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Assessment of airborne asbestos fibers concentration in Yazd city in summer 2015

Mehdi Mokhtari [1], Negar Jafari [2], Asghar Ebrahimi [1], Amir Mohammadi [1]
Ali Abdolahnejad [1], Yaghob Hajizadeh [3], Hamideh Niknazar [4]*

[1] *Environmental Science and Technology Research Center, Department of Environmental Health Engineering, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.*
[2] *Environmental Research Center, Faculty of Public Health, Isfahan University of Medical Sciences, Isfahan, Iran.*
[3] *Environmental Research Center, Department of Environmental Health Engineering, Faculty of Public Health, Isfahan University of Medical Sciences, Isfahan, Iran.*
[4] *Department of Occupational Health Engineering, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.*

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Corresponding Author:
Ali Abdolahnejad
Email:
abdolahnejad.a@gmail.com
Tel:
+989129307844

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ABSTRACT

Introduction: Today, have been approved scientifically relationship between presence of asbestos fibers in the human respiratory area and malignant diseases such as lung advanced fibrosis (Asbestosis), gastrointestinal, lung and Laryngeal cancers. The aim of this study was the determination of asbestos fibers concentration in Yazd city's air in the summer of 2015.

Methods: This is a descriptive cross sectional study in which 13 high-traffic points of Yazd city were selected for asbestos sampling. Sampling was conducted in the summer in two stages using SKC pump. In total was collected 26 samples from the high traffic points of Yazd city. Also for the counting of asbestos fibers was used scanning electron microscopy (SEM).

Results: In the current research, the highest and the lowest concentration of asbestos fibers were related to Shohadaye mehrab square (0.02131fiber/ml) and Azad Shahr (0.00112 fiber/ml) respectively. Qualitative analysis of asbestos fibers by SEM showed that 75% of the samples were asbestos fibers and the other was non-asbestos fibers.

Conclusion: The present study showed that the average of asbestos fibers concentration in total sampling stations (0.0848 fiber/ml) was higher than WHO guidelines (2.2×10^{-3} fiber/ml). The main reason for the presence of these fibers in the air of Yazd city can be attributed to brake pad, clutch and automobile gasket adhesive.

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Introduction

Asbestos is one of the types of pollutants and is important among the particles in the air[1,2]. Asbestos is a general term refers to six different types of silicate minerals which are separated by chopping and processing and can be dispersed in the environment with long, thin and flexible strands[3, 4]. Asbestos are divided into two groups or classes: Serpentine and amphibole. Only fiber in serpentine class is chrysotile (which is mostly known as white asbestos) which has relatively long and flexible fibers. Amphiboles include five

groups as Crocidolitetype (blue asbestos), Amosite (brown asbestos), Actinolite, Tremolite and Anthophyllite[3, 5- 6]. Due to the unique physical and chemical properties of asbestos (such as strength, flexibility, low electrical conductivity and resistance to heat and chemicals) they are widely used in various industries such as asbestos cement, clutch and brake linings, insulation materials, adhesives, flooring, vinyl asbestos, wall panels of canals for ventilation and water and sewage systems pipes[7,8]. chrysotile as a kind of asbestos has been a raw material of clutch and brake pads for cars from 1900 to 1980 which their contain of chrysotile in these products have been reported from 35 to 65 percent[3, 9]. Humans may be exposed to the different types of particles and fibers in the air. The fibers with a diameter of less than 3 microns can penetrate deep into the respiratory system of humans and can be the potential threat to their health[10,11]. From mid-1960 there were some evidences about the health risks of asbestos can lead to lung cancer and mesothelioma was raised[6]. All forms of asbestos can cause malignant diseases such as lung cancer, but the amphibole especially Crocidolite and tremolite have been identified as responsible for mesothelioma[3,12]. Today, the relationship between the presence of asbestos fibers in human respiratory and malignant diseases such as advanced lung fibrosis (asbestosis), gastrointestinal cancers, laryngeal cancer, pleural effusion, pleural plaques (pages on pleural calcification) and cancer lung has been approved[7,13]. According to the international centre for cancer registry in 2005, 55 cases of asbestos-related malignant mesothelioma has been registered in Iran[14,15]. Nowadays, production and consumption of asbestos has been banned in many countries of the world[16]. In 2007, almost 55,000 tons of asbestos have been entered into Iran[14]. However, the current rules on the production and use of asbestos have been overlooked and 11 large factories for producing cement- asbestos sheets and pipes are operating in Iran[8]. Asbestos is one of carcinogen materials (IARC Group 1)[17]. There is no amount of security for asbestos because of the uncertainty in the threshold. So exposure to asbestos should be decrease in to minimum[18].According to the lack of data about the levels of asbestos in the air and its 40-years old record in Iran to assess the concentrations of airborne asbestos in the air, providing the necessary information to develop effective management strategies is necessary and essential. Nowadays in Iran, there are no specific criteria for asbestos in the environment, such as air, which directly threatens public health[1]. Several studies have been conducted throughout the world to measure the concentration of asbestos fibers. For example, Kakouei et.al in Tehran from 2009 to 2013 showed that the average concentration of asbestos fibers in Tehran was 0.014 (14 fibers/ml) and 0.016 (16 fibers/ml), respectively[7,14]. Another study by Hyun-Sul LIM in 2004 in Korea indicated that concentrations of asbestos fibers in urban and rural areas were 0.62 and 0.3 fiber/ml, respectively[19]. The concentration of asbestos fibers in the air of New York City in the United States was reported 0.0001 fibers/ml[20].

In another study by Kakouei et.al about measuring the concentration of asbestos in worker's breath in destruction of old houses was reported that concentrations of asbestos was 0.20 to 0.42 of fiber/ml because of asbestos cement and asbestos insulator in the old houses[13]. Since the inhalation of asbestos known carcinogens undoubtedly, environmental and breathing regularly measurements seem necessary. So, the aim of this study was to measure the concentration of asbestos fibers in high-traffic areas of Yazd.

Methods

This research is a cross-sectional study. According to similar studies conducted in other cities of Iran, in the study 13 traffic points in Yazd were selected for sampling asbestos. Sampling was done in mid-summer (July) and late- summer (September), the interval of every 45 days. A total of 26 samples were collected from the traffic jams of Yazd in this season.

For sampling we used an SKC sampling pump (SKC Mcs Flite, Swedish) which was calibrated and carried out with flow rate of 10 liters per minute for 4 to 6 hours. Sampling of selected points using Mixed Cellulose Ester (MCE) Membrane Filters (MCE) (lot. No. 12557-7DC-

163) 25 mm with 8.0 micron and Holder (SKC-Lot No. R2DM43689) was conducted with opening parts for sampling of asbestos along with preventing channels from generating static electricity. Then, the used filter was transferred to the laboratory and the filters coated with gold were used to determine the type and number of fibers with ISO 14966 methods using scanning electron microscopy (SEM).At least 100 fields in each filter were analyzed randomly under scanning electron microscope at magnifications of 2000 and the number of longitudinal fibers that were greater than 5 and had a diameter of less than 3 microns were counted. Since the diagnosis of asbestos fibers from non-asbestos fibers needs to study using the analysis system of elements identification in samples (EDS) which is the basis of comparison and judgment in identification of asbestos fiber was used. Then, the asbestos fiber concentrations in the air in terms of the quantities of fiber per ml of air were reported using the following equation (Fig. 1)[13,14].

$C = 100\ N\ \pi\ r^2 / Vn \times a$

C: number of fibers in per ml of air

N: number of observed fibers

r: radius of each filter

V: volume of sampled air

n: number of observed fields

a: the level of each field in m with magnification 2000 in terms of mm^2.

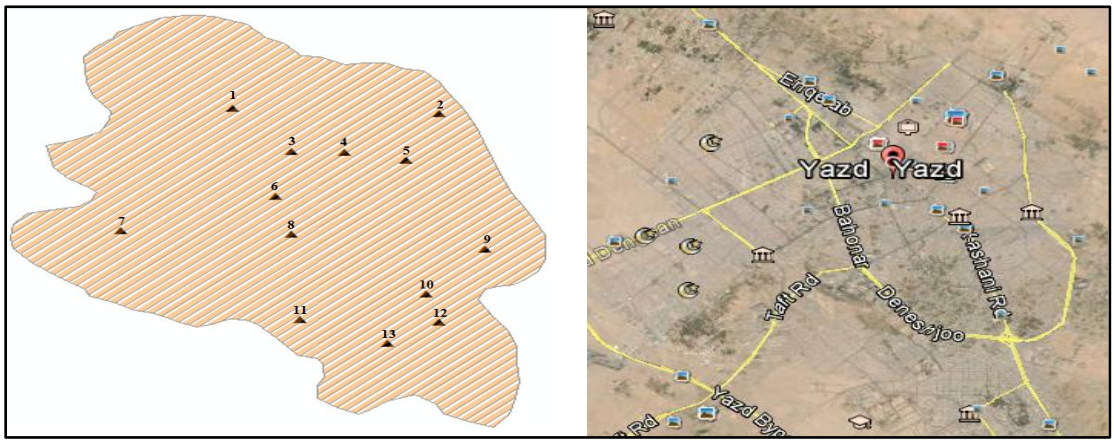

Fig. 1: Map of Yazd and sampling stations in high traffic areas in Yazd

Results

Table 1 shows the average concentration of asbestos fibers in each sampling stations from high-traffic areas and crowded city. According to the above figure, the highest concentration of asbestos fibers was observed in Mehrab Square (0.02131 fiber/ml), Bahonar Crossroad (0.01732 fiber/ml) and Imam Hussain Square (0.01663 fiber/ml), respectively and the lowest concentration of asbestos fibers were Azadshahr (0.00112 fiber/ml), Modares Blvd (0.00125fiber/ml) and Alem Square (0.00132 fiber/ml). Qualitative analysis of asbestos fibers in the present study using SEM showed that 75% of sample fibers taken in the summer were asbestos while the remaining were non-asbestos fibers. (Fig. 2) represents that concentration of asbestos fibers in the air of different areas, while fig. 3 shows the SEM and EOX of termolite asbestos fibers.

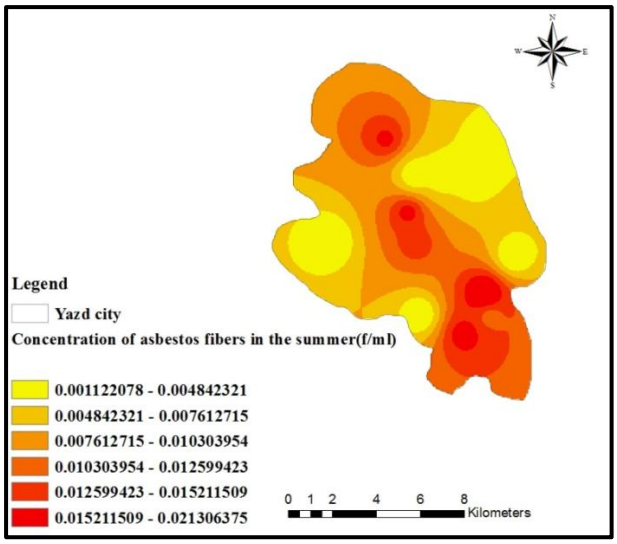

Fig. 2: Zoning concentration of asbestos fibers in the air of traffic areas in Yazd

Table 1: concentration of asbestos fibers (fiber/ml) in the sampling stations

The sampling stations	Code of stations	number of samples	The average concentration of asbestos (fiber/ml)
AZADSHAHR	7	2	0.00112±0.09
JAME MOSQUE CROSSROADS	5	2	0.00321±0.12
NIKPOOR HEALTH CENTER	3	2	0.00179±0.10
BEASAT SQUARE	4	2	0.00221±0.08
AFSHAR HOSPITAL	1	2	0.1609±0.2
ABOOZAR SQUARE	12	2	0.01149±0.05
SHOHADAYE MEHRAB SQUARE	10	2	0.02131±0.15
MODARES BOULEVARD	9	2	0.00125±0.035
EMAM HOSEIN SQUARE	8	2	0.01663±0.10
ATLASI SQUARE	13	2	0.01433±0.13
BAHONAR CROSSROADS	6	2	0.01732±0.15
FAZAYE SABZ SQUARE	2	2	0.00221±0.07
ALEM SQUARE	11	2	0.00132±0.11
AVERAGE OF ALL STATIONS			0.00848±0.11

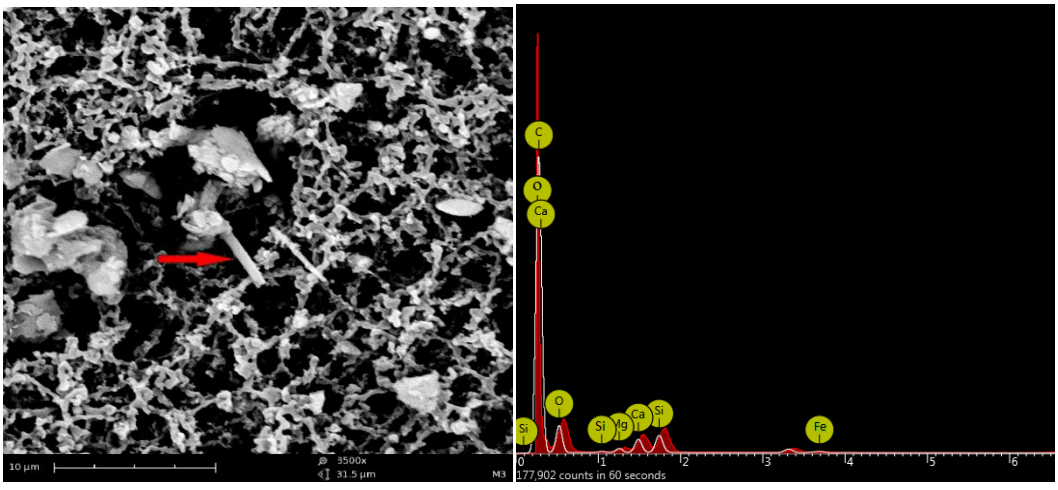

Fig. 3: SEM image and elemental analysis (EDX) of tremolite asbestos fiber

Discussion

Table 1 showed that the average concentration of asbestos fibers in total stations is 0.00848 fiber/ml of air or 8.48 fiber/liter of air and the values in the study by Kakouei et.al from 2009 to 2013 in Tehran were reported 0.014 fiber/ml of air (14 fiber/liter of air) and 0.016 (16 fiber/liter of air), respectively[7, 14]. The cause of the difference between the concentrations of asbestos fibers in Tehran and Yazd can be high population, the high number of vehicles and high traffic volume attributed in Tehran. According to a similar study was conducted by. Gualtieri in Modena; Italy, the average concentration of asbestos was 0.0013 fiber/ml[1]. Another study by LIM in 2004 in Korea reported the concentrations of asbestos fibers 0.3 and 0.62 fiber/ml in urban and rural areas, respectively[19]. The concentration of asbestos fibers in the air of New York City was 0.0001 fiber/ml[20]. These fibers concentrations in the air in Iran is more than American and European countries, because the developed countries in recent years have reduced their asbestos production or have banned asbestos, but in developing countries such as Iran there are many industries use asbestos in the production of their products and 2,000 tons of chrysotile asbestos are used in Iran's industry[3]. According to Table 1 and Figure 2 about the zoning concentration of asbestos fibers in high traffic areas of Yazd, the highest concentration of asbestos fibers was observed in Shohadaye Mehrab Square (0.02131 fiber/ml), Bahonar Crossroads (0.01732 fiber/ml), and Imam Hosein Square (0.01663 fiber/ml), respectively, while the lowest concentration of asbestos fibers were in Azadshahr (0.00112 fiber/ml), Modares Blvd (0.00125 fiber/ml), and Alem Square (0.00132 fiber/ml). Considering the guidelines of World Health Organization (WHO) in which the concentration of asbestos fibers (based on analyzing by SEM) in cities' general air was reported as 2.2×10^{-3} fiber/ml of air, asbestos concentrations in the air of most monitored stations in Yazd have exceeded guidelines of WHO[21]. Since; cars are an important source of air pollution in cities and the most important sources for emissions of asbestos fibers in the air are brake pads and clutch, the high concentration of asbestos fibers in areas with high traffic due to getting consecutive brake and clutch, is not unexpected. A study was conducted in Tehran by Kakouei at al in 2013 showed that in urban environments and non-urban areas with high traffic, pipes and sheets of asbestos - cement (Asbestos cement) used in buildings and weather conditions play an important role in high concentrations of fibers in these regions[7]. In another study by Kakouei at al to measure the concentration of asbestos in worker's breath in the old house was showed the concentrations of asbestos from 0.02 to 0.42 fiber/ml due to asbestos cement and asbestos insulation used in the old house[13]. High levels of these pollutants in urban air are relevant to the brake, clutch, gaskets and car washers[7]. In the fall of 2001, Tehran Air Quality Control Company in collaboration with the School of Health in Tehran University examined 11 Brake pads included 6 types of internal and 5 types of external to determine the amount of asbestos used in brake pads available in the market, the results of all the tests were positive and 5 to 30% of the tested pads have asbestos[22]. High concentration of asbestos fibers in the occupational and non-occupational environment can cause many diseases such as pulmonary fibrosis (asbestosis), malignant mesothelioma and lung cancer. In the United State and around the world almost 120,000 deaths each year are due to diseases related to asbestos fibers and it is a potential risk for sensitive groups such as pregnant women, children, the sick and the elderly people[23]. Mensi in Italy evaluated the effects of occupational, family and the location next to a cement factory related to malignant mesothelioma and showed that half of the 147 registered cases related to malignant mesothelioma in these regions were due to non-occupational and environmental exposures[24]. Elemental analysis EDX and SEM image (Fig. 3) showed obvious picks of elements such as Si, Mg, Ca and weak peak of Fe in fiber that correspond with the chemical properties of tremolite fibers[25].

Usually In asbestos-cement and building industries, polyvinyl alcohol (PVA), cellulose, polyacrylonitrile (PAN) and fiberglass used as a substitute and in the manufacturing of rubbing materials (pads, clutch, etc.) of the aramid fiber, Pan (PAN), and some semi-metallic alternatives

such as copper-containing material (usually in combination) discs with organic materials (with glass fiber, carbon or rubber), ceramic discs and discs with low metal, potassium titanate can be used[26, 27].

Conclusion

The study showed that asbestos fibers are in areas of high traffic and average concentration of the pollutant in the majority of sampled stations is above the guidelines set by WHO (2.2×10^{-3} fibers/ml of air) that the main reason for existence of the fibers in Yazd can be brake pads, clutch linings and car washers. Considering the dangers of asbestos fibers is recommended for citizens to do other activities such as replacing products, reducing traffic and moving the industry to other locations in order to reduce the concentration of asbestos fibers in the city.

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Conflict of interest

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