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ORIGINAL ARTICLE

Measuring the Concentrations of Asbestos Fibers in Some Crowded Areas of Baghdad in The Summer of 2020

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ABSRRACT

Aims of this research to determine asbestos fibers levels in surrounding air of some crowded sites of Baghdad city were monitored in summer 2020. Collection of samples was conducted by directing air flow to a mixed cellulose ester membrane filter mounted on an open‐faced filter holder using sniffer a low flow sampling pump, samples of air were collected from five studied areas selected in some heavy traffic areas of Baghdad city, (Al-Bayaa and Al-Shurta tunnel, Al-Jadriya, and Al-Meshin commercial complex, control), then analyzed to determine concentrations of asbestos fibers. Counting of asbestos on the filters was carried out through using both scanning electron microscope SEM and an energy dispersive X‐ray system EDS to count and determine asbestos fibers. The results of this research appeared that the levels of asbestos fibers which recorded minimum value in control site was 0.018±0.001 f/ml and maximum value in Al-Gadriya was 0.121±0.006 f/ml. The concentrations of asbestos fibers in all studied areas were more than standards of world health organization WHO for air was 0.0022 f/ml. This may be because the presence of crowded traffic, occurrence of industries near studied areas. Therefore, effective plans like management of traffic, changing of industrial locations, and products substitution replacement can be effective in reduce concentrations of asbestos fibers.

Keywords: Asbestos Fibers, SEM, Crowded Areas, Ambient Air, Summer.

INTRODUCTION

Pollution of air is defined as the emission of particulate toxic elements into the atmosphere by natural or anthropogenic (manmade) sources (1). These sources can be further differentiated into either mobile or stationary sources (2). Today the major sources of man-made air pollution are motorized street traffic (especially exhaust gases and tire abrasion), the burning of fuels, and larger factory emissions (3). Depending on the size pollutant particles, they can be carried for distances of several thousand miles. With decreasing diameter, they are able to infiltrate finer lung structures like asbestos (4).

Asbestos is a unique mineral (Greek word meaning inextinguishable) is the term for a family kind of naturally occurring minerals that readily separate into thin fibers and are found in many parts of the world abundant and widespread in nature. Asbestos was once widely used in building supplies and other consumer products (5). Because of its mechanical, electrical, chemical, thermal and biological degradation resistance characteristics, asbestos fibers are exploited in numerous commercial and industrial settings (6).

Asbestos is formed from two main groups namely, serpentine and amphibole, only fibers in serpentine type is chrysotile mineral, also called (white asbestos fibers), which has relatively long and flexible fibers, chrysotile is the most class of asbestos fibers that produced and consumed in the world (7). While amphiboles include five classes as crocidolite type which called (blue asbestos fibers), amosite called (brown asbestos fibers), actiolite, tremolite, and anthophyllite, which are separated by chopping and processing and can be dispersed in the environment with long, thin and flexible strands. Therefore asbestos is one of the pollutants types and is important among the particles in the air (8).

Because the lack of data about the levels of asbestos in the air in Iraq to assess the concentrations of airborne asbestos in the air, providing the necessary information to develop effective management strategies is necessary and essential.

MATERIAL AND METHODS

Five studied areas which selected in some intersection of Baghdad city, two areas located in Karkh include Al-Bayaa (Latitude: N 33º 15′ 57″ Longitude: E 44º 20′ 13″) and Al-Shurta tunnel (Latitude: N 33º 18′ 23″ Longitude: E 44º 19′ 28″), and two in Rusafa Al-Jadriya (Latitude: N 33º 16′ 52″ Longitude: E 44º 23′ 20″) and Al-Meshin commercial complex (Latitude: N 33º 17′ 45″ Longitude: E 44º 27′ 1″). In addition to fifth area as control site (Latitude: N 33 16′ 38″ Longitude: E 44º 23′ 15″) namely in the green area located near the University of Baghdad.

The sampling was carried out during the day at various times in the downwind side of the location. Sampling points were selected by taking into account the strength of traffic, density of population, the industrial sources of pollutants, and prevalent winds direction. Thus, air samples from five sampling points were selected which cover the five geographic areas of Baghdad city.

The sampling was carried out during the day at various times in the downwind side of the location. The sniffer device was placed at the height of 1.5 meters higher than the ground level. The fibrous matters collected on the filter were identified and counted via using scanning electron microscope SEM (TESCAN DynaTOM, USA) and energy dispersive X‐ray spectroscopy EDX (9).

In order to evaluate the parameters in this study (the difference between means of all levels of asbestos, temperature, relative humidity, and wind speed) and compare between areas in summer using least significant differences (LSD) at $p \leq 0.05$ to explain the differences between means, and expressed that as (mean ± SE). Capital and small letters indicate to comparison in row and column respectively, similar letters are non-significantly differences between means at ($p \leq 0.05$), Using (LSD test). Farther that finds the correlation coefficient for parameters in this study and determines the significant at $p \leq 0.05$. Using spss program 2010 and excel application to find the result and draw the figures with some effects.

Sampling sites: Sites of sampling were chosen by taking into account the dense of traffic, intensity of population, pollutants industrial origin, and direction of prevailing winds table 1.

Sniffer (SKC MCS Flite, Swedish) is a device used in field to collect air pollutants samples like asbestos fibers, heavy metals, and TSP in sites and measurement unit (l/min).

Before sampling cellulose filters were dried at 40 C0 for 30 minutes and then weighted to record original weight W1 by using sensitive balance (10). In the sampling site, the filter placed in the sniffer device were put on the height of one meter or more above the ground to avoid the dust by the movement of wind and with the direction of the prevailing winds in the region. then at the end of sampling operation, the exposed filter removed from the sampler and kept inside a sealed container and weighted in the laboratory, this weight represent the final weight W2 ((11).

Thus, the samples of polluted air were gathered from five sampling sites which cover five areas of Baghdad city. Map of the

city and the sampling sites are appearing in fig. 1. Sampling was conducting through directing air flow to a mixed cellulose ester membrane filter mounted on an open‐faced filter holder by using sniffer, a low flow sampling pump. Counting of the asbestos fibers on the filter was carried out by using scanning electron microscope SEM and energy dispersive X‐ray system EDS, to determine total fibers. The filters were located inside sealed plastic petri dish and transferred to Mira laboratories in Tehran, Iran for examine.

Figure 1: Sampling sites

Preparation of samples and analysis: The air samples collected from selected areas were examined in the nano laboratory of the minerals research office at the Iraqi Ministry of Science and Technology. Scanning electron microscope (SEM) coupled to energy dispersive X‐ray system (EDS) was utilized to count and identify the asbestos fibers (12).

Scanning electron microscope SEM and energy dispersive X‐ray system EDS was used together to counted and diagnosis the asbestos fibers, energy dispersive X‐ray system EDS method gives a spectrum showing elemental content of the fibers. For analysis the samples, the filters were provided and analyzed by scanning electron microscope SEM for determination fibers of asbestos according to the method of BS ISO 14966. The filters were mounted on sample stub with two sided copper adhesive and were then status on coating device (EMITECH K 450X, EM Technologies Ltd. England) for coating by gold, and then, using scanning electron microscope SEM with magnifications ranging from 500 to 10000, asbestos fibers with long more than five micrometer 5µm and diameter more than three micrometer 3µm, and the ratio of length and diameter of 3/1 were considered as fibers of asbestos. Scanning electron microscope SEM sensitivity is evaluated in the scope of 0.0001 f/ml of air (13).

Count of asbestos fibers: For preparation and scanning electron microscope SEM analysis and energy dispersive X‐ray system EDS analysis, the filters that collected air pollutants located inside lidded plastic petri dish and tightly sealed then transferred to nano laboratory of the minerals research office at the Iraqi Ministry of Science and Technology.

The concentrations of asbestos fibers were determined by following formula using the SEM results (14).

CSEM = (1000XN*A) / (V* n* a)

Where

C Concentration of asbestos fibers in the air (fibers/milliliter) f/ml

N Number of counted fibers

A Effective area of the filter (the area that varied in color than other area of the filter due to flow of air stream) equal to 385 mm2

V Volume of sampled air (liter)

N Number of counted fields of images

A Calibrated area of each image (mm2).

RESULTS AND DISCUSSION

Based on the data that obtained in this study, the levels of asbestos fibers which recorded minimum value in control site was 0.018±0.001 f/ml and maximum value in Al-Gadriya was 0.121±0.006 f/ml, fig. 2. From data were taken from this study, find that the overall rate of asbestos fibers concentration in control site lower than that in other study sites during summer, asbestos concentration in all sites including control site, not with limits of WHO 0.002 f/ml. This attributed to the commercial nature of this region and because the activities of repairing and underway construction street near this area that led to dense roads, also, emission of asbestos fibers from materials that used in constructions, can be the main causes for the high concentrations of the fibers of asbestos in the air in this area. As well as, it can be attributed to the heavy of coach and bus locations which is located near this area. Other high polluted site was Al-Shurta tunnel which consider industrial region that make it in heavy traffic in most times in addition to present of old building that consider an important source of air asbestos. The old building also causes in study sites may be one of the reasons of these levels of asbestos fibers. Andrzej (2020) obtained a similar result for what was obtained in the current study on the effect of old buildings on increasing the concentration of asbestos in some cities in Poland (15). These results reveal significant differences (P≤0.05) between means of asbestos fibers concentrations of examined sites during summer.

Counting and analysis of asbestos fibers in samples of air were collected from five locations was conducted via scanning electron microscope SEM, while chemical content of the asbestos fibers was analyzed through energy dispersive X‐ray system EDX. Based on the values that obtained from analysis of scanning electron microscope SEM, the number of the fibers of asbestos in the filters and then, in the surrounding air of the studied sampling locations was calculated using the above mentioned formula. All these results exceed the standards conducted via the World Health Organization WHO which determined the asbestos fibers concentrations not exceed 0.0022 f/ml.

Those results were more than others measured concentrations that carried out in some countries of the world. For example, in Romania Anca have found an average level of 0.02702 f/ml conducted in several points in Bucharest (16). While in some cities in Italy, Gualtieri and his colleges counted an average level of 0.00056 f/ml (17). Examples of an SEM image of asbestos fibers shown in fig. 3.

Others two studied locations, Al-Bayaa and Al-Meshin complex, also recorded high level of asbestos fibers due to it is commercial areas and characterized by congested traffic. It is important to mention that natural sources such as weathering and erosion are one of the important reasons for the spread of asbestos in the surrounding air (18).

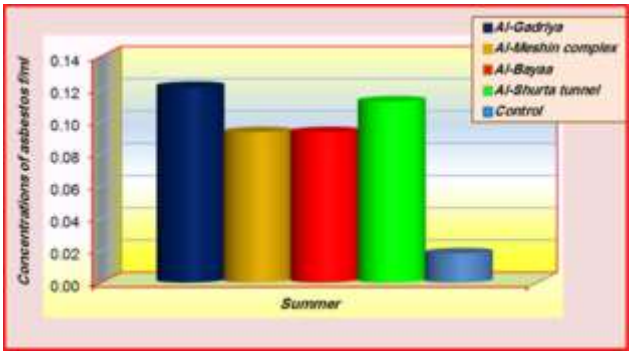

Figure 2: Concentrations of asbestos fibers of the study sites during summer

Generally, increase in temperature and wind speed accompanied with a decrease in the concentration of asbestos fibers and vice versa is true as the wind speed has an important role in the spread of pollutants where the wind transported

contaminants from emitted sources toward the prevailing wind. Therefor when built factories must become within prevailing wind through the year to spread among large area and then dilute these pollutants (19).

in summer noted decrease in asbestos fibers, this is due to weather factors such as increased wind speed and higher temperatures that helped to a large extent reduce the levels of asbestos fiber concentrations as a result of increases in temperatures and wind speed in addition to the condition that combined with spread corona virus COVID-19 and temporary stopped of life and cars and industries, these exceptional conditions and procedures reduced to some extent the emission of asbestos fibers into the air (20).

Also, the decrease in wind speed during the fall and winter seasons may be led to the accumulation of these fibers in the air of the city of Baghdad and not to spread them over large areas and then disperse and reduce their concentrations. While in spring and summer noted decrease in asbestos fibers, this is due to weather factors such as increased wind speed and higher temperatures that helped to a large extent reduce the levels of asbestos fiber concentrations as a result of increases in temperatures and wind speed in addition to the condition that combined with spread corona virus COVID-19 and temporary stopped of life and cars and industries, these exceptional conditions and procedures reduced to some extent the emission of asbestos fibers into the air.

Relationship between Fibers of Asbestos Level and Weather Factors: Some parameters such as temperature, relative humidity, and wind speed were collected for each sampling days. The results that obtained from weather variables among summer on the concentration of asbestos fibers were revealed that relationship among levels of asbestos fibers and weather parameters (21). These relationships given in tables 1 and 2.

Table 1: Mean values ± SE of, temperature, relative humidity RH, wind speed, and asbestos fibers

				Mean ± SE	
Area name	Al-Gadriya	Al-Meshin complex	Al-Bayaa	Al-Shurta tunnel	Control
Variables	Summer	Summer	Summer	Summer	Summer
Temp.C°	41±1.790	45±1.559	48±1.386	42±1.212	45±0.981
RH%	21.8±1.790	16.9±1.674	26±1.559	27.8±2.367	10±1.097
Spee. m/sec	5±0.231	5±0.289	5±0.404	3±0.173	8±0.808
Concentration of asbestos f/ml	0.121±0.006	0.093±0.002	0.093±0.004	0.112±0.009	0.018±0.001

Table 2: Correlation between weather factors and concentration of asbestos fibers

	Correlation table
Variables	Concentration of asbestos
	Summer
Temp.	-0.424 S
RH	0.820 S
Wind speed	-0.885 S

Energy Dispersive X-Ray Spectrometry EDX Results: Depending on the results obtained from energy-dispersive spectrometry EDX analysis, The chemical composition of the asbestos fibers consist of main minerals magnesium (Al), and silica (Si), which considers the main mineral in asbestos content, therefore all samples that collected from the fourth studied area contain Mg and Si in their chemical composition. The result show Al content between 5.09 – 5.26%, while the percent of Si between 33% - 36%. The chemical composition of the asbestos fibers is shown in table 3 and figures 4 and 5.

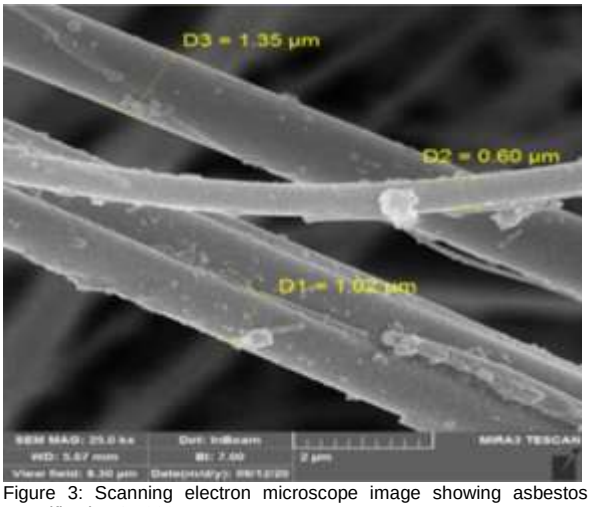

Figure 3: Scanning electron microscope image showing asbestos fiber magnification 25,000×

Through the results obtained from EDX analysis, they confirm that asbestos fibers contain the elements that make it the most dangerous type to human health (26, 27) and due to the type of chemical bonding between these elements, it is difficult for a person to get rid of the fibers because of their ability to bond tightly with tissues of the lungs (28, 29, 30).

Table 3: Chemical content percent of asbestos fibers

Season	Summer			
Area name	Al-Bayaa	Al-Gadriya	Al-Shurta tunnel	Meshin complex
Element	Wt%	Wt%	Wt%	Wt%
C	2.4	2.17	3.8	1.95
O	37.01	39.01	38.84	38.02
Na	10.21	10.95	10.39	10.76
Mg	-	-	-	-
Al	5.13	5.23	5.09	5.26
Si	36.11	35.06	33.93	35.92
S	-	-	-	-
Cl	-	-	-	-
K	3.44	2.98	2.96	3.19
Ca	2.38	1.96	2.35	2.05
P	-	-	-	-
Fe	-	-	-	-
Ti	-	-	-	-
Zn	0.55	0.39	0.33	0.4
Ba	2.77	2.26	2.3	2.45
Total:	100	100	100	100

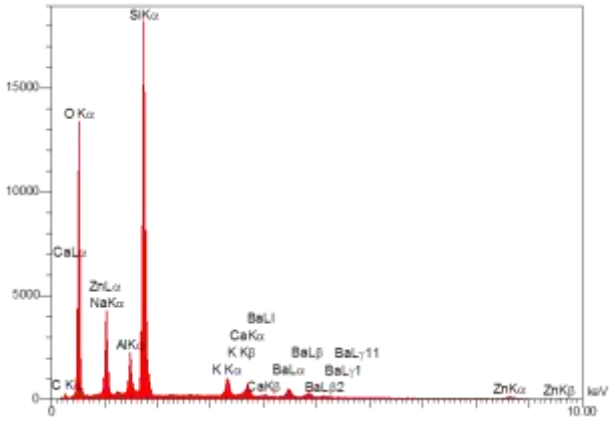

Figure 4: Energy-dispersive spectrometry EDS image by (SEM) of asbestos composition of Al- Bayaa air sample

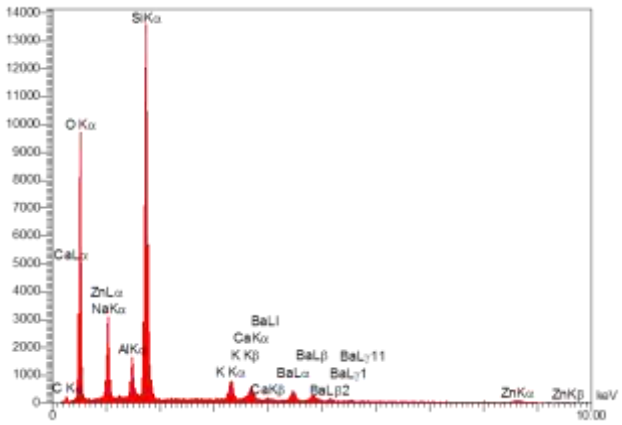

Figure 5- Energy-dispersive spectrometry EDS image by (SEM) of asbestos composition of Al-Meshin complex air sample

CONCLUSIONS

The values that obtained from this research not within the allowable standards that conducted by valid organizations such as the World health organization WHO which is 0.0022 f/ml.

This accrues due to the nature of area which located among dense traffic and process of demolition of older houses.

Also, these concentrations considerably higher than the threshold limit value (TLV) suggested by American conference of governmental industrial hygienist ACGIH, National Institute for Occupational Safety and Health NIOSH, and Occupational Safety and Health Administration OSHA a standard which is 0.1 f/ml.

As well as more than those conducted for Europe environment. The presence of different anthropogenic sources of asbestos fibers in and surrounding city and heavy traffic in the city considered the major causes for the high concentrations of the fibers asbestos in the surrounding air and then main sources of diseases. Also high level of pollution by asbestos attributed to commercial and industrial nature of the studied areas. Owing to the high concentration of asbestos fibers, surrounding community's health, occupational groups, taxi drivers and traffic officers can be negatively affected. Also weak speeds of wind, little rain, desertification, and reduced of green areas led to low dispersion, precipitation, and self-purification of atmosphere which result in accumulation of air pollutants over Baghdad city.

Therefore, the better solutions to reduce asbestos emission are changing it with other products like pads of brake, transferring of industries that work with fibers of asbestos away from city, and management of traffic by preventing the presence of heavy cars in the city at rush hours of traffic, replacing of asbestos with safe substances in different materials like gear and pads of clutch, development of green spaces can help to reduce and even eliminate the asbestos fiber and other pollutants emission from the environment may be beneficial for human health. The asbestos ban is also one of the important options for eliminating asbestos pollution. In Iraq, country of current study, asbestos was banned in 2016, according to Iraqi government's decision numbered 41, and in it the Council of Ministers it decided to prohibit the production, import, or dealing in asbestos. However, asbestos is still widely used.

Due to there have been no reports of airborne asbestos levels in the automobile brake, clutch, and asbestos cement manufacturing industries, and there have been no reports of asbestos at exposure levels in demolition of older houses process, and this lack of data on levels of airborne asbestos, therefore an evaluation of asbestos is needed (22)

However, those values were higher compared to the measured concentration in some parts of the world, for instance, In Iran some studies coundected by Shahla and, Yaghoub (2016); Hossein and Mohammad (2014); Mohammad and Yaghoub (2016), these researchers found that average levels of asbestos fiber between 0.01364 f/ml and 0.01224 f/ml (7.10,11). While in Romania, Anca, (2015) reported an average concentration of asbestos fibers was 0.02702 f/ml measured in several points in Bucharest (23). As well as in some cities in Italy, Gualtieri et al. (2009) reported an average concentration of 0.00056 f/ml (24). When compare concentration of asbestos fibers in summer with that in winter in the same year found that in winter asbestose concentrations more than summer may be due to weather factors such temperature, humidity, and wind speed (25,26).

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