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Original Article

Spirometric Parameters in Waterpipe Smokers, Cigarette Smokers, and Non-smokers of Shahedieh Cohort Study

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Abstract

Background: Different kinds of smoking tobacco may affect pulmonary function and reduce some spirometric parameters. This study aimed to assess the relationship between smoking cigarettes and waterpipe and spirometric parameters.

Methods: This was a cross-sectional study on 1543 middle-aged individuals, as a sub-study of the Shahedieh cohort study in Yazd. The participants were randomly selected from the Shahedieh cohort population and were divided into 6 groups according to their smoking habits: non-smokers (n=455), cigarette smokers (n=139), waterpipe smokers (n=287), ex-cigarette smokers (n=131), concurrent waterpipe and cigarette smokers (n=121), and cigarette or waterpipe passive smokers (n=410). Spirometry was performed on all participants and spirometric parameters were compared between different groups. The data were analyzed by SPSS (version 20) using Kolmogorov-Smirnov, Kruskal-Wallis, and Mann-Whitney U tests.

Findings: FEV_1%, FEV_1/FVC, and $PEF_{25-75\%}$ were significantly lower in cigarette smokers, compared to waterpipe smokers and non-smokers. The measures were not significantly lower in waterpipe smokers in comparison to non-smokers. The frequency of obstructive pattern and small airway diseases was significantly higher in cigarette smokers compared to waterpipe smokers and non-smokers.

Conclusion: The results of this study showed that in the middle-aged population, spirometric parameters related to airway obstruction (FEV_1, FEV_1/FVC, and $FEF_{25-75\%}$) were significantly lower in cigarette smokers than in non-smokers and waterpipe smokers, but these parameters were not significantly different between waterpipe smokers and non-smokers.

Keywords: Spirometry, Waterpipe, Cigarette, Smoking, PERSIAN cohort

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Introduction

Tobacco, a plant containing nicotine, is consumed in different ways, most frequently inhalational. About 6 million preterm deaths are caused each year in the world due to consuming tobacco products.[1,2] In the US, about 400 000 preterm deaths each year are attributed to cigarette smoking.[3] Cigarette and waterpipe smoking are two main methods of consuming tobacco. Cigarette smoking is the main preventable cause of cancer and chronic pulmonary diseases.[3,4]

The negative impact of cigarette smoking on pulmonary function has been previously proved in different studies.[5-7] Other types of smoking may affect pulmonary function as well. Waterpipe (also called qalyan, hookah, shisha, nargile, or hubble-bubble) is a conventional device used for tobacco consumption, especially in countries located in the Middle East. Its consumption is increasing in Asian, African, and Middle East countries, especially among the Young and females.[8-10] There are some reasons for this increased use including introducing flavored tobacco products (Mu'assel) and a popular belief that waterpipe smoking may not affect the lungs and airways because the smoke passes through water.[11-13] The prevalence of waterpipe consumption has been estimated to be between 5% and 15% in the general population of different countries.[8,13] In Iran, the prevalence of waterpipe use has been estimated between 5% and 8% with an increase in young age.[14] Danaei et al found a prevalence of 43.8%,

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28.8%, and 7.2% for ever, current, and daily waterpipe smokers, respectively, in southeastern Iran.[15]

Studies have shown significant exposure to toxic substances, such as nicotine, carbon monoxide, polyaromatic hydrocarbons, some heavy metals, etc. in each session of waterpipe consumption.[12] Different complications may be induced after waterpipe consumption including ischemic heart disease, chronic obstructive pulmonary disease, and emphysema.[11] Some studies have proved the negative impact of waterpipe smoking on pulmonary function and spirometric parameters,[16-19] though with different effect sizes. Some studies have shown smoking waterpipe has a significant and large effect on spirometric parameters,[20,21] and some have shown only a weak effect.[22] Even though most of them have indicated that cigarette has a more significant effect than waterpipe,[22-25] Al Mutairi et al showed a more significant effect for waterpipe than cigarette.[19] Conversely, Kiter et al[26] and Aydin et al[27] indicated spirometric parameters were not significantly lower in waterpipe smokers than in non-smokers.

Due to different types of tobacco and devices used in different countries, this study was conducted to assess the effect of waterpipe and cigarette smoking on pulmonary function in comparison to ex-cigarette smokers, passive smokers, and non-smokers in an Iranian middle-aged population.

Methods

This was a cross-sectional analysis of Shahedieh data on 1543 middle-aged individuals. Shahedieh cohort study started in Yazd in 2015 on 10 000 participants as a branch of the PERSIAN cohort study, a national multi-center cohort study on the adult population (age range: 35-70 years), to assess risk factors of non-communicable diseases. The follow-up phase of the study is ongoing.[28] The participants were selected by simple random sampling method from among the Shahedieh cohort participants who had no history of respiratory disorders but acceptable spirometry test results. According to the status and type of smoking, the participants were divided into the following groups: waterpipe smokers (n = 287), cigarette smokers (n = 139), concurrent waterpipe and cigarette smokers (n = 121), ex-cigarette smokers (n = 131), cigarette or waterpipe passive smokers (n = 410), and non-smokers (n = 455). Demographic data and smoking history were extracted from the Shahedieh cohort study database. The participants smoking at least one pack of cigarettes per year were considered cigarette smokers and those smoking at least two waterpipe heads per year were considered waterpipe smokers. The individuals having given up smoking cigarettes or waterpipe for at least one year were considered ex-smokers. Passive smokers were those with close contact with a cigarette or waterpipe smoker at home or in the workplace for at least one year.

Spirometric measurements

Spirometry was performed using Spirolab III (MIR, Italy). All tests were performed in the morning and in the sitting position. At least three forced vital capacity (FVC) maneuvers were performed for each participant considering the acceptability and repeatability criteria according to the American Thoracic Society/European Respiratory Society task force.[29] At first, the participants with contraindication of spirometry were detected and excluded from the study. The intervening conditions (smoking within 1 hour of the procedure, exercising within 30 minutes of the procedure, having a large meal within 2 hours of the procedure) were also taken into account and if positive, the test was postponed to another time. Then, the maneuver was explained to each participant and the test was performed with the guidance of the operator. All tests were performed by an operator trained for the spirometry procedure. FVC, forced expiratory volume at 1 s (FEV_1), FEV_1/FVC, peak expiratory flow (PEF), and forced expiratory flow at 25-75% of FVC ($FEF_{25-75\%}$) were measured for each participant. The maneuver with the highest FVC + FEV_1 was selected as the best maneuver. FEV_1/FVC lower than 70% was considered an obstructive pattern and $FEF_{25-75\%}$ lower than 60% was considered a small airway disease.[30]

Statistical analysis

SPSS (version 20) was used for data analysis. Normality of the data was tested by Kolmogorov-Smirnov test, and Kruskal-Wallis, and Mann-Whitney U tests were used to analyze the data. The level of significance was set at $P < 0.05$.

Results

A total of 1543 participants entered the study. Table 1 shows the demographic characteristics of the participants.

There was a significant difference regarding age and amount of cigarette smoking among the study groups. However, pairwise comparison of the groups showed that the difference in age was only significant for ex-smokers. Table 2 shows the mean (standard deviation) of spirometric parameters in different study groups.

The parameters related to airway obstruction were significantly lower in cigarette smokers than in other groups. These parameters were not significantly decreased in waterpipe smokers. Table 3 shows pairwise comparisons of different spirometric parameters among the study groups.

Figure 1 compares the frequency of obstructive pattern and small airway diseases in different groups.

Discussion

Waterpipe smoking is becoming more frequent in many countries[13] including Iran, especially among the youth. In this study, spirometric parameters were compared

Table 1. Descriptive statistics of the study participants in different groups according to smoking status

Variable	Smoking status						*P* value
	Non-smoker	Cigarette Smoker	Waterpipe smoker	Concurrent cigarette and waterpipe smoker	Ex-smoker	Passive smoker	
Number	455	139	287	121	131	410	-
Age (year)	47.3±9.2	49.3±5.9	47.6±8.9	48.4±7.8	52.3±8.2	47.6±9.3	<0.001
Percentage of males	46.2	100	96.4	100	100	27.2	<0.001
Packs (year)	NA	11.86±6.53	NA	8.97±6.22	8.23±12.31	NA	<0.001
Lifelong waterpipe heads	NA	NA	387.23±987.36	473.25±722.48	NA	NA	0.004
Waterpipe heads per week	NA	NA	2.35±7.34	2.89±6.85	NA	NA	0.28

NA: not applicable.

Table 2. Mean of spirometric parameters in different groups

Variables		Study groups					
		Non-smoker	Cigarette Smoker	Waterpipe smoker	Concurrent cigarette and waterpipe smoker	Ex-smoker	Passive smoker
FVC (L)	Mean	3.37	4.12	4.16	4.16	3.98	3.98
	SD[a]	0.79	0.75	0.69	0.78	0.63	0.78
FVC%[a]	Mean	95.01	94.86	94.62	96.00	97.85	97.85
	SD	13.15	13.74	12.13	13.65	12.93	12.48
FEV_1 (L)	Mean	2.83	3.33	3.48	3.36	3.24	3.24
	SD	0.68	0.61	0.64	0.57	0.56	0.62
FEV_1%	Mean	96.25	93.38	95.78	94.28	97.71	97.71
	SD	13.14	14.29	11.75	12.87	14.21	12.62
FEV_1/FVC	Mean	84.54	80.76	83.54	81.12	81.55	81.55
	SD	5.59	6.21	5.41	6.72	5.28	5.89
PEF (L/s)	Mean	6.31	7.7	8.39	7.74	7.70	7.75
	SD	1.90	1.69	1.88	1.51	1.88	1.89
PEF%	Mean	90.06	89.83	97.84	90.65	89.83	93.58
	SD	19.08	18.76	18.33	17.73	17.26	20.31
$FEF_{25-75\%}$ (L/s)	Mean	3.29	3.44	3.29	3.55	3.44	3.44
	SD	0.83	0.96	0.97	1.08	0.94	0.87
$FEF_{25-75\%}$%	Mean	100.79	91.76	100.79	94.37	97.82	97.82
	SD	24.03	25.05	23.49	28.23	24.71	24.30

[a] SD: Standard deviation; [b] Percentage of predicted value

between individuals with different kinds of smoking (cigarette, waterpipe, concurrent cigarette and waterpipe), ex-smokers, passive smokers, and non-smokers in an adult Iranian population in Shahedieh, Yazd province, central Iran.

The results showed that spirometric parameters related to airway obstruction (FEV_1, FEV_1/FVC, and $FEF_{25-75\%}$) were significantly lower in all individuals who smoked cigarettes (including only cigarette smokers, concurrent cigarette and waterpipe smokers, and ex-smokers) than in other groups, i.e., non-smokers and waterpipe smokers. These parameters were not significantly different between waterpipe smokers and non-smokers. However, the PEF predicted in waterpipe smokers was significantly higher in waterpipe smokers than in non-smokers. Although there was a significant difference among the study groups regarding age and gender, the predicted percent of each value was considered which adjusts the parameters for age, gender, and anthropometric dimensions (i.e., height and weight), so that the comparisons were not affected by these variables.

Most previous studies have shown that cigarette smoking negatively affects pulmonary function and causes spirometric parameters to decrease, except for FVC,[5,7,31] and most of them have shown a more significant effect for cigarettes than waterpipe.[2,23-25,32] The present study also showed a considerable effect of cigarette smoking on the pulmonary function which was significantly higher than that of waterpipe.

This study, consistent with the results of the studies conducted by Al Mutairi et al[19] and Kiter et al[26] did not show a significant difference in predicted FVC according

Table 3. Pairwise comparisons of spirometric parameters between study groups

Study groups	*P* value (95% CI)				
	FVC%[a]	FEV_1%	FEV_1/FVC	PEF%	$FEF_{25-75\%}$%
Cigarette smoker vs. non-smoker	0.91 (-2.27-2.52)	**0.02** (0.49-5.25)	**<0.001** (2.77-4.79)	0.89 (-3.09-3.54)	**<0.001** (4.68-13.33)
Waterpipe smoker vs. non-smoker	0.66 (-1.35-2.13)	0.57 (-1.26-2.20)	**0.009** (0.25-1.74)	**<0.001** **(-10.32- -5.25)**	0.97 (-3.29-3.16)
Concurrent cigarette and waterpipe smoker vs. non-smoker	0.44 (-3.49-1.52)	0.12 (-0.52-4.46)	**<0.001** (2.33-4.50)	0.12 (-4.14-2.95)	**0.007** (1.75-11.08)
ex-cigarette smoker vs. non-smoker	**0.04** (-5.52- -0.16)	0.29 (-4.16-1.25)	**<0.001** (1.86-4.12)	0.07 (-7.38-3.38)	0.24 (-1.94-7.89)
Passive vs. non-smoker	0.31 (-0.73-2.29)	**0.004** (-1.62-1.41)	**0.003** (-1.68- -3.36)	0.93 (-2.15-2.34)	0.09 (-5.24-0.39)
Cigarette smoker vs. Waterpipe smoker	0.85 (-2.35-2.84)	0.09 (-4.99-0.18)	**<0.001** (-3.95- -1.62)	**<0.001** (-11.76- -4.26)	**<0.001** (-13.98-4.15)
Cigarette smoker vs. Concurrent cigarette and waterpipe smoker	0.51 (-4.49-2.21)	0.59 (-4.24-2.44)	0.64 (-1.95-1.27)	0.71 (-5.10-3.46)	0.43 (-9.10-3.91)
Cigarette smoker vs. ex-cigarette smoker	0.08 (-6.42-0.44)	**0.02** (-7.98- -0.68)	0.29 (-2.28-0.70)	0.12 (-8.52-1.02)	**0.06** (-12.42- -0.34)
Cigarette smoker vs. passive	0.62 (-1.84-3.10)	**0.02** (-5.50- -0.47)	**<0.001** (-5.96- -3.65)	0.94 (-3.87-3.61)	**<0.001** (-16.16- -6.77)
Waterpipe smoker vs. Concurrent cigarette and waterpipe smoker	0.32 (-4.08-1.33)	0.26 (-1.09-4.09)	**0.001** (1.16-3.67)	**<0.001** (3.22-11.15)	**0.02** (1.11-11.84)

Note: Bold figures show significant difference.
[a] Percentage of predicted value.

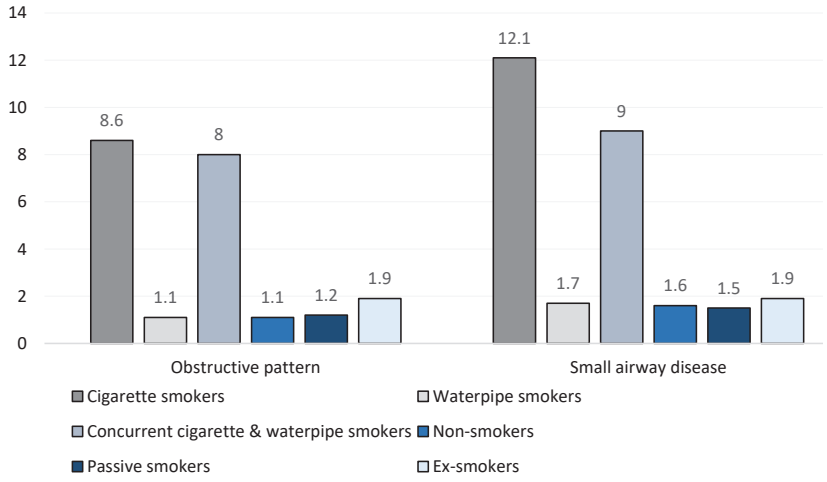

Figure 1. Frequency (%) of obstructive pattern and small airway diseases in different groups

to the smoking condition but predicted FEV_1 and FEV_1/FVC were lower in all groups of cigarette smokers, even in ex-smokers, compared to non-smokers and waterpipe smokers. This was also in agreement with the results of the studies by Al Mutairi et al[19] and Mohammad et al.[22]

Some previous studies have shown that waterpipe smoking can negatively affect pulmonary function.[21,31,33] Hawari et al, in a study on a young population (18-25 years), found that waterpipe smokers had lower FVC, FEV_1, and FEV_1/FVC than non-smokers.[21] This is contrary to the results of the present study. The population in the present study was older than 35 years and waterpipe consumption per week was much lower than in the study by Hawari et al. Moreover, Boskabady et al found a significant decrease in spirometric parameters in waterpipe smokers in comparison to non-smokers in the middle-aged population which is inconsistent with the results of the present study.[31] In this study, the amount of waterpipe smoking was comparable with that of the present study; nevertheless, our population was older. The small and non-significant difference observed between waterpipe smokers and non-smokers was probably due to the older age of the population which affects pulmonary function and also probably because of exposure to some other respiratory hazards such as occupational and environmental exposures in non-smokers. Another study on the Iranian population found similar results and reported that waterpipe smoking did

not significantly affect pulmonary function.[34]

Furthermore, different kinds of tobacco and various devices used in different populations may explain different results in the studies. It is stated that the pattern of inhalation in waterpipe is different from that of cigarette smoking, probably shallower, so its effect on pulmonary function is probably lower than cigarette as most studies have shown. The smoke in waterpipe passes through water and moves through a hose (with different lengths) before it reaches the lungs, and the smoke that reaches the airways, especially small airways, is probably less than cigarette smoke which directly enters the respiratory system. This is probably important in lowering the effect of waterpipe smoke on pulmonary function.[26,34] Another possible mechanism is the mucolytic effect of waterpipe smoke in reducing its negative effect.[34]

This study had some limitations. First, it was a cross-sectional study, hence suffering from the integral limitations of these kinds of studies. There were no baseline spirometric parameters and the longitudinal changes in the spirometric parameters of the participants were possible. Moreover, other environmental and occupational causes of impaired respiratory function could not be assessed. Besides, the type of waterpipe device or tobacco as well as the method and depth of smoking were not examined which might have influenced the results.

Conclusion

The results of this study showed that spirometric parameters related to airway obstruction (FEV_1%, FEV_1/FVC, and FEF_{25-75}%) are probably lower in cigarette smokers than in non-smokers and waterpipe smokers in the middle-aged population. Nonetheless, the results should be interpreted cautiously due to some confounding factors and the cross-sectional design of the study. Longitudinal studies are recommended which can more precisely show the association between pulmonary function and different kinds of smoking, especially waterpipe smoking.

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Authors' Contribution

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Competing Interests

The authors declare no conflict of interest.

Ethical Approval

This study reports the results of a thesis on occupational medicine. The protocol of the study was approved by the ethics committee of Shahid Sadoughi University of Medical Sciences (Ethics code: IR.SSU.MEDICINE.REC.1397.148). Informed consent was obtained from each participant.

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