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The prevalence of chronic obstructive pulmonary disease in hookah smokers

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Abstract

Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality worldwide. Hookah smoking is growing worldwide and particularly in Iran. The aim of this study was to determine the prevalence of obstructive pulmonary dysfunction in hookah smokers. We conducted a population-based study in Bushehr Province, Iran. A total of 245 subjects aged 35 years or older who were taking hookah for at least 15 years and 245 healthy controls were enrolled in the study and spirometry was done. Statistical analyses were performed using SPSS for windows software version 19. The prevalence of COPD among the exposed group of hookah smoke was 10.2%, with the rate being significantly higher in the patients with older age ($p < 0.001$), duration of hookah smoking ($p < 0.001$), men ($p = 0.026$), $\geq$3 hookahs/day ($p = 0.006$), history of cough for $\geq$2 years ($p = 0.002$), in patients with a history of sputum for $\geq$2 years ($p = 0.031$), and in patients with a history of dyspnea for $\geq$2 years ($p = 0.001$). The results of the logistic regression analysis demonstrated that older age, male gender, smoking, and occupational exposure were independent predictive factors for COPD. The results of our study suggest that hookah smoking significantly increases the risk of COPD. Given the importance of COPD in the global burden of diseases, it is necessary to carry out further studies on the relationship between hookah use and COPD.

Keywords

Prevalence, COPD, hookah smoking, spirometry

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Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality worldwide. In 2020, COPD is estimated to rank fifth worldwide in terms of the burden of disease and third in terms of mortality.[1] The COPD prevalence, morbidity, and mortality vary across countries and across different groups within countries. COPD is currently the third leading cause of death in the United States, accounting for 149,205 annual deaths.[2]

Worldwide, cigarette smoking is the most commonly encountered risk factor for COPD. Other types of tobacco (e.g. pipe, cigar, hookah) and marijuana are also risk factors for COPD. Other risk factors for COPD include outdoor air pollution from traffic and other sources, occupational exposures, genetic factors, second-hand smoke exposure, biomass smoke, long-standing asthma, and tuberculosis, although the

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evidence is not sufficiently conclusive to infer a causal relationship.[3,4]

Hookah smoking (also known as narghile, hubble-bubble or water pipe, and shisha) is growing worldwide and particularly in Iran. Recent studies show that the prevalence of current hookah smoking ranges from 6% to 34% among Middle Eastern adolescents, 5–17% among American adolescents, and that hookah smoking use is increasing worldwide.[5] It has been seen that cigarette and hookah smoking decrease respiratory quality of life in adults.[6]

Many believe that water-pipe smoking is not addictive and less harmful than cigarette smoking. Despite the evidence regarding the effects of hookah smoking on health and the fact that a high prevalence of hookah smoking is seen in developing countries, several studies have reported the effects of hookah smoking on small airways function and pulmonary function tests.[7] However, the mechanisms underlying its effects are not well known. Recent experimental studies reported that acute exposure to hookah smoking caused an increase in pro-inflammatory cytokines and markers of oxidative stress.[8,9] Chronic exposure to hookah smoking resulted in the occurrence of DNA damage and enlargement of alveolar spaces and ducts associated with impairment of lung function.[10]

So far, few studies have been conducted in the field of hazardous compounds in the hookah smoke. The amount of carbon monoxide in the hookah smoke depends on size of the pipe, type of tobacco, and coal. However, the available data indicate that the carbon monoxide hazard is as high with hookah smoking compared with cigarette smoking.[11] Hookah smokers may absorb higher concentrations of hazardous substances, including the number of puffs, deep breathing, and duration of use of the hookah at any time.

Since few studies exist regarding hookah smoking in Iran, the aim of this study was to evaluate the effects of hookah smoking on pulmonary functional tests and the respiratory symptoms in the general population of Bushehr, Iran, and to assess the demographic and social characteristics of hookah smokers.

Materials and methods

Study design and population

This study was approved by the Ethics Committee of the Bushehr University of Medical Sciences. This cross-sectional study was conducted in Bushehr Province, Iran, between January 2006 and December 2010. From the list of wards in Bushehr Province (includes a total of 852 villages, 36 towns, and 10 counties), seven rural and urban wards were selected using a simple random technique with population of 63,276. Systematic random sampling method was used to select the study sample. The study included 245 adult population aged 35 years or older who were taking at least 15 years of hookah smoke. In addition, 245 healthy subjects were also studied as a control group, who were free of any respiratory disease or symptom. The two groups were matched for age and sex. The exclusion criteria included (1) history of asthma and allergies, (2) concomitant use of cigarettes, (3) use of bronchodilator drugs, and (4) recent surgery on the chest and abdomen. All studied patients signed an informed consent form and declared their willingness to allow the application of their anonymous data for research purposes.

Ethical approval

Ethics approval was obtained for this study from the Ethics Committee of the Bushehr University of Medical Sciences. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments.

Assessment of pulmonary function

The evaluation of pulmonary function was performed using Spirolab II Spirometer (MIR, Rome, Italy) in accordance with the standards of lung function testing of the American Thoracic Society and European Respiratory Society.[12] All tests were done by an experienced technician. Before each measurement, full calibration and verification of the equipment were performed. By doing at least three measurements of proportionate, the highest value was recorded as the baseline value. All participants rested for 15 minutes before the start of the test and were explained about the procedure.

The measured spirometric parameters included forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), the ratio of FEV_1 to FVC (FEV_1/FVC), vital capacity (VC), and forced expiratory flow between 25% and 75% (FEF 25–75%). The pulmonary function test results were expressed as percentages of the expected values adjusted for age, sex, height, weight, body mass index, and race. The values were considered abnormal if they were less than 80% of the predicted value.

In patients with pulmonary obstructive disease, we evaluated airways reversibility by using inhalation of salbutamol spray. Reversibility was demonstrated by a $\geq$12% and 200 ml increase in FEV_1 15 minutes after an inhaled salbutamol spray. A standardized questionnaire was administered and spirometry results were collected.

Diagnostic criteria

Spirometric results were interpreted according to the National Institute for Health and Care Excellence (NICE) recommendations.[13] If the post-bronchodilator values were significant, diagnosis was based on post-bronchodilator values. A diagnosis of restriction was given if the FEV_1 (% predicted) was less than 80% and the ratio of FEV_1 to FVC was greater or equal to 0.8. At present, neither the NICE nor the Global Initiative on Obstructive Lung Disease (GOLD) guidelines recommend reversibility testing in the diagnosis of COPD. Post-bronchodilator spirometry was necessary for diagnosis of COPD according to the GOLD guidelines[14] but not the NICE guidelines.[13]

A diagnosis of COPD was confirmed by spirometry when the FEV_1/FVC ratio is <0.70. Patients with COPD were classified according to the GOLD criteria on the basis of the post-bronchodilator lung function into the following categories:[15]

GOLD 1 (mild, FEV_1/FVC $<$ 0.70 and $FEV_1$3 80% predicted);

GOLD 2 (moderate, FEV_1/FVC $<$ 0.70 and 50% £ $FEV_1<$ 80% predicted);

GOLD 3 (severe, FEV_1/FVC $<$ 0.70 and 30% £ $FEV_1<$ 50% predicted); and

GOLD 4 (very severe, FEV_1/FVC $<$ 0.70 and $FEV_1<$ 30% predicted).

Statistical analysis

Statistical analyses were performed using IBM SPSS® for windows software version 19.0 (SPSS Inc., Chicago, IL, USA). The independent *t*-test was then used to evaluate the correlation between qualitative and quantitative variables and the χ^2 test was used to assess the correlation between the qualitative variables. The results of VC, FVC, and FEV_1, FEV_1/FVC%, FEF25%/75%, and MVV measures were compared using paired *t*-test. The logistic regression was then used to evaluate the relationship between the obstructive pulmonary dysfunction with age, occupation, and duration of hookah smoking. A value of $p < 0.05$ was taken as statistically significant.

Results

A total of 490 patients were randomized, 245 to the exposed group of hookah smoke and 245 to the control group. In the exposed group of hookah smoke, 148 (60.4%) were male and 97 (39.6%) were female. In the control group, 122 (49.8%) were male and 123 (50.2%) were female. In the exposed group of hookah smoke, the mean age was 48.28 years, whereas the control group was 48.49 years old. Table 1 shows the baseline demographic characteristics of the study population.

Pulmonary function tests

Table 2 shows the comparison of spirometry parameters between hookah smokers compared to control subjects. Of the 245 subjects in the control group, 235 patients (95.9%) had normal lung function, 10 patients (4.1%) had restrictive impairment, and there was no obstructive impairment. Of the 245 subjects in the exposed group of hookah smoke, 200 patients (81.6%) had normal lung function, 18 patients (7.4%) had restrictive impairment, 25 patients (10.2%) had obstructive impairment, and two patients (0.8%) had mixed pattern. According to the GOLD spirometry–based severity criteria, the frequency of pulmonary dysfunction in exposed group of hookah smoke compared with the control group is shown in Table 3. In addition, Table 4 shows the distribution of cases by COPD severity according to the GOLD categories between hookah smokers compared to control subjects.

Relationship between duration and amount of hookah smoking with pulmonary function tests

In this study, pulmonary function test findings were studied in relation to sex, age, duration of hookah smoking, number of the hookah smoking per day, respiratory symptoms, and occupation, and these results are summarized in Table 5.

Of the 490 enrolled patients, 25 patients (5.1%) had obstructive pulmonary dysfunction, of which 20 (13.5%) were male, while 5 (5.2%) were female. Based

Table 1. Demographic characteristics of the study population.

Characteristic		Control subjects ($n = 245$)	Hookah smokers ($n = 245$)	p-Value
Mean age (years)		48.49	48.28	0.341
Sex	Male	49.8%	60.4%	0.078
	Female	50.2%	39.6%	
Educational status	Illiterate	8.5%	46.2%	0.001
	Primary school	21.2%	24.8%	
	Secondary school	24.6%	13.7%	
	High school	29.1%	8.2%	
	University degrees	16.6%	7.1%	
Marital status	Single	13.8%	5.9%	0.001
	Married	78.4%	84.2%	
	Divorced	7.8%	9.9%	
Working status	Unemployed	1.8%	1.2%	0.001
	Working	58.6%	41.8%	
	Housekeeper	24.3%	36.1%	
	Retired	15.3%	20.9%	

Table 2. Comparison of spirometry parameters between hookah smokers compared to control subjects.

Parameters	Control subjects ($n = 245$)	Hookah smokers ($n = 245$)	p-Value
Age (years)	48.49 ± 8.16	48.28 ± 7.96	0.341
Weight (kg)	72.84 ± 1.48	76.26 ± 2.39	0.158
Height (cm)	169.64 ± 1.27	171.81 ± 2.30	0.491
FEV_1 (liter)	4.36 ± 0.94	2.59 ± 0.82	0.0001
FEV_1 (%) predicted	97.36 ± 36.28	76.84 ± 31.49	0.0001
FVC (liter)	5.16 ± 0.72	4.92 ± 0.94	0.298
FVC (%) predicted	95.13 ± 14.28	93.95 ± 13.36	0.318
FEV_1/FVC (%)	89.75 ± 8.54	70.68 ± 9.62	0.0001
$FEF_{25–75\%}$ (liter/second)	3.84 ± 0.42	5.13 ± 0.98	0.108
PEF (liter/second)	6.95 ± 1.38	6.49 ± 1.48	0.415
PEF (%) predicted	79.28 ± 37.2	76.16 ± 31.8	0.574

FEV_1: forced expiratory volume in one second; FVC: forced vital capacity; $FEF_{25–75\%}$: forced expiratory flow between 25% and 75%; PEF: peak expiratory flow.

on these results, the prevalence of obstructive pulmonary dysfunction was higher in men compared to women ($p = 0.026$). In this study, the prevalence of COPD among the exposed group of hookah smoke was significantly higher in the patients with older age ($p < 0.001$) and duration of water-pipe smoking ($p < 0.001$).

In the hookah smoker group, the mean number of daily hookah smoking episodes was divided into two categories: (1) more than or equal to three times a day and (2) less than three times a day. In patients with obstructive pulmonary dysfunction, 23 patients (92%) had ≥3 hookahs/day and 2 patients (8%) had <3 hookahs/day. In patients without obstructive pulmonary dysfunction, 142 patients (64.5%) had ≥3 hookahs/day and 78 patients (35.5%) had <3 hookahs/day. These results showed that the relationship between the number of hookah smoking episodes ≥3 hookahs/day and obstructive pulmonary dysfunction was statistically significant ($p = 0.006$).

Respiratory symptoms

In the hookah smoker group, the duration of clinical symptoms (cough, sputum, and dyspnea) was divided into two categories: (1) more than or equal to 2 years and (2) less than 2 years. In this study, the prevalence of COPD among the exposed group of hookah smoke was significantly higher in patients with a history cough for ≥2 years than in patients with a history cough for <2 years ($p = 0.002$), in patients with a

Table 3. Frequency of pulmonary dysfunction in exposed group of hookah smoke compared with the control group.

Spirometry pattern		Number of control group (% of total)	Number of the exposed group of hookah smoke (% of total)
Normal		235 (95.9%)	200 (81.6%)
Obstructive	Mild	0 (0%)	6 (2.6%)
	Moderate	0 (0%)	2 (0.8%)
	Severe	0 (0%)	16 (6.4%)
	Very severe	0 (0%)	1 (0.4%)
	Total	0 (0%)	25 (10.2%)
Restrictive	Mild	7 (2.9%)	4 (1.5%)
	Moderate	3 (1.2%)	6 (2.6%)
	Severe	0 (0%)	8 (3.3%)
	Very severe	0 (0%)	0 (0%)
	Total	10 (4.1%)	18 (7.4%)
Mixed		0 (0%)	2 (0.8%)
Total		245	245

Table 4. Distribution of cases by COPD severity according to the GOLD categories between hookah smokers compared to control subjects.

	COPD severity according to the GOLD criteria			
Groups	Mild	Moderate	Severe	Very severe
Control subjects (%)	0	0	0	0
Hookah smokers (%)	24	8	64	4

COPD: chronic obstructive pulmonary disease; GOLD: Global Initiative on Obstructive Lung Disease.

history sputum for $\geq$2 years than in patients with a history of sputum <2 years ($p = 0.031$), and in patients with a history of dyspnea for $\geq$2 years than in patients with a history of dyspnea for <2 years ($p = 0.001$).

The results of the logistic regression analysis demonstrated that older age, male gender, smoking, and occupational exposure were independent predictive factors for COPD. The relative risk for age, occupation, and duration of hookah smoking was 0.991, 2.848, and 1.064, respectively.

Discussion

This is the first study from Iran that analyzed the relationship between hookah smoking and COPD. In this study, the prevalence of COPD among the exposed group of hookah smoke was 10.2%, with the rate being significantly higher in the patients with older age, duration of hookah smoking, in men than in women, in patients with $\geq$3 hookahs/day than in patients with <3 hookahs/day, in patients with a history cough for $\geq$2 years than in patients with a history cough for <2 years, in patients with a history sputum for $\geq$2 years than in patients with a history of sputum <2 years, and in patients with a history of dyspnea for $\geq$2 years than in patients with a history of dyspnea for <2 years.

Over the past decade, hookah smoking has spread in the world at an alarming rate. In developing countries particularly, the prevalence of hookah smoking has already surpassed those of cigarette.[16] Hookah smoking is now common among young adults in the United States and high in areas where cigarette smoking prevalence is the lowest and the smoke-free policies have a longer history. In 2015, Salloum et al.[17] conducted a review of data from the 2009–2010 National Adult Tobacco Survey in the United States among 118,581 adults who smoked hookah. The national prevalence of hookah smoking was 9.8% and current smoking was 1.5%. States with the highest prevalence included District of Columbia (17.3%), Nevada (15.8%), and California (15.5%). Prevalence was highest among male (13.4%), 18–24 years old (28.4%), non-Hispanic White (9.8%), some college education (12.4%), and sexual minority status (21.1%). The Centers for Disease Control and Prevention estimated that, among high school seniors in the United States, about 17% of boys and 15% of girls have used hookah smoking in the past year.[18] From 2011 to 2012, current use of hookah smoking among all high school students increased from 4.1% to 5.4%. Other small studies of young adults have found high prevalence of hookah smoking use among college students in the United States. These studies show past-year use ranging from 22% to 40%.[18]

The results of a systematic review showed that the prevalence of current hookah smoking among university students was high in the Persian Gulf region (6%), the United Kingdom (8%), the United States (10%), Syria (15%), Lebanon (28%), and Pakistan (33%). The prevalence of current hookah smoking among adults was the following: Pakistan (6%), Persian Gulf region (4–12%), Australia (11% in Arab-speaking adults), Syria (9–12%), and Lebanon (15%).[19] However, no studies from Iran were included in this review.

The prevalence of hookah smoking has been reported to be high among university students in

Table 5. Pulmonary function test findings in relation to sex, age, duration of hookah smoking, number of the water-pipe smoking per day, and respiratory symptoms in the exposed group of hookah.

		Number of exposed group of hookah smoke (245 patients)		
Variable		Number of patients with obstructive pulmonary dysfunction (%) 25 (10.2%)	Number of patients without obstructive pulmonary dysfunction (%) 220 (89.8%)	*p*-Value
Sex	Male	20 (80%)	128 (58.2%)	0.026
	Female	5 (20%)	92 (41.8%)	
Mean age (years)		55.92	47.41	<0.001
Mean duration of hookah smoking (years)		36.24	26.73	<0.001
Number of hookah smoking episodes	<3/day	2 (8%)	78 (35.5%)	0.006
	≥3/day	23 (92%)	142 (64.5%)	
Duration of cough	<2 years	5 (20%)	29 (59.2%)	0.002
	≥2 years	20 (80%)	20 (40.8%)	
Duration of sputum	<2 years	5 (27.8%)	14 (63.6%)	0.031
	≥2 years	13 (72.2%)	8 (36.4%)	
Duration of dyspnea	<2 years	13 (24%)	219 (99.5%)	0.001
	≥2 years	19 (76%)	1 (0.5%)	

Iranian population. Hookah smoking among university students in Isfahan, Iran, has been reported to be 28.7% in men and 11.5% in women.[20] A study of university students in South Iran found a prevalence of 18.7% for students who had used hookahs in the previous 30 days whereas state university students in Iran reported 40.3% hookah use.[21] In a previous study of Iranian adolescents, the overall prevalence of current hookah smoking was 28.0%, significantly higher among males (34.8%) than females (21.4%).[22]

In the present study, the male to female ratio of lifetime hookah use was approximately 1.5:1. Consistent with other studies, male sex is a predictor of tobacco use. A study found a tendency toward females increasing use of tobacco products other than cigarettes, such as hookahs.[23] A recent study reported similarly high rates of hookah smoking in university students in Iran (including universities from Tehran), suggesting that higher hookah smoking rates are observed in Tehran than in other parts of the country.[24] The latter study included 1524 adolescent students aged 14–18 years (764 boys and 760 girls) from governmental, semi-governmental, and non-governmental schools in the city of Sanandaj, Iran. The prevalence rates of cigarette and hookah smoking were 9.5% and 10.4%, respectively. Compared with girls, prevalence of both cigarette (13.1% vs. 6.4%) and hookah (13.7% vs. 7.1%) smoking was higher among the boys.[25]

Comparing I.R.IRAN Global Youth Tobacco Survey results in first round (2003) with second round (2007) shows that smoking of other types of tobacco products which mainly contains hookah is dramatically raised (12.1% vs. 26.1%, respectively). Hookah smoking raised from 16.0% to 31.9% in boys and from 8.7% to 19.5% in girls. While cigarette smoking prevalence has been estimated to be 3% among adolescents aged 13–15 years in Iran, from 2003 to 2005, hookah smoking increased from 35.5% to 40.9% in males and from 19.7% to 26.1% in females aged 10–18 years. Among Iranian university students, 11.5% of females and 28.7% of males have been reported to smoke hookahs, compared to 2.5% of females and 18.3% of males who smoke cigarettes. This raise alarms that the country is in a real danger of facing a great risk of sever increase in smoking prevalence in near future among youth population. This concern seems to be more important when we see that increase in other tobacco products is made significantly in both boys and girls.[26]

In order to compare the lung function and respiratory symptoms among hookah smokers, deep or normal inhalation cigarette smokers, and non-smokers, Boskabady et al.[27] evaluated these three different groups of smokers. Among both hookah smokers and cigarette smokers, results showed an increased prevalence and severity of respiratory symptoms. Hookah smoking and deep inhalation cigarette smoking were shown to have similar effects on the respiratory status. The results from this study revealed that there was a profound effect of hookah smoking on lung function values and respiratory symptoms, which were similar

to the effects observed in deep inhalation cigarette smokers. Although the effect of normal inspiration cigarette smoking was less than that of hookah or deep inspiration cigarette smoking, it contributed significantly to respiratory disorders.[27]

The great strength of our study is that none of the participants are cigarette smokers. The findings in this report are subject to at least two limitations. First, the great weakness is the young age at a point (subjects aged 35 years or older) where COPD may not yet have developed. Second, in this study, the prevalence of hookah smoking was carried out only in Bushehr Province and, therefore, is not representative of all the people in other provinces and needs to be evaluated further.

Conclusion

The results of our study suggest that hookah smoking significantly increases the risk of COPD. Given the importance of COPD in the global burden of diseases, it is necessary to carry out further studies on the relationship between hookah use and COPD.

Declaration of conflicting interests

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