and 72.9%(121) of those who have been smoking hookah for 11-20 years and less than

10 years respectively had some lesion (p= 0.041). Smokers' palate, melanosis, leukoplakia, thermal burns and hyperkeratosis increased significantly years of smoking.

It was seen that 90%(117) subjects who had smoked hookah for more than 40,000 "Hours in lifetime" had lesions as compared to 81.8%(630) subjects who smoked less than 40,000 "Hours in lifetime" and had lesions in oral cavity (p= 0.012).

As per Table 4, the overall mean years of hookah smoking in the study population was 30.39± 17.53 years and it significantly increased with age. Median pack years of smoking were found to be 82.03. Median smoking index for the study population was 1640.62 i.e. heavy smokers. Based on Pack Years and Smoking Index, moderate and heavy smokers showed significantly more OMLs as compared to light smokers (p=0.000) as depicted in Table 5.

When binary logistic regression was applied to verify the association between smoking index, years of smoking hookah and presence of OMLs; it was found that those who smoked hookah for more than 20 years had more lesions as compared to those who had smoked for less than 10 years (OR=2.478) as shown in Table 6.

Table 4 Hookah smoking quantification in term of median quantity of smoke variable (i.e. hours of smoking in lifetime), cigarette per day, smoking index & pack years as per age range

AGE RANGE	MEDIAN QUANTITY OF SMOKE (i.e. hours of smoking in lifetime)	MEDIAN CIGARETTE/DAY	MEDIAN SMOKING INDEX	MEDIAN PACK YEARS
18-39 YEARS	1368.75 (7.60-61593.75)	31.25 (0.8-468.5)	281.25 (1.56-12656.25)	14.06 (0.08-632.81)
40-59 YEARS	8516.67 (15.21-114062.50)	87.5 (0.8-468.5)	1750 (3.13-23437.50)	87.5 (0.16-1171.88)
≥60 YEARS	22508.33 (136.27-168812.50)	106.25 (0.8-468.5)	4625 (28-34687.50)	231.25 (1.40-1734.38)
TOTAL	7984.38 (7.60-168812.50)	87.5 (0.8-468.5)	1640.63 (1.56-34687.50)	82.03 (0.08-1734.38)

Table 5 Association of oral mucosal lesion in hookah smokers

CHARACTERISTICS	LESION PRESENT (%)	LESION ABSENT (%)	Level of significance
EDUCATIONAL STATUS			
ILLITERATE	152 (84.4)	28 (15.6)	$\chi^2= 19.088$ p= 0.004
PRIMARY SCHOOL EDUCATION	93 (88.6)	12 (11.4)	
MIDDLE SCHOOL EDUCATION	131 (86.2)	21 (13.8)	
HIGH SCHOOL EDUCATION	240 (85.1)	42 (14.9)	
INTERMEDIATE GRADUATE/POST-GRADUATE	82 (71.9)	32 (28.1)	
PATTERN OF SMOKING			
MIXED HABITS (HOOKAH+BIDI/CIGARETTE/CHEWING TOBACCO)	358 (85.4)	61 (14.6)	$\chi^2= 3.312$ p= 0.041
EXCLUSIVE HOOKAH SMOKERS	389 (80.9)	92 (19.1)	
YEARS OF SMOKING			
≤10 YEARS	121 (72.9)	45 (27.1)	$\chi^2= 28.565$ p= 0.000
11-20 YEARS	94 (74)	33 (26.0)	
≥21 YEARS	532 (87.6)	75 (12.4)	
QUANTITY OF SMOKE (i.e. hours of smoking in lifetime)			
0-40000 hours	630 (81.8)	140 (18.2)	$\chi^2= 5.277$ p= 0.012
≥ 40001 hours	117 (90.0)	13 (10.0)	
CIGARETTES/DAY			
0-20 CIGARETTES/DAY	160 (85.9)	28 (14.9)	$\chi^2= 0.747$ p= 0.227
≥20 CIGARETTES/DAY	587 (82.4)	125 (17.6)	

Table Continued...

CHARACTERISTICS	LESION PRESENT (%)	LESION ABSENT (%)	Level of significance
PACK YEARS			
0-5 PACK YEARS	72 (66.7)	36 (33.3)	$\chi^2= 24.351$ $p= 0.000$
6-15 PACK YEARS	62 (89.9)	7 (10.1)	
≥16 PACK YEARS	613 (84.8)	110 (15.2)	
SMOKING INDEX			
1-100	72 (66.7)	36 (33.3)	$\chi^2= 25.378$ $p= 0.000$
101-300	72 (91.1)	7 (8.9)	
≥301	603 (84.4)	110 (15.6)	

Table 6 Stepwise binary logistic regression: odd's ratio & β coefficient for association of smoking index, years of smoking and presence of oral mucosal lesion

HOKKAH SMOKING	VARIABLE	β COEFFICIENT	STANDARD ERROR	WALD'S RATIO	ODD'S RATIO	95% CI	P VALUE
YEARS OF SMOKING	≤10 YEARS	REFERENCE CATEGORY					
	11-20 YEARS	-0.018	0.292	0.004	0.982	0.554- 1.742	0.951
	≥21 YEARS	0.908	0.258	12.406	2.478	1.496- 4.107	0
SMOKING INDEX	1-100	REFERENCE CATEGORY					
	101-300	1.599	0.449	12.68	4.949	2.052- 11.934	0
	≥301	0.544	0.269	4.073	1.723	1.016- 2.921	0.044

Similarly those who were moderate smokers i.e. smoking index 101-300; had more lesions as compared to light smokers (OR=4.949). Also the odd's of having a lesion for heavy smokers was lower than that for moderate smokers (OR=1.723).

Discussion

In our study out of 900 study subjects, 98.3% were males while 1.7% were female hookah smokers. These findings are similar to that reported in nearby areas and also corroborate to earlier studies.²⁶⁻²⁹ Regarding literacy rates of study population it was found that 20% of the study population was illiterate which is slightly higher than the overall literacy rates of the Haryana as per national census. About 70% of the participants belonged to the lower middle and lower socio-economic class unlike as reported by Kakodkar PV et al³⁰ where most of the subjects belonged to upper, upper middle and middle class.

Also in our study it was found that 85.3%(768) of the study subjects smoke hookah daily, which is alarmingly higher than that reported by Mazaik et al²⁶, Dar-Odeh et al³¹ and Combrink et al.³² In our study subjects the average length of smoking was around 11-30 minutes which was lesser than those reported for Syrian subjects where the hookah session ranged for 60 minutes²⁶, however these subjects were also not daily smokers unlike our study population.

Although majority of our subjects were exclusively hookah smokers, this can be attributed to the fact that it is the cheapest form of tobacco available. Bidi and cigarette smoking were other habits present in our study subjects which is similar to study conducted in 1977 in a village near Bhiwani, Haryana.³³ These findings indicates the gravity of addiction to tobacco as hookah smoking is usually practiced at a localized place and people resort to other tobacco products when they go for work or at other places.

Mean age of initiation of hookah smoking for the study population was found to be 22.25±9.94 years which was similar to another Indian study by Jindal SK et al³⁴ (20-21years). This was more than the age of initiation reported by Qudsia Anjum et al³⁵, Mazaik et al.³⁶ This is

suggestive of the fact that hookah smokers generally tend to initiate smoking when they are grownup to take their own decisions apart from the influence on their families. This decision is usually affected by the social circle and local culture of community which often leads an individual to start smoking hookah. Another observation was that most of the subjects were farmers by profession and hence resorted to this habit in the middle age as a leisure activity to keep them occupied.

Prevalence of OMLs among hookah smokers in this study was 83%. All the lesions were diagnosed in accordance with international recommendations.^{22,37-40} Since there is no previous study available in literature about the association of OMLs and hookah smoking the findings of current study are being compared to studies on association of other tobacco smoking habits particularly cigarette smoking and OMLs.

Around 2 (0.2%) subjects were found to have malignant tumor (squamous cell carcinoma) of the hard/soft palate area which is the usual area of placement of hookah mouth piece which was higher than 0.03% reported by Lay KM et al⁴¹ but lower than 1.1% reported by Ahmadi-Motamayel F et al⁴² among cigarette smokers and 2.4% reported by Ramulu C et al⁴³ among reverse smokers.

Prevalence of leukoplakia was 9.2% which was lower than 14.4%, 13.6% as reported by Sujatha D et al⁴⁴ and Salonen L et al⁴⁵ respectively but higher than 2.3% reported by Al-Attas SA et al⁴⁶ in subjects with mixed tobacco habits. Prevalence of smokers' melanosis was 21.5% which was higher than 11.8% as reported by Sujatha D⁴⁴ et al however it was lower than 36% prevalence as reported by Al-Attas SA et al⁴⁶ in subjects with mixed tobacco habits. Another study with a larger sample of 31,000 smokers from Swedish population found same prevalence (21.5%) for smokers' melanosis.⁴⁷

Smokers' palate was the highest reported lesion affecting 60.4% of subjects, similar to 62.79% prevalence among reverse smokers reported by Ramulu C et al.⁴³ The prevalence was higher than that reported by Al-Attas SA et al⁴⁶ among Arabic smokers with mixed

habits and Salonen L et al⁴⁵ among Swedish population. Such high prevalence can again be attributed to the mucosal changes caused by the delivery of carcinogens at a high temperature directly at the level of hard/soft palate from the mouthpiece of hookah just like reverse smoking.

More lesions were found in those belonging to lower middle socio economic class with education less than primary school level. This can be attributed directly to lack of awareness as evident from the results of this study among lower socio-economic classes. Those who worked as unskilled workers or practiced farming had more lesions. This was because majority of this group were involved in their respective occupation for some particular time in a year with more spare time to smoke hookah and they even smoke hookah at workplace i.e. usually farms etc.

More lesions were seen in subjects with mixed habits i.e. consumption of tobacco in other forms along with hookah smoking. The possible reason could be increase in time of contact or exposure to tobacco as compared to exclusive hookah smokers.

Quantification of hookah smoking is an important feature of this study. This can be used to compare hookah smoking with other forms of tobacco. We did quantification based on hours spent smoking hookah in lifetime, hookah sessions in terms of cigarettes per day, smoking index⁴⁸ and pack years.

Presence of OMLs increased significantly among subjects with more years, hours of hookah smoking in their lifetime but who were moderate smokers in terms of cigarettes per day, pack years and smoking index in our study. This finding was similar to the effect of cigarette smoking over the risk of developing oral epithelial dysplasia. Li L et al⁴⁹ found almost 3 times risk of developing oral dysplasia in subjects with cigarette smoking more than 15 pack years but these were subjects who smoked moderately for more number of years. Systematic review by Lubin JH et al⁵⁰ found evidence that the risk of developing oral cancer was more for moderate smokers who smoked for a longer period of time.

Thus similar to cigarette, hookah smoking followed a direct relationship i.e. increase in both quantity and duration lead to increase in OMLs. But for quantity of hookah smoked, this relationship is followed only for transition from light smoking to moderate smoking. For heavy smokers again the number of lesions decreased when compared to moderate smokers. However for number of years spent smoking hookah i.e. duration followed direct relationship with development of OMLs across all categories. This suggests that after a cut-off dose of nicotine and other carcinogens, the changes to mucosa may be irreversible. Hence, further longitudinal studies are required to measure this dose response relationship of hookah smoking and development of OMLs.

In particular, cross-sectional studies do not establish causal relationships, and thus caution should be exercised in interpreting the reported odds ratio. However, our aim was to establish the prevalence of suspicious OMLs among hookah smokers. Since the information on the habits was self-reported, there can be information and recall bias expected. However, the information was gathered through structured interviews and use of questionnaire by a single examiner, minimizing the possibility of any misclassification of the exposure. Also quantification of hookah smoking was done based on current smoking status. However shifts in pattern and frequency of smoking are often observed among smokers. Majority of the subjects also had habit of alcohol consumption which could be confounding factor contributing to the oral mucosal changes. Clinical examination and toluidine blue

staining was used to identify suspicious oral lesions, but very few with dysplastic toluidine blue positive results gave consent for biopsy of lesion. Hence further research is needed to closely study the rate of progression of OMLs histologically among hookah smokers from epithelial dysplasia, as established by our findings, to various stages of malignancy.

Conclusion

Within its limitations, the study provides information about the pattern of use and personal characteristics of hookah smokers. Moreover with dearth of data on hookah smoking this study provides important preliminary insights into the magnitude of problem and also highlights the intensity of serious situation of tobacco use which has missed the focus of policy makers. Socially acceptable health education programs should be conducted for public to counteract the ancient lore and popular belief that hookah smoking is safe, also regarding the risk and their potential effects on young children, pregnant women and others. This will also assist in formulating appropriate nationwide hookah cessation programs along with spreading awareness about its harmful effects.

Acknowledgments

None.

Conflicts of Interest

None.

References

1. IARC Working Group on the Evaluation of Carcinogenic Risk to Humans. Tobacco Smoke and Involuntary Smoking. *Lyon: International Agency for Research on Cancer*; 2004. (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, No. 83).
2. Abro B, Pervez S. Smoking and Oral Cancer. In: *Development of Oral Cancer 2017* (pp. 49-59).
3. Lee JJ, Hong WK, Hittelman WN, et al. Predicting cancer development in oral leukoplakia: ten years of translational research. *Clin Cancer Res*. 2000;6(5):1702–1710.
4. DK Daftary, PR Murti, RB Bhonsle, et al. Oxford Medical Publications. Oral precancerous lesions and conditions of tropical interest. In: Prabhu SR, Wilson DF, Daftary DK, Johnson NW, (eds). *Oral diseases in the tropics*; 1992:402–428.
5. WHO fact sheet, Tobacco, June 2016.
6. Types of tobacco use. Available from <http://www.who.int/tobacco/en/atas4.pdf>. Accessed on 2/11/17
7. Prevalence of tobacco smoking. Available from <http://www.who.int/gho/tobacco/use/en/>. Accessed on 2/11/17.
8. Reddy KS, Gupta PC. Tobacco control in India. New Delhi: Ministry of Health and Family Welfare, Government of India. 2004:43-47.
9. Global Adult Tobacco Survey -2. INDIA 2016-17. Available from <http://nicpr.res.in/index.php/component/k2/item/276-global-adult-tobacco-survey>. Accessed on 2-11-17
10. Dangi J, Kinnunen TH, Zavras AI. Challenges in global improvement of oral cancer outcomes: findings from rural Northern India. *Tob Induc Dis*. 2012;12;10(1):10–15.
11. Viegas CA. Noncigarette forms of tobacco use. *J Bras Pneumol*. 2008;34(12):1069–1073.
12. World Health Organization, WHO Study Group on Tobacco Product Regulation. Advisory note: waterpipe tobacco smoking: health effects, research needs and recommended actions by regulators. 2005.

13. Jarrett T, Blossnich J, Tworek C, et al. Hookah use among US college students: results from the National College Health Assessment II. *Nicotine Tob Res.* 2012;14(10):1145–1153.
14. The hazards of hookah. Available from https://www.health.harvard.edu/newsletter_article/The_hazards_of_hookah. Accessed on 2-11-17.
15. Cobb CO, Vansickel AR, Blank MD, et al. Indoor air quality in Virginia waterpipe cafes. *Tob control.* 2013;22(5):338–343.
16. Trend AE. Waterpipe Tobacco Use. American Lung Association. 2007.
17. US Department of Health and Human Services. Preventing tobacco use among youth and young adults: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. 2012;3.
18. American Lung Association, An Emerging Deadly Trend; Waterpipe Tobacco Use, 2007 American Lung Association: Washington, DC.
19. Javed F, ALHarthi SS, BinShabaib MS, et al. Toxicological impact of waterpipe smoking and flavorings in the oral cavity and respiratory system. *Inhal Toxicol.* 2017;29(9):389–396.
20. Seifi S, Feizi F, Mehdizadeh M, et al. Evaluation of cytological alterations of oral mucosa in smokers and waterpipe users. *Cell J.* 2014;15(4):302–309.
21. Waterpipe tobacco smoking: Health effects, research needs and recommended actions by regulators WHO study group on tobacco product regulation (Tob Reg) 2005.
22. Oral Health Survey. Basic methods, 5th ed. Geneva, World Health Organization 2013;83–88.
23. Kramer IR, Pindborg JJ, Bezroukov V, et al. Guide to epidemiology and diagnosis of oral mucosal diseases and conditions. World Health Organization. *Community Dent Oral Epidemiol.* 1980;8(1):1–26.
24. Myers EN. The Toluidine Blue Test in Lesions of the Oral Cavity. *CA Cancer J Clin.* 1970;20(3):134–139.
25. Prasad BG. Social Classification of Indian families. *J Indian Med Assoc.* 1961;37:250–251.
26. Maziak W, Hammal F, Rastam S, et al. Characteristics of cigarette smoking and quitting among university students in Syria. *Prev Med.* 2004;39(2):330–336.
27. Poyrazoğlu S, Şarli Ş, Gencer Z, et al. Waterpipe (narghile) smoking among medical and non-medical university students in Turkey. *Ups J Med Sci.* 2010;115(3):210–216.
28. Al-Naggar RA, Saghir FS. Water pipe (shisha) smoking and associated factors among Malaysian university students. *Asian Pac J Cancer Prev.* 2010;12(11):3041–3047.
29. Anand K, Shah B, Yadav K, et al. Are the urban poor vulnerable to noncommunicable diseases? A survey of risk factors for noncommunicable diseases in urban slums of Faridabad. *Natl Med J India.* 2007;20(3):115–120.
30. Kakodkar PV, Bansal SS. Hookah smoking: characteristics, behavior and perceptions of youth smokers in Pune, India. *Asian Pac J Cancer Prev.* 2013;14(7):4319–4323.
31. Dar-Odeh NS, Bakri FG, Al-Omiri MK, et al. Narghile (water pipe) smoking among university students in Jordan: prevalence, pattern and beliefs. *Harm Reduct J.* 2010;7(1):7–10.
32. Combrink A, Irwin N, Laudin G, et al. High prevalence of hookah smoking among secondary school students in a disadvantaged community in Johannesburg. *S Afr Med J.* 2010;100(5):297–299.
33. Malik SK, Singh K. Smoking habits, chronic bronchitis and ventilatory function in rural males. *Indian J Chest Dis Allied Sci.* 1978;20(2):73–79.
34. Jindal SK, Aggarwal AN, Chaudhry K, et al. Tobacco smoking in India: prevalence, quit-rates and respiratory morbidity. *Indian J Chest Dis Allied Sci.* 2006;48(1):37–42.
35. Anjum Q, Ahmed F, Ashfaq T. Knowledge, attitude and perception of water pipe smoking (Shisha) among adolescents aged 14-19 years. *J Pak Med Assoc.* 2008;58(6):312–317.
36. Haroon M, Munir A, Mahmud W, et al. Knowledge, attitude, and practice of water-pipe smoking among medical students in Rawalpindi, Pakistan. *J Pak Med Assoc.* 2014;64(2):155–158.
37. Axéll T, Pindborg JJ, Smith CJ, et al. Oral white lesions with special reference to precancerous and tobacco-related lesions: conclusions of an international symposium held in Uppsala, Sweden, May 18–21 1994 International Collaborative Group on Oral White Lesions. *J Oral Pathol Med.* 1996;25(2):49–54.
38. Zain RB, Ikeda N, Gupta PC, et al. Oral mucosal lesions associated with betel quid, areca nut and tobacco chewing habits: consensus from a workshop held in Kuala Lumpur, Malaysia, November 25-27, 1996. *J Oral Pathol Med.* 1999;28(1):1–4.
39. Gupta PC. Leukoplakia and incidence of oral cancer. *J Oral Pathol Med.* 1989;18(1):17.
40. Kramer IR, Lucas RB, Pindborg JJ, et al. Definition of leukoplakia and related lesions: An aid to studies on oral precancer. *Oral Surg Oral Med Oral Pathol.* 1978;46(4):518–539.
41. Lay KM, Sein K, Myint A, et al. Epidemiologic study of 6000 villagers of oral precancerous lesions in Bilugyun: preliminary report. *Community Dent Oral Epidemiol.* 1982;10(3):152–155.
42. Ahmadi-Motamayel F, Falsafi P, Hayati Z, et al. Prevalence of Oral Mucosal Lesions in Male Smokers and Nonsmokers. *Chonnam Med J.* 2013;49(2):65–68.
43. Ramulu C, Raju MV, Venkatarathnam G, et al. Nicotine stomatitis and its relation to carcinoma of the hard palate in reverse smokers of chuttas. *J Dent Res.* 1973;52(4):711–718.
44. Sujatha D, Hebbar PB, Pai A. Prevalence and correlation of oral lesions among tobacco smokers, tobacco chewers, areca nut and alcohol users. *Asian Pac J Cancer Prev.* 2012;13(4):1633–1637.
45. Salonen L, Axell T, Hellden L. Occurrence of oral mucosal lesions, the influence of tobacco habits and an estimate of treatment time in an adult Swedish population. *J Oral Pathol Med.* 1990;19(4):170–176.
46. Al-Attas SA, Ibrahim SS, Amer HA, et al. Prevalence of Potentially Malignant Oral Mucosal Lesions among Tobacco Users in Jeddah, Saudi Arabia. *Asian Pac J Cancer Prev.* 2014;15(2):757–762.
47. Axeix T, Hedin CA. Epidemiologic study of excessive oral melanin pigmentation with special reference to the influence of tobacco habits. *Scand J Dent Res.* 1982;90(6):434–442.
48. Singh N, Aggarwal AN, Gupta D, et al. Prevalence of low body mass index among newly diagnosed lung cancer patients in North India and its association with smoking status. *Thorac Cancer.* 2011;2(1):27–31.
49. Li L, Psoter WJ, Buxó CJ, et al. Smoking and drinking in relation to oral potentially malignant disorders in Puerto Rico: a case-control study. *BMC cancer.* 2011;11(1):324.
50. Lubin JH, Purdue M, Kelsey K, et al. Total exposure and exposure rate effects for alcohol and smoking and risk of head and neck cancer; a pooled analysis of case-control studies. *Am J Epidemiol.* 2009;170:937–947.