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Joint Iranian-Russian studies of airborne asbestos concentrations in Tehran, Iran, in 2017

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ABSTRACT

Assessment of airborne asbestos in urban areas of Tehran is important due to its potential health risks posed by a significant excess of current standards. Determination of airborne fibers can be performed using Phase Contrast Microscopy (PCM) as well as such a modern technique as Facade pane and its spectrum (SEM). Since PCM cannot differentiate asbestos and non-asbestos fibers, SEM is recommended to monitor the airborne asbestos content. The objective of this study was to determine asbestos fiber concentrations in ambient air in different areas of Tehran. Following the collection of samples using standard methods, we determined all fiber counts using PCM and asbestos fiber counts using SEM with X-ray diffraction microanalysis. The study results were then compared to the data related to the past six years obtained from the Air Quality Control Company (Iran) conducting annual airborne dust measurements in residential areas of Tehran using PCM. It should be noted that the scope of activities of the Air Quality Control Company did not include differentiation of asbestos from non-asbestos fibers.

According to the results, all airborne fibrous particles sampled were either organic or mineral fibers, the appearance and specter of which were different from those of asbestos. Filter loading with mineral and organic fibers as well as soot particles from automobile exhausts indicated generally high ambient air pollution at all sampling sites. Optical and electron microscopy analyses of five dust samples collected from horizontal outdoor surfaces detected no asbestos fibers. We recommend regular monitoring of ambient air pollution in the streets of Tehran at different seasons of the year and establishing asbestos fiber concentrations using scanning electron microscopy for complete characterization of air pollution.

1. Introduction

Asbestos occurs naturally in the environment in two main families of fibrous minerals, namely serpentine and amphibole. The amphibole forms are more hazardous to health due to certain carcinogenicity (ATSDR, 2001). Asbestos may be found in different products and materials such as roofing sheets, façade panels, pipes, floor tiles, and braking systems. Asbestos fibers can be released into the air after disruption of these materials by cutting, sanding, and other remodeling activities. Exposure to these fibers can cause lung cancer, mesothelioma, and asbestosis (ATSDR, 2015). Recognizing the risks associated with asbestos exposure led to establishment of some standards and legislations, followed by banning all uses of asbestos. The current health hazards of asbestos are related to erosion of the already installed materials or stored ones, resulting in the air pollution with respirable fibers. Therefore, it is necessary to consider assessment of health risks resulting from occupational and especially environmental exposures to airborne asbestos fibers (Pawełczyk and Bozek, 2015; Awad, 2011).

Even though the non-occupational level of asbestos is lower than the occupational one, it should not be disregarded because a long-term exposure to even these low concentrations may cause adverse health effects (Goldberg and Luce, 2009). Thus, it is important to monitor multimedia asbestos pollution to assess probable exposures. In this regard, there are some standard methods of sampling and analyzing of asbestos in different samples as well as its control to comply with regulations. The aim of these analyses can be determination of the presence of asbestos, and, if so, of its type (HSE, 2005). Phase Contrast Microscopy (PCM) is widely applied for determination of the total number of fibers in air samples collected for environmental and personal monitoring. Although this technique is fast and low cost, it is not able to distinguish asbestos fibers from other fibers. Therefore, PCM cannot exactly indicate the presence of asbestos. Currently, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) are advised for diagnostic monitoring and differentiating asbestos from non-asbestos fibers. In case of determining the asbestos content in bulk samples, SEM technique is recommended as an

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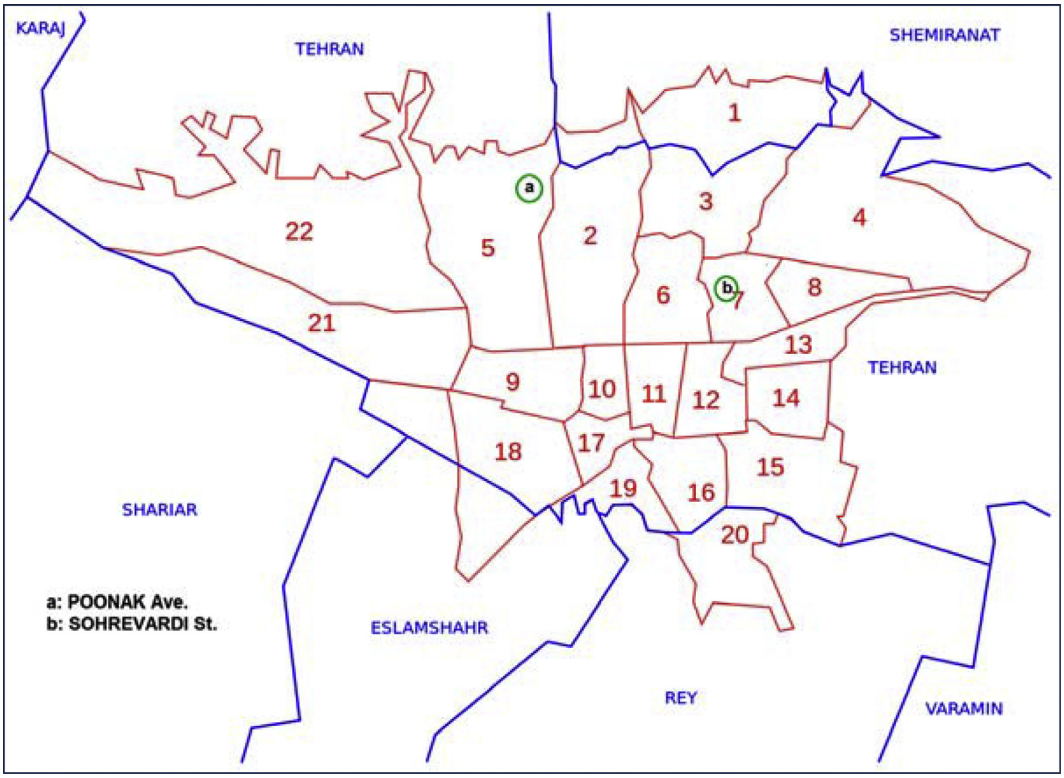

Fig. 1. The map of Tehran showing selected locations for airborne asbestos sampling (Wikimedia Commons, 2012).

alternative for Polarized Light Microscopy (PLM) (Dodson et al., 2008; Richmond, 2006; OSHA, 1995).

Because of the importance of environmental monitoring of asbestos fibers, this study was initiated to assess the concentration of these fibers in collected samples using PCM and SEM techniques as well as to compare the obtained results with measurements conducted in the past years in the city of Tehran.

2. Materials and methods

2.1. Sampling

Within the framework of the study, we took six ambient air samples at two sampling sites at the roadsides of Poonak Avenue and Sohrevardi Street in Tehran, five samples of dust accumulated on horizontal surfaces at the roadsides of Poonak Avenue and Sohrevardi Street in Tehran, and a sample of a building material in the vicinity of a highway bridge and a road junction in Gisha Street. The map of Tehran shows selected locations for airborne asbestos sampling (Fig. 1). Sampling was performed jointly by specialists of Tehran University of Medical Sciences, Iran, and Moscow Research Institute of Occupational Medicine, Russian Federation.

All air and bulk samples were collected in residential areas of Tehran during two days in September 2017 (Table 1). The average temperature, relative humidity, and wind speed during the sampling were 36 °C, 7%, and 11 mph, respectively.

2.1.1. Sampling for SEM

For further analysis by scanning electron microscopy with an X-ray diffraction microanalysis, 1920 to 2112 L of air were pumped through 25-mm *Isopore* membrane filters (this type of filters is defined as NP) with a pore size of 0.8 µm. The total of four samples was collected this way, two parallel samples per each site. The sampling time at each site averaged 2 h, the flow rate equaling 16 L per minute. The average traffic density was also estimated during sampling.

Table 1
Information related to airborne asbestos sampling in Tehran, September 2017.

Sample No.	Filter type/ ID	Start time	End time	Flow rate (l/min)	Sampled air volume (l)	Analysis
Sampling site: Poonak Avenue[a]						
1	1 NP/P	10:20	12:20	16	1920	SEM
2	2 NP/P	10:08	12:20	16	2112	SEM
3	1 MP/P	10:08	11:45	12	1164	PCM
Sampling site: Sohrevardi Street[a]						
4	1 NP/S	13:38	15:38	16	1920	SEM
5	1 NP/S	13:38	15:38	16	1920	SEM
6	2 MP/S	13:45	15:30	12	1260	PCM

[a] Air sampling was carried out at roadsides. Road traffic densities on Poonak Avenue and Sohrevardi Street were 220 and 245 motor vehicles per minute in both directions, respectively.

2.1.2. Sampling for PCM

For the analysis by phase-contrast optical microscopy, 1164 to 1260 L of air were pumped through 25-mm *Millipore* membrane filters (this type of filters is marked as MP) with the pore size of 0.8 µm using an open-face filter holder (model FP050/2; Schleicher and Schull, Dassel, Germany) and a suction pump (Tajhizeade, model 00023, Iran) at a flow rate of 12 l/min. The sampling times were adjusted so that the optimum fiber loading can be obtained on the filters (NIOSH, 1994). Two samples were taken this way, one per each sampling site. The samples were obtained at a height of one meter above the ground and in each area, control samples were also provided for ensuring accuracy of the technique.

2.1.3. Bulk sampling

Bulk samples were collected in airtight containers from the top surface of public phone booths (Fig. 2) at roadsides in Tehran where