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Evaluation of Asbestos-Related Pulmonary Diseases in Lining Workers and Makers of Isfahan

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ABSTRACT

Background: *Lining is made up of different materials, the most important and dangerous one being Asbestos. With the increasing knowledge and awareness of lining workers (men who repair brake linings) in regard to asbestos and its associated dangers, this concept is induced in their mind that they might be affected by asbestos-related lung diseases. The aim of this study was to determine the prevalence of asbestos-related pulmonary diseases among the lining workers and lining makers of Isfahan.*

Materials and Methods: *In a cross-sectional study, 47 workers (18 from Gort lining factory, and 29 from lining workshops of Isfahan) were evaluated. They underwent history taking, clinical examination, chest x-ray (CXR), spirometry, CT-scan (HRCT), bronchoscopy, and bronchoalveolar lavage (BAL) examinations. Since there were no reports measuring the number of asbestos fibers in the air of the working places (factory and workshops), the mean number of asbestos fibers in these areas was calculated.*

Result: *A total of 47 male workers were studied. The age range was 35-75 years, mean ± SD=47.96±10.33, and 95% CI=45.01, 50.91. Also, they had an occupational history of 20-69 years, mean ± SD=29.57±8, and 95% CI=27.28, 31.86. The frequency of asbestos related pulmonary diseases (pulmonary fibrosis, pulmonary plaque, peribronchial thickening) was 21.28% (17.03% among smokers) with relative frequencies of smoking 64%, cough 31.92%, sputum 48.94%, dyspnea 72.34%, and wheezing 19.15%. The frequencies of abnormal CXR, spirometry, and HRCT were 27.6%, 23.5% and 19.2% respectively.*

The number of asbestos fibers in the air of the working place was mean±SD=0.36±0.1 fbr/cc (p value<0.05, t=3.26).

Conclusion: *Exposure to asbestos without considering the safety measures and principles of occupational health and security results in a number of asbestos-related lung diseases among the lining workers and lining makers. It is notable that smoking augmentates the harmful effects of asbestos: the fact which has been confirmed by clinical and para-clinical examinations of this research. Due to short mean duration of occupational history, asbestos-related malignant pulmonary disease was not detected. As a conclusion, in addition to abstaining from smoking, obeying the health-security measures present at work and finding a suitable replacement for asbestosis in lining industries as well as follow-up and regular screening of the workers are also recommended.*

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Key words: *Asbestos, Brake lining, Lining makers, Asbestosis, Lung cancer, Malignant mesothelioma, Diffuse pleural fibrosis, Atelectasis, Pleural plaque, Pleural effusion*

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INTRODUCTION

Many people driving a car are somehow familiar with various parts of an automobile and know that stopping a car is more important than driving (1).

The brake system of a car is a mechanism for reducing the speed of an automobile and stopping it. One of the important parts of a brake system is the brake lining (2).

A brake lining is made by combining different materials, the most important and dangerous one being Asbestos. The type of asbestos used in lining is chrysotile which is a form of serpentine asbestos (2,3).

Asbestos is a mineral with many different properties. Some of these properties are: being thermally and chemically resistant, having flexibility and capability of spinning, producing good friction, and having an acceptable toughness. Ancient people were familiar with these properties and, thus, used asbestos widely (4-9).

In the years between the two world wars, asbestos was produced abundantly and used widely in the industries. However, because people became aware of the dangers of asbestos, its usage declined gradually during the late 1980's. By the year 1999, 25 countries banned the use of asbestos in their factories. Still, it is widely used in Africa, Asia, and South America (5).

The pathogenicity of asbestos fiber depends on its physical characteristics, solubility, aerodynamic size, and dimension as well as the duration and intensity of exposure and biological/physiological status of the workers (5).

Asbestos-related pulmonary diseases are as follows:

1. Asbestosis
2. Lung cancer
3. Malignant mesothelioma
4. Diffuse pleural fibrosis
5. Rounded atelectasia
6. Chronic bronchitis
7. Pleural plaques
8. Benign asbestos-related pleural effusion

The radiological manifestations of asbestos related pulmonary diseases may appear long after exposure to this toxic material. The earliest, most common and persistent symptom with which asbestosis patients refer, even in the presence of a normal CXR is dyspnea. Cough with sputum is the other common complaint (8-10). Similarly in the patients suffering from lung cancer, the individual may refer to various physicians with signs and symptoms of neoplastic syndromes; however, diagnosis is delayed until paraclinical findings become apparent (5-11).

It is at this point that the importance of regular and periodical screening and examination of high risk individuals becomes clear and apparent (12). One of the important risk factors in this regard is smoking. According to various studies and researches, smoking increases the risk of lung cancer in asbestos exposed individuals by many folds. (50-90 times more than non-smokers) (8,13,14,15).

Although CXR is the most important diagnostic test for pneumoconiosis, it does not have the required sensitivity and specificity in the diagnosis of lung diseases (8,14,16). Thus, if the results of x-rays and spirometries are suspicious and unclear, HRCT and biopsy are performed (12-17).

Increasing knowledge regarding the risks of working with asbestos has induced worries among lining workers, that they might be afflicted by asbestos-related pulmonary diseases.

Several factors such as WHO recommendation (in regard to carrying out accurate epidemiological evaluations in developing countries), determination of the status and prevalence of respiratory diseases in a country (12-18) and finally lack of similar studies in Iran necessitated the conduction of such a research in this country. This study was carried out not only to determine the frequency and prevalence of asbestos related lung diseases among lining workers and lining makers of Isfahan but also to asses the level of asbestos toxicity in this occupation.

MATERIALS AND METHODS

The study population consisted of workers of Gort lining factory and nearly all lining workshops of Isfahan. The study was conducted from Oct. 2001 to the end of May 2002.

In an analytic cross-sectional study, we recruited 115 cases of lining workers by easy sampling technique.

The formula was: $n = N Z^2 P (1-P) / (N-1) d^2 + Z^2 P (1-P)$.

Based on the above formula, a minimum number of 108 were considered as the size of the study sample. Since there was the possibility that some workers would not agree to participate in the study, a total of 115 lining workers and lining makers were chosen from Gort lining factory (27 cases) and lining workshops of Isfahan (88 cases). It is notable that although this study was initially performed on 115 workers, the final study population included only 47 workers. The reason for this decrease in number was the fact that asbestos related pulmonary diseases usually appear long after the initial exposure; a minimum duration of 20 years is required for the appearance of this group of diseases. Thus, all those workers having an occupational history of less than 20 years were excluded.

Initially a questionnaire containing questions in regard to respiratory diseases was prepared (19). After referring to their workplaces and explaining the questions, the questionnaires were filled out for each worker. Based on a fixed schedule, they were asked to refer to Khorshid and Alzahra Hospitals. Various clinical examinations, CXR, and spirometry were performed. The spirometry was carried out by a technician using Erich Jaeger (Made in Germany) apparatus.

Based on references (20,21), the obstructive and restrictive patterns were defined and determined.

After undergoing spirometry, chest x-rays were taken in PA and lateral views in standing and deep inspiration positions (Philips super 80cp-Made in Germany)

The spirometry and CXR reports were read and abnormal cases were drawn out. According to ILO-1980 (22), abnormal chest x-ray findings were as follows:

1. Small rounded opacities
2. Small irregular opacities
3. Large opacities
4. Pleural lesion
5. Peribronchial thickening

Out of 47 workers that had undergone examination, those with abnormal spirometry and/or CXR reports were selected and referred once again to the hospital for HRCT and/or bronchoscopic examinations.

The next part of the research had 2 stages:

First stage: This group of patients underwent HRCT (using CT-Sytec 3000 ge apparatus-Made in USA) with or without contrast (using Omnipaque 40 cc IV), and later the reports were studied.

Second stage: Bronchoscopy was performed in those individuals that had abnormal HRCT, (using Olympus-OCV-200, Made in Japan). The bronchoalveolar lavage (BAL) was then sent to pathology for examination.

Since there were no statistical reports on the mean number of asbestos fibers present in the air of the working places of lining factories and workshops, we determined this figure in our study.

After coordinating with the Health Center of Isfahan province (occupational-industrial health unit) samples from the air of working places of Gort lining factory and lining workshops of Isfahan were obtained using Sibatta (Made in Japan), and SKC pumps (Made in USA). The filters used were cellulose nitrate filters with pore size of 0.8 micron and diameter of 25 nm (code D-37582, Made in Passel company-Germany). The duration of air sampling was half an hour in each workshop for which debi pump was used for collecting air at a rate of 1 lit/min. After sampling, number of asbestos fibers were counted using the phase contrast microscope (lens 10X). Later the volume of air sample and also the number of asbestos fibers per cubic centimeter of air were calculated.

It is noteworthy that for better evaluation of asbestos exposure, air samples should be obtained at different working hours and air pollution levels. TWA is then calculated. However because of financial problems present in this study, the procedure was not carried out here.

Finally, all the results obtained were entered into SPSS software (verson.9); mean, standard deviation, and 95% CI were calculated. The relative frequency of qualitative variables was also determined.

RESULT

A total of 115 male workers were enrolled in this study.

The age range was 16-75. (mean±SD=37.1±13.1). Since asbestos-related pulmonary diseases appear after a long latent period, those workers having an occupational history of less than 20 years were excluded. This left only 47 workers with an occupational history of more than 20 years in this study. The mean age was mean ±SD= 47.96±10.33 years, 95% CI: 45.01, 50.91 and an occupational history of 20-69 years, mean ± SD= 29.57±8 years, 95% CI= 27.28, 31.86 (table 1).

According to our results, the frequency of asbestos-related pulmonary diseases among the lining workers and lining makers of Isfahan was 21.28%. This group of diseases and their relative frequencies were as follows: small irregular opacities in pulmonary fibrosis 6.38% (of which 4.26% were smokers), pulmonary plaques (pleural lesion) 10.64% (8.51% were smokers), peribronchial thickening 4.26% (all were smokers) (Table 2,3).

The relative frequency of smoking was 64%.

Table 1. Demographic characteristics of the under-study population shown in different age groups.

Occupational history	20-29 yr	30-39 yr	40-49 yr	50-59 yr	60-69 yr	Total (%)
Parameters						
Number (%)	26 (55.32)	13(27.62)	7 (14.89)	0	1 (2.13)	47
Mean age (%95CI)	42.77±8.31 (39.57, 45.96)	50.46±7.57 46.34, 54.57)	58.71±4.68 (55.24, 62.18)	0	75	47.96±10.33 (45.01, 50.91)
Occupational history (%95 CI)	23.65± 3.38 (22.35, 24.95)	32.31± 3.1 (30.62, 34)	42.14±2.47 (40.31, 43.97)	0	60	29.57±8 (27.28, 31.86)
Number of smokers (%)	12 (25.53)	4 (8.51)	1 (2.13)	0	0	17 (36.17)

Table 2. Frequency of the probable asbestos-related pulmonary diseases observed in different age groups of the under-study population

Occupational history	20-29 yr	30-39 yr	40-49 yr	50-59 yr	60-69 yr	Total (%)
Pulmonary diseases	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
Pulmonary fibrosis	2 (4.26)	1 (2.13)	0 (0)	0 (0)	0 (0)	3 (6.38)
Pleural lesion	0 (0)	3 (6.38)	1 (2.13)	0 (0)	1 (2.13)	5 (10.64)
Peribronchial Thickening	1 (2.13)	0 (0)	1 (2.13)	0 (0)	0 (0)	2 (4.26)

Table 3. Frequency of the probable asbestos-related pulmonary diseases in the smokers and non-smokers of the under-study population.

Smoking Status	Smoker	Non smoker	Total (%)
Pulmonary disease	No.(%)	No. (%)	
Pulmonary fibrosis	2 (4.26)	1 (2.13)	3 (6.38)
Pulmonary plaque	4 (8.51)	1 (2.13)	5 (10.64)
Peribronchial Thickening	2 (4.26)	0 (0)	2 (4.26)

Also, the relative frequencies of the symptoms were as follows: cough 31.91%, sputum 48.94%, dyspnea 72.34%, and wheezing 19.5% (Table 4,5). None of the study workers complained of pleuritic chest pain.

The frequency of abnormal CXR, HRCT, and spirometry were 27.6%, 19.2%, 23.5% respectively. From the individuals that had abnormal HRCT, 7 were ready to undergo bronchoscopy; all the reports were normal. Also, results of all 7 bronchoalveolar lavage fluids (BAL) were normal (negative in regard to detection of asbestos bodies).

Overall, based on our results, no abnormal bronchoscopy or BAL was detected.

Meanwhile, 74.47% were aware of the risks of asbestos-exposure and followed the basic rules and regulations of health and security at work; 51.06% had knowledge of prevention, and only 10.64% had a working place that was properly ventilated with the health-security principles being implemented. Also, it is notable that 97.87% of the study population washed their dirty cloths at home.

Based on their knowledge of health-security principles and awareness of the asbestos related complications, the demographic characteristics of the cases are shown in Table 6. The mean number of asbestos fibers present in the air of Gort lining factory and lining workshops of Isfahan was mean ± SD=0.36±0.1 fbr/cc; with a 95%CI=0.26, 0.46 and p-value<0.05, t=3.26.

Finally, although several asbestos-related complications were detected, asbestos-related malignant pulmonary lesions were not observed.

Table 4. Frequency of clinical manifestation in workers having different durations of occupational history.

Occupational history	20-29 yr	30-39 yr	40-49 yr	50-59 yr	60-69 yr	Total (%)
Complaint	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
Cough	6 (12.77)	5 (10.64)	3 (6.38)	0 (0)	1 (2.13)	15 (31.92)
Sputum	10 (21.28)	7 (14.89)	5 (10.64)	0 (0)	1 (2.13)	23 (48.94)
Wheezing	3 (6.38)	3 (6.38)	3 (6.38)	0 (0)	0 (0)	9 (19.15)
Dyspnea	15 (31.91)	11 (23.40)	7 (14.89)	0 (0)	1 (2.13)	34 (72.34)

Table 5. Frequency of clinical manifestations in the smoker and non-smoker groups of the understudy population.

Smoking Status	Smoker	Non smoker	Total (%)
Complaint	No. (%)	No. (%)	
Cough	10 (21.28)	5 (10.64)	15 (31.92)
Sputum	14 (29.79)	9 (19.15)	23(48.94)
Wheezing	6 (12.77)	3 (6.38)	9 (19.15)
Dyspnea	20 (42.6)	14 (29.8)	34 (4.26)

Table 6. Demographic characteristics of the under-study population in regard to obeying the health security principles.

Topic		Number of individuals	(%)
Workers that were aware of the dangers of working with asbestos		35	74.47
Workers that were aware of methods that prevented asbestos complications		24	51.06
Workers that used fruit juices and milk (preventing from asbestos complications)		9	19.15
Workers that had working places which were adequately ventilated and health-security principles implemented.		5	10.64
	At the work place, washing with hand	1	2.13
Site and method of washing the dirty cloths.	At home, washing with hand	5	10.64
	At home, washing with washing machine	41	87.23

The only exception was a 75-year-old worker who had an occupational history of 60 years. During the clinical examinations, he was diagnosed as having a pleural lesion (pulmonary plaques). After the completion of the study, he developed pleural effusion. Closed pleural biopsy was performed and malignant pleural mesothelioma was confirmed.

DISCUSSION

In this research, multiple asbestos-related pulmonary complications such as pulmonary fibrosis (small irregular opacities), pulmonary plaques (pleural lesion), and peribronchial thickening were detected. However, considering the duration of the occupational history (mean ±SD=29.57±8 year) of the study population, no malignant pulmonary lesion was detected. The only exception was a 75-year-old worker that had pleural plaque and developed pleural effusion. He was later diagnosed as having malignant pleural mesothelioma. In other words, due to the number of asbestos fibers present in the air of workshops and factories (mean ±SD=0.36±0.1 (fbr/cc)) and the defined standard limits for the asbestos fibers i.e. 0.2 fbr/cc, it is clear that the longer the duration of asbestos exposure, the higher will be the risk of acquiring malignant pulmonary lesions and asbestos-related complications (12-19). Asbestos-related complications usually appear after a long latent period. For example, the latency periods for various asbestos-related disorders are: 20 years of asbestos exposure for asbestosis (the exceptions are severe cases in which the duration is shortened to few months or 1 to 2 years), 30 years for more than 70% of pleural plaques, 40 years for lung cancer and 45 years of asbestos exposure for pleural mesothelioma (19).

Among the respiratory symptoms, dyspnea was the most common complaint, the importance of which must be noted (72.34% and 42.6% in smokers). Even in the absence of radiological manifestations, dyspnea indicates asbestos-related pulmonary diseases such as asbestosis. The earliest, most common and persistent finding and complaint in asbestosis is dyspnea (8,10,11).

Poor ventilation of the working place, lack of attention to the occupational health principles (e.g. not wearing masks), and the high concentration of asbestos fibers in the air of the working places resulted in asbestos-related pulmonary disorders and respiratory symptoms (such as dyspnea, sputum, and wheezing) in lining workers and makers of Isfahan industries. Also, the longer the duration of asbestos exposure, the higher is the risk of respiratory signs and symptoms. These individuals are in high risk of acquiring COPD (9-10). The above mentioned issue is further confirmed by our results; as clinical and para-clinical findings were more commonly observed in the older age group (>40 years.). In this study, 64% were addicted to smoking with the respiratory signs and symptoms being more common in them. This finding was consistent with earlier references and studies made in this regard (6,11,15). Although the most common cause of cough in smokers is smoking (6,19), there is the possibility that both smoking and asbestos exposure (augmentating each others effect) increased the incidence of cough in the smokers of this study.

As seen in this research, there was a low incidence of cough in the old age group (above 40 years old.); one reason could be that old people (>40 years) considered cough as a normal symptom in the aging process and, thus, gave a negative answer when questioned about cough.

Among the respiratory complaints, dyspnea was the most frequent symptom followed by sputum and cough.

Since one of the most important clinical manifestations of asbestosis (after dyspnea) is persistent cough with sputum (8,19) and that radiological features of asbestosis appear long after exposure to asbestos (6,11); thus, more extensive evaluations and examinations (such as performing spirometry and comparing FEV_1 values with the previous recorded ones and/or confirming progressive pulmonary fibrosis) are needed to confirm asbestos related complications and disorders (12,16,19).

Chest x-ray (CXR) is the most important diagnostic test for diagnosing asbestosis and pneumoconiosis. Also, it is a valuable method for the follow-up of the workers and epidemiological studies (14). For better reporting of CXR, there was the need of defining a set of standard criteria for scientists. For this purpose the "International Labour Office" classification (ILO) was proposed, which is used nowadays for CXR reporting and classifying pneumoconiotic group of diseases (22).

Although CXR is the main tool for diagnosing pneumoconiosis, it is neither specific nor a sensitive test for diagnosing pleural and parenchymal pulmonary diseases (10). HRCT has significantly helped us in evaluating and diagnosing pleural and parenchymal lung lesions (23).

In the presence of suspicious and non-diagnostic CXRs' or spirometries (19), HRCT is performed to confirm pulmonary parenchymal lesions, pleural plaques, and pleural thickening (24). For further confirmation, bronchoscopy, BAL, and biopsy are performed (12).

According to the results obtained, many of our workers were not aware of the asbestos-related complications, its dangers, and methods of prevention. As an example, one of the ways by which asbestos-related complications could be prevented is the daily consumption of fruit juices, milk, and carrot juice (25). Another method is by wearing masks which are specially designed for this purpose. Although the workers had masks, because of their unawareness, the masks were not used. As a result, with the passage of time the workers were exposed to a significant amount of asbestos fiber and dust. Even in some cases, the workers used asbestos sheets as carpets for resting on them. It was also observed that workers washed their grimy cloths at home, sometimes being mixed and washed with those of others. These workers were not aware of the risks of transmission of asbestos fibers via this way. Households are exposed to asbestos in different ways e.g. washing cloths, insulation; insulating materials are the most important methods by which asbestos is transmitted. The above fact is responsible for 15% of the malignant mesotheliomas' acquired in this way (6).

The Federal Organization of United States has established rules and regulations for the factories and industries where toxic materials such as asbestos are used. The authorities of the above mentioned places must display the related rules and regulations on boards and also make the workers aware of the toxicities of these substances. In this way by referring to the Material Safety Data Sheet (MSDS) (8), the workers and physicians become aware of the associated problems and complications.

Since majority of the lining workers and lining makers are not aware of the existing complications and methods of prevention of asbestos exposure, recommendations and information given in regard to asbestos exposure, smoking cessation, and occupational health-security principles are of vital importance. Also, periodical examinations and screening of the exposed workers are very important, helping in early diagnosis and, thus, treatment (12). This shows the important role that the factory authorities have in the follow-ups, screening and clinical examinations of the workers. Finally, since the dangers of asbestos-exposure have been long known and many countries have banned the usage of this toxic material in their industries and factories (5), it is their recommendation to ban the use of asbestos in lining factories and also to replace it with a harmless material.

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