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Water-pipe smoking and pulmonary functions

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Water-pipe smoking is a type of smoking habit, widely encountered in Turkey and Arabic and Middle East countries. However there is limited data about the effects of water-pipe smoking. The aim of this study is to investigate this habit with regard to the duration and amount of smoking and to analyse its characteristics and effects on pulmonary function by the correlation of the results with those of cigarette smokers and non-smokers. All cafés in Izmir city were visited for this purpose. A total of 397 males were studied in four groups: water-pipe smokers, water-pipe smokers who used to smoke cigarettes, active cigarette smokers and non-smokers. After recording a detailed history of smoking, pulmonary function tests on each person were performed. There were statistically significant differences between cigarette smokers and non-smokers within most of the parameters. The results of recent study have shown that the detrimental effects on pulmonary function of water-pipe smoking are not as great as cigarette smoking (FEV_1, FEV_1/FVC parameters were higher in water-pipe smokers), especially on the parameters for small airways (FEF50, MMEF parameters were higher in water-pipe smokers) ($P<0{\cdot}05$). It is difficult to explain the reasons exactly without estimating possible mechanisms in detail, but the most likely mechanisms arise from the smoking technique itself which involves a water filter and a long spout through which the smoke passes before reaching the lungs.

Key words: tobacco; water-pipe smoking; pulmonary function test.

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Introduction

Although the health problems caused by cigarette smoking are widely described, there are few investigations into water-pipe smoking. According to our clinical experience, it is rare for water-pipe smokers to have chronic obstructive pulmonary disease, proven to be related to cigarette smoking.

Water-pipe smoking uses a different kind of tobacco, which is available in most Arabic countries, in Greece and in Turkey, and is not as common as cigarette smoking, even in those countries.

Water-pipe smoking requires a special device and these are only found in special cafés. Tobacco from the Nicotiana tabacum family, which contains 2–4% nicotine and 1·5–2% protein nitrogen is specially prepared in its commercial form. A small amount of the tobacco product is shaped by hand after being washed and humidified in a cup of water in the cafés. This form, named 'jurak', is then ready to smoke. The jurak is placed at the top of the water-pipe device, where it is burnt with a piece of charcoal ember, the smoke passing through the water in the glass shade, and inhaled via a long, flexible pipe attached to a tube (spout) (Fig. 1). The glass shade with a tube cools the smoke and dissolves soluble compounds (gases and particles, i.e. nicotine and tar). Consecutive but not deep inhalations, via the spout, are required to inhale the smoke and to keep the jurak burning. It takes approximately 1 or 2 h to finish one jurak.

Turkish water-pipe smokers generally start when they give up cigarette smoking, generally in their retirement, and they agree that water-pipes are a symbol of a social group and have no harmful effects. One of the water-pipe smokers' groups was made up of men who had never smoked cigarettes; and according to them, they belonged to a privileged group. They believed in the harmlessness and relaxation benefits of water-pipe smoking.

This study was designed to investigate the characteristics and the effects of water-pipe smoking on pulmonary functions with respect to duration and the amount of tobacco smoked. The cigarette smoker and non-smoker groups were studied for comparisons.

Methods

All the special cafés which water-pipe smokers and cigarette smokers frequented in Izmir city were visited for this investigation: 397 males were studied. The ages ranged between 18 and 85 years. The smokers' categories were determined after visits to a few random cafés. There were three groups of smokers and a non-smokers' control group. All of the non-smokers had never smoked cigarettes or a water-pipe. The determination of the categories were: water-pipe smokers (WPS-I), water-pipe smokers who had

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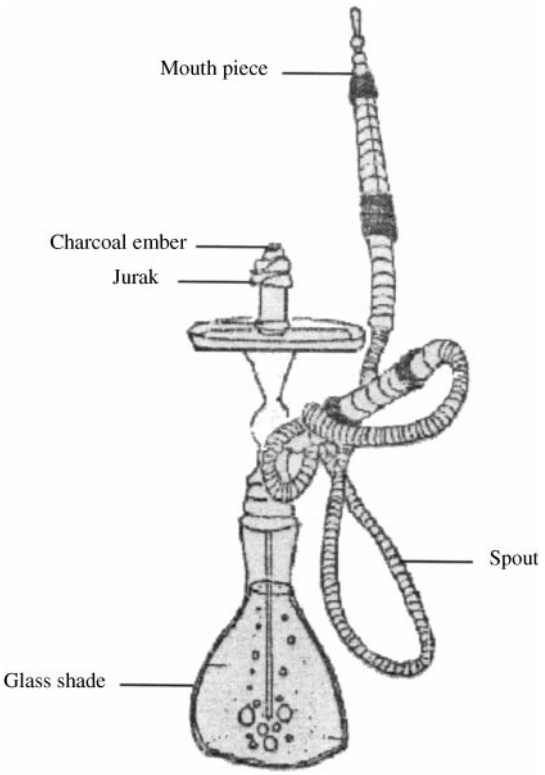

FIG. 1. Water-pipe

quit cigarette smoking (WPS-II), cigarette smokers (CS), never smokers (NS).

In each cafe, approximately 15 or 20 water-pipe smokers were approached and studied. The cigarette smokers and non-smokers were selected randomly, not only in the cafés but also from outside the cafés. The ratio of the respiratory complaints was similar in each group of smokers. Ex-cigarette smokers were not included in this study.

Firstly, the personal information of every participant; their age, type of smoking, duration and daily amount of tobacco smoked, were documented with their verbal permission. Then the pulmonary functions of all participants were analysed with a portable spirometer (Cosmed Pony Spirometer) according to the standards of American Thoracic Society (1).

The smoking histories were defined as 1. *jurak-year* for water-pipe smokers [the multiplication of number of jurak (alternative word for jurak; Bolus, which means a rounded lump of anything, larger than a pill) smoked a day and total number of smoking years], 2. as *pack-year* for cigarette smokers (the multiplication of number of packs smoked a day and total number of smoking years).

The pulmonary functions of each participant were tested with the same spirometer after calibration. The pulmonary function test (PFT) was explained to each participant in detail and the best of three reproducable tests was accepted. The measured (actual) and percentage of predicted (predicted%) values of forced expiratory volume in 1 sec (FEV_1), forced vital capacity (FVC), peak expiratory flow rate (PEF), FEV_1 as a percentage of FVC (FEV_1/FVC), forced expiratory flow in 25% of forced vital capacity (FEF25), forced expiratory flow in 50% of forced vital capacity (FEF50) and maximal mid-expiratory flow (MMEF) parameters of each participant were considered. The predicted% values was calculated automatically according to age, sex and height (CECA'83: Communaute Europeenne du Charbon et de l'Acier).

Statistical analyses were made with a personal computer via the Statistical Package for Social Sciences (SPSS) program for Windows, release 6·0. The mean $\pm$ standard deviation (SD) values for age, amount of smoking, and each PFT, as above, were analysed for each group. Comparison for age between groups was made by Student's *t*-test.

The multivariate variance analysis was used for comparative analyses between groups with adjustment for age and height to eliminate the effects of these variables on PFT parameters. Because of the limitation on this program, the mean $\pm$ SD values of PFT parameters could not be expressed as the standardized values according to age and height. The mean $\pm$ SD values of predicted% values for the PFT parameters were also used for comparisons and comparative analysis of these values were made by Student's *t*-test.

A *P*-value $< 0{\cdot}05$ was considered statistically significant for all analyses.

The relationship between PFT parameters and the amount of smoking was detected by correlation analyses and regression analyses. For FEV_1 parameter and smoking history, the slope of the regression line has been considered.

Results

GENERAL CHARACTERISTICS OF THE STUDY POPULATION

The total number of participants was 397. All were males. Mean $\pm$ SD value of ages was 50 ± 14 years (between 18 to 85 years). General characteristics of participants are summarized in Table 1. The mean age was not significantly different between water-pipe smokers and water-pipe smokers who had quit cigarette smoking, and between cigarette smokers and never smokers, but water-pipe smokers and water-pipe smokers who had quit cigarette smoking were older than cigarette smokers and never smokers ($P < 0{\cdot}000$).

COMPARATIVE ANALYSIS OF PFT PARAMETERS BETWEEN GROUPS

The mean $\pm$ SD values of actual PFT parameters are not shown in a table to avoid the inaccurate interpretation of comparison for the statistically different PFT parameters analysed after standardization for age and height. However the results of comparative analysis of actual (not standardized) PFT parameters were the same with predicted% PFT parameters'. The mean $\pm$ SD values of the latter are given in Table 2.

The PFT parameters which showed statistically significant difference are shown in the Table 3, according to the comparison in dual groups.

TABLE 1. The age, height and tobacco smoking features of each group

	WPS-I ($n=82$)	WPS-II ($n=95$)	CS ($n=103$)	NS ($n=117$)
Age (years)	56±10	54±12	46±14	46±16
(age range)	(32–84)	(23–81)	(18–81)	(19–85)
Height	173±6	172±7	172±6	173±7
Jurak-years	47±33	37±42	0	0
Pack-years	0	38±32	38±30	0

Results are expressed as (mean±SD). WPS-I: water pipe smokers; WPS-II: water pipe smokers who had quit cigarette smoking; CS: cigarette smokers; NS: never smokers.

TABLE 2. PFT parameters for each group and comparisons

PFT parameter	NS	WPS-I	WPS-II	CS
FEV_1	93·60±15·48	88·63±19·14	87·15±25·03	84·09±22·99
FVC	96·66±16·19	93·97±27·43	90·84±23·68	91·30±3·55
FEV_1/FVC	96·82±8·19	98·16±13·28	93·80±13·62	89·31±13·77
PEF	82·09±20·95	65·79±23·40	64·75±25·07	68·30±28·84
FEF25	82·60±24·24	70·91±26·29	65·86±33·54	69·19±26·81
FEF50	80·74±23·06	78·79±27·65	71·83±30·59	69·81±32·53
MMF	77·63±22·15	77·78±25·77	69·07±29·19	63·92±26·94

Results are expressed as mean±SD of predicted% values for each PFT.
See Table 1 for abbreviations.

RELATIONSHIP BETWEEN AMOUNT OF SMOKING AND FEV_1

Only in cigarette smokers did pack-year have a negative correlation with FEV_1 ($r:-0{\cdot}50$; $P<0{\cdot}000$); while water-pipe smokers showed no correlation and water-pipe smokers who had quit cigarette smoking showed a negative correlation ($r:-0{\cdot}35$; $P<0{\cdot}000$) between smoking history and FEV_1.

The comparison between the slope of the regression lines for the correlation between FEV_1 and smoking history, shows the highest value was in cigarette smokers ($-0{\cdot}016$). In water-pipe smokers and water-pipe smokers who had quit cigarette smoking, the slope of the regression lines were $0{\cdot}007$ and $-0{\cdot}006$ respectively.

Discussion

The nicotine content in the tobacco for a water-pipe is 2–4% and for cigarettes 1–3% (2,3,6). Because of the differences in content and smoking pattern of these two kinds of tobacco, water-pipe smoking should be investigated for its effects on pulmonary functions.

In this investigation, the men in the two groups of water-pipe smokers were older than the cigarette smokers and non-smokers. Because of the decrease in pulmonary function parameters in the elderly and the effects of height, the standardization of PFT parameters according to age and height for comparative analyses was necessary.

Recent results showed that cigarette smoking decreased all PFT parameters except FVC compared with values in non-smokers. Cigarette smoking is the primary risk factor for chronic obstructive pulmonary disease and the spirometry method used in our study is a standard test for determination of airway obstruction. FEV_1, FVC and FEV_1/FVC define airway obstruction. MMEF, FEF25 and FEF50 measurements are considered to be indicators of small airway (less than 2 mm in diameter) dysfunction and are more localized than the FEV_1 (5,6).

When compared with non-smokers, statistically significant decreases in PEF of water-pipe smokers and in PEF, FEF25 and FEV_1/FVC of water-pipe smokers who quit cigarette smoking were found. In addition, there were statistically significant differences between the two water-pipe groups in FEF25 and FEV_1/FVC. All those findings show that after a cigarette smoking history, beginning to smoke a water-pipe, has no or little additional effect to cigarette burden.

Also, FEV_1, FEF50, FEV_1/FVC and MMEF were significantly lower in cigarette smokers' than in water-pipe smokers'. According to these findings, it is possible that cigarette smoking has more harmful effects on airways, especially on small airways, than water-pipe smoking.

The amount of smoking was negatively correlated with PFT in the cigarette smokers. There was no evident

TABLE 3. The PFT is which showed statistically significant difference between groups

Compared groups	PFT parameter
WPS-I *vs.* CS	FEV_1*, FEV1/FVC*, FEF50*, MMEF*
WPS-I *vs.* NS	PEF†
WPS-II *vs.* CS	$FEV_1$$^{\#}$, FEV1/FVC$^{\#}$, FEF50$^{\#}$, MMEF$^{\#}$
WPS-II *vs.* NS	FEF25†, FEV1/FVC†, PEF†
WPS-I *vs.* WPS-II	FEF25$^{\Psi}$, FEV1/FVC$^{\Psi}$
CS *vs.* NS	FEV_1†, FEV1/FVC†, PEF†, FEF25†, FEF50†, MMEF†

* significantly higher in WPS-I compared to CS group ($P<0{\cdot}05$); †significantly higher in NS compared to WPS-I, WPS-II and CS groups' ($P<0{\cdot}05$); $^{\#}$significantly higher in WPS-II compared to CS group ($P<0{\cdot}05$); $^{\Psi}$significantly higher in WPS-I compared to WPS-II group ($P<0{\cdot}05$);
See Table 1 for abbrevations.

correlation in water-pipe smokers. Because of the variability of the tobacco amount used for each jurak and lack of the determination of this value, to interpret this finding may lead to inappropriate comments.

Zahran and Baig explained the significant decrease in FEV_1/FVC% and MMEF of cigarette and water-pipe smokers as a result of partial obstruction of the small airways. Although the mean FVC has been found to be slightly higher in water-pipe smokers than in cigarette smokers, the study sample was not large enough to make precise comments (7).

Two investigations from Turkey have been presented at International conferences (8,9). In one, only PEF was measured (8). Their results were contrary to our study. However the limited number of smokers and the absence of a control group were the shared handicaps of these studies.

For water-pipe smoking, dependency on special cafés and the required length of time required to finish a jurak limits the amount of smoking. The inhalation pattern of water-pipe smoking is shorter and more superficial than that of cigarette smoking.

Water in the glass shade may play the most important role for decreasing the harmful effects of smoke and tobacco contents by filtering the smoke before inhalation. Carbon monoxide, nicotine and tar are the most harmful contents of tobacco smoke and they are filterable.

The main finding of our study is that small airway obstruction was found to be more significant in cigarette smokers than water-pipe smokers when compared to non-smokers. Although it is difficult to explain the reasons exactly without estimating possible mechanisms in detail, the results of the recent study have proven that water-pipe smoking does not effect pulmonary functions as seriously as cigarette smoking does. This may be because the water-pipe smoking allows small airway inflammation to heal (due to intermittent smoking), or because smoke does not reach the lower airways (due to the smoking pattern), or because it is less damaging to the airways (due to the filtration of smoke).

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