

Comparison of Urinary Heavy Metals and Pulmonary Function Test in Cafe Workers Based on Exposure to Secondhand Tobacco Smoke, Tehran 2021

Abstract

Background: Secondhand tobacco smoke exposure is one of the morbidity causes but it is ignored occasionally. Various studies have shown that hookah and cigarette smoke contain significant volume of heavy metals. This study was designed aiming biological monitoring of the level of heavy metals in the urine samples of workers in smoking cafés and its association with their lung function and respiratory symptoms in Tehran City. **Methods:** The list of cafés in Tehran was provided, and they were divided into water pipe cafés (WPC), cigarette smoking cafés (CSC), and non-smoking cafés (NSC); and then, 10 cafés were randomly selected from each group. Sampling was performed after explaining the study and obtaining the consent of the manager and staff. A check list of demographic data and smoking history was completed and analyzed. **Results:** A total of 96 individuals were studied; there were 32 subjects in each group. All subjects were male. Six days a week, they worked about 10 h a day in café. The concentration of heavy metals in the groups of hookah and cigarettes was significantly higher and respiratory indices in these groups were significantly lower than non-smoking group. **Conclusions:** Exposure to secondhand smoke increases the urinary level of heavy metals and reduces the respiratory capacity of people and this can be highly pathogenic in the future. Comprehensive informing on human rights should be provided in this regard and smoking bans in public places must be properly enforced.

Keywords: Heavy metals, lung function, second-hand tobacco smoke, smoking

Introduction

Smoking cafés are places where the air inside has high concentration of various pollutants.^[1] One of the heavy metal pollutants is air pollutants associated with smoking, so that the level of these pollutants in the indoor area of smoking cafés is very high. Various studies have shown that hookah and cigarette smoke contain significant volume of heavy metals, such as lead, cadmium, nickel, and arsenic.^[2] Tobacco has a special ability to absorb cadmium from the soil and causes its accumulation in high concentrations in the leaves (averagely 0.77–7.02 µg/g); therefore, tobacco consumption is an important source of exposure to cadmium.^[3] In addition, fruit-flavored tobaccos contain high levels of organic compounds, aromatic compounds, essential oils, and flavoring additives that are added to this type of tobacco during the production process. High concentration of heavy metals and other

pollutants in these cafés can be attributed to these chemical compounds.^[4] According to the World Health Organization, six million people annually die from tobacco consumption, more than five million of whom die because of direct exposure to tobacco smoke and 600,000 die because of environmental exposure to tobacco smoke water pipe tobacco smoke (WTS), environmental tobacco smoke (ETS).^[5] Environmental hookah smoke (secondhand smoke), like its main stream (firsthand smoke), is a complex compound that contains very high amounts of various pollutants and chemical compounds that are even carcinogenic in some cases.^[6] There are evidences from many laboratory and epidemiological studies representing that hookah smoke increases the incidence of lung cancer, cardiovascular disease, respiratory disease, and other respiratory problems, such as bronchitis, asthma, etc. As a result, environmental hookah smoke has been detected as a human carcinogen.^[7,8]

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Toxic metals, such as cadmium, arsenic, and lead have certain cardiovascular effects. However, most epidemiological studies have focused on people most of whom were from the general population, and there was no evidence of occupational exposure in people working in smoking cafés.^[9,10] Molybdenum and cobalt are essential elements found in the human body and play key roles in various biological processes, but the lack or extra amount of these elements in the human body is harmful.^[11,12] Because the exposure to heavy metals causes damage to almost every tissue and organ in the human body, respiratory diseases are still a major cause of death in cases of exposure to heavy metals and arsenic.^[13,14] This suggests that human lungs may be very sensitive and vulnerable to inhaling heavy metals. In this regard, various epidemiological studies have shown an association between exposure to heavy metals/metalloids (including arsenic, cadmium, copper, manganese, nickel, and lead) and the incidence of respiratory complications, such as asthma, sore throat, wheezing, bronchitis, and respiratory allergies.^[15]

There has been an increasing growth in the tendency of young people to consume hookah around the world, including in Iran, where there are concerns on this issue.^[16] On the other hand, the use of fruit-flavored tobacco and various flavorings and the acceptance of these hookahs by youngsters is a dangerous threat that has targeted people's health.^[17] There are numerous hookah and cigarette cafés in various cities of Iran. One of the pollutants in tobacco smoke is heavy metals; the health effects of human exposure to these pollutants are well documented and their severity mainly depends on the duration of exposure and metal concentration.^[18,19] Exposure to heavy metals has both short-term and long-term effects on human health. Symptoms such as shortness of breath, decreased respiratory capacity, pulmonary dysfunction, headache, dizziness, abdominal pain, respiratory tract irritation, and skin ulcers are associated with short-term exposure to heavy metals.^[20,21] Thus, by searching various databases, no study was found regarding the association between the exposure of workers in smoking cafés and hookah smokers, heavy metal compounds and their pulmonary function and respiratory symptoms.

Therefore, this study was designed and conducted aiming biological monitoring of the level of heavy metals in the urine samples of workers in smoking cafés and its association with their lung function and respiratory symptoms in Tehran City.

Methods

This was a cross-sectional study carried out on middle of 2021. In this study, to begin with, the list of cafés in Tehran was provided, and they were divided into water pipe cafés (WPC), cigarette smoking cafés (CSC), and non-smoking cafés (NSC); and as a sample size of 10 cafés were randomly selected from each group. The age range

of participants was 18–60 and all of them were male and there was no missing data. The approval was performed by Iran National Science Foundation grant No. 99001180. November 2020. Sampling was performed after explaining the study and obtaining the consent of the manager and staff.

In selecting people working in non-smoking cafés as a control group, the following criteria were considered:

1. They do not smoke.
2. They do not have any special diseases (such as respiratory and cardiovascular diseases) or do not take any special medicine.
3. They should not be exposed to cigarette or hookah smoke at home.

Before sampling, using a checklist predesigned by the researchers, background information of the sample donors was recorded, including age, sex, height, weight, BMI, smoking status, duration they work in cafés, and using personal protective equipment. For assessing the nutrition, having daily one part of dairy, fruits and vegetables, and no more than a time fast food in a week was considered as healthy. To measure lung function, participants were asked not to eat dinner the night before the test, and then, the next morning, they were taken to a lung function test on an empty stomach. All participants should not smoke for 1 h before the test. Pulmonary function test include the following: oxygen saturation, total lung capacity, forced vital capacity, and forced expiratory volume in the first second was performed by a personal spirometer in accordance with the device's own instructions and criteria. This test was performed three times for each subject and the best reading for each one was considered. Actual values for each participant were measured directly through this device and predicted values were determined based on age, sex, weight, and height of each subject.^[13]

To collect urine samples, participants were first instructed on how to properly collect samples, and they would be shown the best way to prevent possible contamination. Then, they were asked to collect their urine samples in 100 ml polyethylene containers under the supervision of the researcher. Urine samples were immediately acidified with high purity nitric acid, then were labeled, coded, and transported to the laboratory in a cold box next to dry ice. In the laboratory, the samples were frozen and packed properly and were stored until chemical analysis.

In this study, a microwave digester was used to digest urine samples with nitric acid. In this device, the program used to digest the samples was as follows: 2.5 min at 250 W, 3.5 min at 0 W, 6 min at 250 W, 6 min at 400 W, 5 min at 500 W, 9 min at 400 W, and 6 min for ventilation. Then, the method presented in Heitland *et al.*'s study^[22] was used to analyze heavy metals in digested urine samples with a few modifications. In this method, the inductively coupled

plasm (ICP) device was used to determine the level of eight heavy metals, including lead, cadmium, mercury, arsenic, chromium, nickel, zinc, and copper.

Statistical analyzes of this study were conducted by Microsoft Excel and SPSS software. The normality of data distribution for each of the variables was evaluated using Shapiro–Wilk test. The difference in urinary metal concentrations and pulmonary function test results among exposed and control groups was examined by *t* test.

Research Quality (Validity and Reliability)

Some spiked urine samples were used for quality control and to confirm the accuracy of the analysis method.^[23] The measured values for the spike samples were compared to the values observed for the field samples, and according to the calculation methods presented in other studies, the methodological accuracy was estimated. Spike recovery values were obtained for the target metals. During the analyzes, when the values obtained for heavy metals differed significantly from the actual values, the analyzers were recalibrated to the heavy metals mix standards and repeated the analyzes.^[24]

Findings

About 96 individuals were studied; there were 32 subjects in each group, including WPC, CSC, and NSC. All subjects were male. Six days a week, they worked about 10 h a day in café. Information on age, height, weight, marital status, education, nutritional status, and years of employment is given in Table 1. No significant differences were observed in demographic and social indicators. As there was no statistically difference between three groups regarding variables, this study found matching status.

Information on heavy metals in urine samples and the results of respiratory tests are given in Table 2. The concentration of heavy metals in the groups of hookah and cigarettes was significantly higher, and respiratory indices in these groups were significantly lower than non-smoking group. Lead, cadmium, nickel, and arsenic concentration were more than three times in WPC, and for chrome, it was about five times more. With spirometer test, this study found that the oxygen saturation, total lung capacity, forced vital capacity, and forced expiratory volume in the first second were less about 10% in WPC.

Discussion

This study suggests that non-smokers working in smoking cafés as passive smokers were exposed to secondhand tobacco smoke, so that the concentration of heavy metals in urine samples from smoking cafés was higher than non-smoking cafés, and this trend was much higher in hookah cafés. Furthermore, respiratory test indices in these subjects were significantly lower than those working in non-smoking cafés.

Table 1: Socio-demographic data in samples based on smoking in cafes in Tehran City in 2021

Variable	NSC	CSC	WPC	P (Sig)
Age	43.3±13.5	35.4±8.8	38.7±10.9	0.053
Height (cm)	168.2±8.5	171.8±9.6	170±9.4	0.439
Weight (kg)	76.1±10.8	79.5±11	77.7±10.6	0.627
Marriage (%)				
Single	34.4	53.1	37.5	0.615
Married	53.1	37.5	50	
Separated	12.5	9.4	12.5	
Education (%)				
Under Diploma	39.5	25	25	0.803
Diploma	40.6	50	50	
Over Diploma	21.9	25	25	
Nutrition (%)				
Healthy	37.5	50	53.1	0.415
Non-Healthy	62.5	50	46.9	
Years of work	8.2±4.5	6.8±2	7.5±1.6	0.812

NSC=non-smoking cafés, CSC=cigarette smoking cafés, WPC=water pipe smoking cafés

Table 2: Descriptive statistics for urinary heavy metal and respiratory tests based on smoking in cafes in Tehran City in 2021

Variable	NSC	CSC	WPC	P (Sig)
Heavy Metal (µg/L)				
Lead	5.5±6.6	8.3±9.2	17.9±13.3	0.000
Cadmium	5.3±4.9	7.4±6.6	18.9±14.1	0.000
Chrome	3.7±3.2	6.7±7.3	18.4±13.5	0.001
Nickel	7±10.3	10.4±13.4	19.9±17.3	0.000
Arsenic	6±5.3	8.8±9.1	19.8±16.5	0.001
*Respiratory test (%)				
PO ₂	93±3.8	92.2±4.1	87.9±4.9	0.01
TLC	85±9.1	83.5±8.9	77.7±7.1	0.001
FVC	85±11	83.2±10.9	75±8.6	0.000
FEV1	86.9±7.5	85.1±8.1	76±7.9	0.002

*Respiratory test is the title for 4 indexes below, PO₂=oxygen saturation, TLC=total lung capacity, FVC=forced vital capacity, FEV1=forced expiratory volume in the first second, NSC=non-smoking cafés, CSC=cigarette smoking cafés, WPC=water pipe smoking cafés

Numerous studies have been performed on the concentration of heavy metals in the urine of smokers compared to non-smokers. Afridi *et al.*^[25] in 2010 reported that the concentrations of lead, cadmium, and nickel in the blood and urine samples of smokers were higher than normal.^[26] Furthermore, respiratory test indices in smokers have been estimated in many studies.^[5,16,27] In 2012 and 2014, Boskabadi *et al.* demonstrated that in the lung function test, the lung volumes and capacities of smokers were lower than non-smokers, and this was much lower in hookah consumers.^[28,29]

There are even many studies on environmental smoke and passive smoking.^[28,29] This study also provides

newer evidence to emphasize the harmful effects of passive smoking. This can be against human rights, as non-smokers who are exposed to secondhand tobacco smoke inadvertently experience adverse health effects, and this may indicate the slavery of these individuals.

In this study, much higher levels of heavy metals in subjects working in hookah cafés could indicate that hookah smoke was more toxic than in other studies on cigarettes,^[8,30] resulting in more severe pathogenicity.

Public informing on this issue can raise awareness to prevent people from working in these cafés or reduce the level of exposure over time. Even this can be an indicator of hard work for increasing the wages of these workers compared to other jobs.

Another noteworthy point is the incomplete implementation of the smoking bans in public places approved in 2005 in Iran,^[31] which is not executed accurately with executive guarantee. This could be considered by lawmakers by increasing on-site inspections; as the law is designed to improve public health, negligence can be detrimental.

Limitation

There are a number of limitations in this study that must be considered for applying it extensively and for tobacco cafés. First, the study was limited by a small sample size and not randomizing selection. In addition, in the preliminary design of the study, blank or control cafés had been considered smokefree cafés, and the control samples were supposed to be taken from these cafés. However, during the sampling, this study was not able to find smokefree cafés close to smoking cafés. Furthermore, data were not collected on temperature and humidity concurrent with data collection time. Because temperature and humidity are the main factors generating Particulate matter (PM) levels in the indoor air of cafés, thus, it can be an interesting idea for further research. It should also be noted that water pipe smoking was not the only source producing pollutants. Furthermore, the contaminants studied in this work were limited to the toxic and hazardous pollutants in tobacco smoke such as heavy metals, although PM 2.5 and PM 10, Polycyclic aromatic hydrocarbons (PAHs), 1,3- butadiene, acrolein, acrylonitrile, nitrosamines, ethylene oxide, and others were not evaluated because of unavailability of sampling and analytical equipment and shortage of research budget.

Conclusions

Because exposure to secondhand smoke increases the urine level of heavy metals and reduces the respiratory capacity of people working in cafés, and this can be highly pathogenic in the future, comprehensive informing on human rights should be provided in this regard and smoking bans in public places must be properly enforced.

Implication

The smoking ban in public places approved in 2005 in Iran was incompletely implemented; the ban was not accurately executed with an executive guarantee. This could be considered by lawmakers by increasing on-site inspections; as the law is designed to improve public health, negligence can be detrimental.

Data availability statement

The data underlying this article will be shared on reasonable request to the corresponding author.

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Conflicts of interest

There are no conflicts of interest.

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