

The Prevalence of Silicosis Among Iraqi Silica Quarrying Workers

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ABSTRACT:

BACKGROUND:

Silicosis is reported as the most prevalent, chronic and irreversible lung disease which is caused by the inhalation of respirable silica dusts and associated with prolonged exposures among workers dealing with. It is one of the oldest fibro-nodular, occupational, incurable lung disease caused by inhalation of dust containing free crystalline silica.

OBJECTIVES:

This study aimed to assess the prevalence and risk factors for silicosis among workers exposed to free silica.

METHODS:

In this cross-sectional study, we studied ninety male workers in the quarrying zone of silica in the Iraqi Western Desert. The workers were subjected to clinical interviews and examinations, spiro-metric and chest radiographic examinations.

RESULTS:

It was found that the prevalence of silicosis among these 90 workers was 25(27.8%), 18(20%) and 16(17.7%) depending on suggestive clinical, spiro-metric and radiographic findings respectively.

CONCLUSIONS:

Silicosis is an important and common health hazard affecting quarrying workers in Iraq. The ill health effects of silicosis (diagnosed by suggestive clinical findings, radiograph &/or spirometry) are more prevalent in workers with direct exposure or have more than 10 years exposure to silica dust. Smoking is not a risk factor for silicosis. The implementation of accurate and scientific medical supervision for the workers, with the establishment of proper medical recording system are important steps in prevention the adverse health effects of silica.

KEY WORDS: Silicosis, Occupation, Lung disease.

INTRODUCTION:

Silicosis is a fibrotic disease of the lung caused by the inhalation of dust containing crystalline silicon dioxide ⁽¹⁾. It is reported as the most prevalent chronic occupational disease of the world despite the fact that it is a markedly underestimated disease. The U.S. department of labour estimates in 2000 that in the next ten years 59,000 cases of silicosis will eventually develop among the currently workforce of over 1 million Americans ⁽²⁾. As most of the earth's crust consists of compounds of silicon, people in many occupations are at risk of developing silicosis; these occupations include mining, quarrying, drilling, stone crushing and grinding, cement manufacturing, sandblasting, cutting or manufacturing of heat resistance bricks and glass

Manufacturing, and because of the use of high temperatures and pneumatic air jets or other high-pressure techniques, a dusty environment is produced that will expose worker to excessive concentrations of free silica ^(3, 4, 5). Iraqi western desert contains different quarrying zones for extraction of various metals and compounds. Of these zones, there's an area spreads around Al-Rutba city, this area is rich of silica in its various forms of which free or crystalline silica is the most abundant and mostly extracted. The workers in this zone are subjected to the risk of silicosis which needs careful attention from their authorities ⁽⁶⁾. The development of silicosis depends on the inhalation of respirable free silica particles < 10 µm, small (1-3µm) particles are more dangerous because they are more likely to be deposited distally in the respiratory bronchioles, alveolar ducts, and alveoli. The diagnosis of silicosis depends upon a history of appropriate exposure and confirmed by consistent radiographic and physiologic abnormalities ⁽⁷⁾. Silicosis is usually a chronic disease, and principal symptoms develop later. An earlier, more rapid onset of the disease Would be an indication of a heavier exposure due

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to the unusual circumstances of employment (lack of protection and work in enclosed spaces), or an infectious or immunologic complication. Silicosis can be simple silicosis or complicated one (also called progressive massive fibrosis), a distinction based on the chest radiographic appearance^(8, 9, 10). Simple silicosis may be asymptomatic (recognized by chest radiographic finding) or may present with exertional dyspnea and cough with sputum production. Differentiation from symptoms of chronic bronchitis and emphysema in a smoker may be difficult. In complicated silicosis, dyspnea and productive cough often are accompanied by constitutional symptoms of malaise and weight loss^(10, 11, 12).

Aims of the study:-

- 1- Assessing the prevalence of silicosis (mild and complicated) among workers exposed to free silica in the mentioned quarrying area clinically, radiographically and spirometricly.
- 2- Finding out the risk factors associated with silicosis and their magnitude among those workers.

PATIENTS AND METHODS:

Study design: This is a cross-sectional study conducted for the period from 1st May to 31st Oct 2002 to evaluate the health status of the workers exposed to silica dust in their work-place for more than five years. **Study setting:** The quarrying zones in the western desert of Iraq (Al- Rutba). These zones are under the authority of The State Company for Geological Surveying and Mining and divided into five work sites which are scattering around Al-Rutba city with different distances (15-150 km), at these sites different production processes like quarrying, crushing, sand sieving and loading are carried out actively day by day. These processes are performed mechanically by using shuffles, diggers and loading vehicles though bombing is used infrequently. This information was obtained from the responsible staff in the company through personal communication. **Study sample:** Out of 135 male employees working in the quarrying zone in the western desert (Al- Rutba), only 90 of them were involved as they match the inclusion criteria, only those having contact with silica dust and with duration of last job exceeds five years were involved, so 25 workers were excluded as they perform administrative tasks and their daily work and residence is faraway from mines, and the other 20 workers were excluded because their duration of the last job was less than five years.

Data collection: The collection of data was done in two steps: 1- History taking and clinical examination; the history taking and clinical examinations were done at the working camps

where the workers reside, they were only few meters away from work places by using a previously prepared questionnaire sheet, the data included were age, current job, duration of last job, site of current job (direct or indirect contact), relevant previous medical history, concentrating on the respiratory and cardio-vascular systems, ordinary residence (any evidence of nearby source of silica dust), smoking habits and current complaint (if any). Full systematic clinical examination concentrating on the chest was done for all included workers and the results were reported in their individual sheets.

2- Investigations: The following investigations were done for all workers:

A- Spiro-metric Measurements: A portable computerized Spiro- meter was used. The device belongs to the Iraqi Society of Occupational Health and Safety; it was brought up with its operator to the working camps. Forced vital capacity (FVC), forced expiratory volume in one second (FEV₁) and their ratio were estimated for each worker. All findings were plotted on the examination sheets mentioned above individually. **B- Radiographic examinations** were carried out in Al-Rutba hospital. The films were of 14X17 inches size and viewings were strictly supervised by specialist to ensure proper exposures. Postero-anterior exposures, standing position and deep inspiration were the points strictly applied. Ninety films then collected and referred to three of the dependable specialists in Baghdad teaching hospital to gain sound & firm readings. **Diagnostic criteria:** 1- By clinical findings: a- Normal (free):- No clinical findings b- Simple silicosis: - Scattered wheezes or scattered crepitations c- Complicated silicosis:- Signs of pulmonary tuberculosis (PTB) or heart failure (Fever, orthopnea, frank debility, rapid pulse, right upper lobe bronchial breathing sounds, right sided dullness, bilateral basal crepitations or dullness). 2- By radio-graphic findings' only parenchymal abnormalities (opacities) and Pleural thickening and/ or calcification were considered as suggestive findings of silicosis^(13,14,15,16, 17,18).

3- By Spiro-metric findings; only restrictive and combined readings considered as suggestive findings for silicosis^(19, 20).

Analysis of data: Analysis of collected data was done by using; 1- Descriptive statistics (frequencies and percentages) 2- Inferential statistics (X²-test), p-value less than 0.05 considered to be statistically significant.

3- Kappa statistics to find out the level of agreement among the above three diagnostic tools (>80%=Excellent agreement, 60%-80%= Good agreement, 40%-79%=Intermediate agreement, <40%=poor agreement)⁽²¹⁾.

RESULTS:

The results of this study were based on the analysis of the sheets including the clinical, Spirometric and radiographic findings of the 90 workers in silica quarrying zone in Iraqi western desert. All of these workers are attending their work places according to a special schedule, so after every 22

days of work they have eight days vacation. During these 22 days, the workers are exposed to silica dust all over the day as their residence is nearby their work-places. The mean of the workers age was 35.3 ± 8.3 (years), Figure-one shows the percentage of their age distribution.

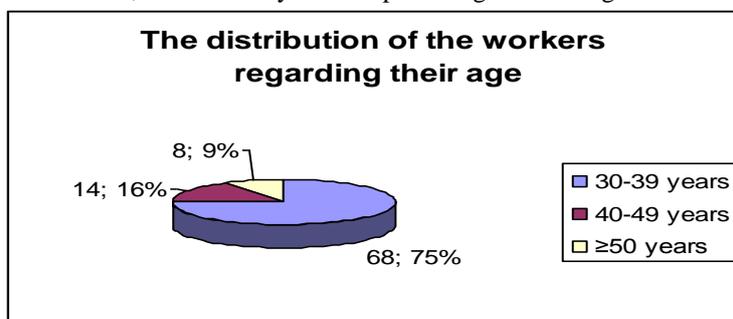
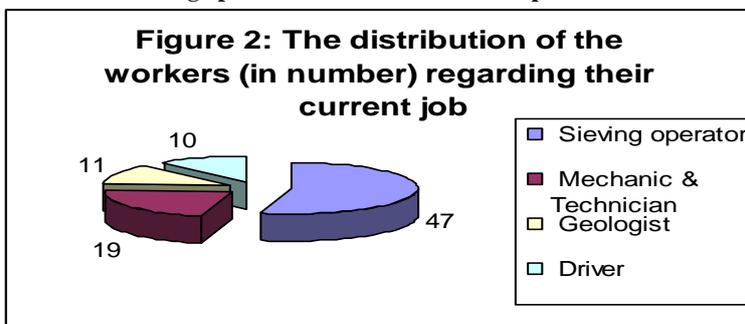


Figure -two shows the distribution of the workers according to their current jobs, 57(63.3%) of them were drivers & sieving operators who were in direct exposure to silica dusts.



Diagnosis by suggestive clinical finding:

The study revealed that the prevalence of silicosis, diagnosed by suggestive clinical findings among our sample was 25(27.8%) workers, while 65(72.2%) had no such findings, 16(64%) of the affected workers were belong to the age group 30-39 years. While four out of eight (50%) of the age group ≥50 years had such findings. This study also shows that out of 25 workers who had clinical findings suggesting silicosis, 21(84%) were in direct contact with silica dust, of these 21workers, 15(71.4%) showed clinical features of simple silicosis. On the other hand 17(68%) of the 25

workers had more than 10 years employment in their current job, and only 11 (64.7%) of them had the features of simple silicosis. Out of the 25 workers with suggested diagnosis of silicosis, 9(36 %) had relevant previous medical history. 7(78%) of them gave history of bronchitis, and 2(22%) gave history of pneumonia. Regarding the association between the suggested clinical diagnosis and level of smoking, the results show no significant statistical association between them as shown in table one.

Table1: The distribution of the study group by the clinical findings and smoking levels.

Suggested diagnosis	Smoking level (Cig./day)*				Total
	None	Light	Moderate	Heavy	
Normal	39	15	7	4	65
Simple silicosis	9	4	3	1	17
Complicated silicosis	3	1	1	3	8
Total	51	20	11	8	90

$X^2=0.135$ df = 6 No significant association.

*(Light = < 5, Moderate = 5-10, Heavy = >10)

Diagnosis by spiro-metric examination:

The spiro-metric examination showed that 18(20%) of the workers had ventilation changes suggested the diagnosis of silicosis, 8(44%), 5(28%), and 5(28%) of them were in age groups 30-39, 40-49, and ≥ 50 years old respectively. There were 15(83%) workers had abnormal Spiro- metric findings that predict the diagnosis of silicosis and their duration of the current job exceeds 10 years regardless the type of exposure. On the other hand 3(17%) workers with such findings were exposed

directly to silica dust and their duration of employment was 5-10 years. Out of 18 workers that had spiro-metric findings which suggest the diagnosis of silicosis (simple or combined), seven (39%) gave relevant past medical history, of whom five had bronchitis and two had childhood asthma. The association between smoking and the spiro-metric findings that suggest the diagnosis of silicosis is not statistically significant as shown in table two.

Table 2: The distribution of workers by their spiro-metric findings and smoking level.

Spiro-metric findings	Smoking level				Total
	None	Light	Moderate	Heavy	
Non-suggesting silicosis	40	17	8	7	72
Suggesting silicosis	11	3	3	1	18
Total	51	20	11	8	90

$X^2= 3.6$ df = 3 p-value=0.81 No significant association.
*(Light = < 5, Moderate = 5-10, Heavy = >10)

Diagnosis by radiographic examination:

Regarding the radio-graphic findings, 16 (17.7%) out 90 workers had findings that suggest silicosis whom distributed almost evenly in the age groups, as shown in table three. There was no one with pleural thickening or calcification.

Table 3: The distribution of workers by their radio- graphic findings & age.

Radio-graphic findings	Age (years)			Total	
	30-39	40-49	≥ 50	No.	%
Negative	55	8	2	65	72.3
Parenchymal opacities	6	5	5	16	17.7
Others*	7	1	1	9	10.0
Total	68	14	8	90	100

* Others = Increased lung markings, increased lung translucency, cavitations, abnormal cardiac shadow, Honey- comb appearance.

Out of the 16 workers who had the radiographic findings which suggest the diagnosis of silicosis, 11(69%) were with duration of the current job for more than 10 years, 8 (73%) of them had direct contact with silica dust. Of those workers with radiographic findings suggesting silicosis, only six (37.5%) gave positive relevant past medical history, four (67%) of them had bronchitis, and 2(33%) had pneumonia. Radio-graphic findings suggesting silicosis showed no significant statistical association with smoking level as shown in table four.

Table 4: The distribution of workers by their radio- graphic findings & smoking level.

Radio- graphic findings	Smoking level				Total
	None	Light	Moderate	Heavy	
Non-suggesting silicosis	42	17	8	7	74
Suggesting silicosis	9	3	3	1	16
Total	51	20	11	8	90

$X^2= 2.8$ df = 3 p-value= 0.79 No significant association
*(Light = < 5, Moderate = 5-10, Heavy = >10)

PREVALENCE OF SILICOSIS

Tables 5, 6 & 7 show the agreement in numbers of workers diagnosed as silicosis by using suggestive clinical, Spiro-metric & radiological diagnosis. The clinical diagnosis versus radiographic findings show agreement in 79 out of 90 workers (Kappa=65.9%, intermediate agreement), and the clinical diagnosis versus Spiro-metric findings also show agreement in 79 (Kappa=66.7%, intermediate agreement). While the radiographic versus spiro-metric findings show agreement in 86 (Kappa=85.7%, excellent agreement).

Table 5 : The suggested diagnosis of silicosis by clinical diagnosis versus radiographic findings.

Clinical diagnosis	Radio- graphic findings		Total
	Positive	Negative	
Positive	15	10	25
Negative	1	64	65
Total	16	74	90

Table 6: The suggested diagnosis of silicosis by clinical diagnosis versus Spiro-metric findings.

Clinical diagnosis	Spiro-metric findings		Total
	Positive	Negative	
Positive	16	9	25
Negative	2	63	65
Total	18	72	90

Table 7: The suggested diagnosis of silicosis by radiographic versus spiro-metric findings.

Radio- graphic findings	Spiro-metric findings		Total
	Positive	Negative	
Positive	15	1	16
Negative	3	71	74
Total	18	72	90

DISCUSSION:

Silicosis is an occupational lung disease attributed to the inhalation of crystalline form of SiO₂ or free silica dust. Despite that the etiology is well recognized and workers at risk are fairly defined, this serious disease remains prevalent all over the world^(14,15). Unfortunately, in Iraq very few studies had been conducted in this field⁽⁶⁾. The current study was carried out to outline the morbid effect of occupational exposure to silica dust on the respiratory system of the workers employed in the quarrying zone of silica in the Iraqi western desert. The selection of the study sample was based on certain inclusion criteria; these were the duration and the type of the current job, so only those working in the quarrying zone for more than five years were selected to achieve a better evaluation. Since the diagnosis of silicosis rests primarily on clinical, spiro-metric and radiographic changes for workers with history of exposure, we depended on these measures to establish the diagnosis and the evaluation^(18,19,20,21). Our study sample is at risk to develop silicosis as they: **1-** Spend 22 days out of 30 in the workplace. **2-** Are exposed to silica dust throughout the day. **3-** Are not using proper protective measures. **4-** Have more than five years duration of the current jobs.

Since the ordinary residences of the workers are remote from any source of silica dust, there is no chance for further exposures to interfere with our results. Because of the majority of them belong to the age group 30-39 years and mean age of the total number was 35.3 years, we could expect that the findings elicited are attributed to silicosis rather than other health problems. The variation in the education levels and low chances to run training courses because of the distant site of work may have a role in the high frequency of low levels of apprehension and implementation of occupational safety instructions. As mentioned in the preceding chapter the prevalence rate of silicosis among the study sample was 27.8% depending on the clinical findings alone. Al-Falluji, A.⁽⁶⁾ in 2003 found that the prevalence of silicosis diagnosed on clinical bases among the workers in Al-Falluja White Cement Factory was 30%; this relatively higher prevalence rate could be attributed to the closed environment of the factory compared with the open one in the desert work. On the other hand Mathur, ML.⁽²²⁾ in 1999 outlined that the prevalence of silicosis diagnosed by suggestive clinical findings was 25% in a sample of 168 sand –stone quarrying workers in a desert environment;

This relatively lower prevalence rate may be due to the use of proper protective measures. The results of the current study are consistent with the previous publishes regarding the effect of the duration of employment in the risky jobs and the nature of exposure, whether direct or indirect. 14 (56%) out of 25 workers having clinical picture of silicosis were in direct contact for more than 10 years, while only one (4%) was in indirect contact for less than 10 years employment. Also the association between cigarette smoking and silicosis was not statistically significant, as this association is found to be with asbestosis rather than with silicosis^(3, 17, 20,23). In those workers gave relevant medical history, 78% of them had bronchitis which renders more association (37.5%) with the complicated silicosis than with simple cases (23.5%) which may be attributed to the severity of bronchitis or to the individual variability. Spirometry is a dependable & valuable tool to diagnose respiratory disorders whether obstructive, restrictive or combined, yet, one of its disadvantages is the inability to distinguish between the underlying diseases in the same category. Since Silicosis affects mainly the parenchyma of the lung & in advanced cases the terminal bronchioles, so it is regarded as a restrictive or a combined disorder^(20, 22). The study revealed that 18 (20%) of the 90 workers had spirometric findings rendering the diagnosis of silicosis and 13 (72%) of them belong to the age groups (30-49) years. This finding may be attributed to the type and duration of exposure rather than to age or other factors, the fact that is confirmed by our finding that (83%) of workers assigned as spirometrically silicotic had been employed in the current job for more than 10 years as shown in tables seven and eight. The association between smoking levels and suggestive spirometric findings again proved statistically insignificant and is in the line of the abroad documents. The relevant past medical history was found in 39% of those assigned as silicotic by spirometric examination, 71% of them had bronchitis. This may be explained by the residual effect of bronchitis on the obstructive component of the combined form of silicosis. Wang, X.R. and Christiani, D.C. in 2000 found a higher prevalence of dyspnea and chronic cough in workers with pneumoconiosis associated with poorer pulmonary function especially those with past history of bronchitis and smoking^(17,23). The association to smoking may be related to other forms of pneumoconiosis like asbestosis rather than to silicosis. All abnormal radiograph suggesting silicosis in the current study showed rounded opacities of small size grade p/p (primary

and less than 1.5 mm.), few in number regarding concentration & distributed in the right upper, right middle or both zones with normal lung markings. Absolutely there was no pleural abnormality. 50% of these abnormalities were observed among the workers who were in direct contact with silica for more than ten years, while only 6% were found in those with indirect contact for less than ten years. Wang – X and Yano- E. in 2000 assessed the prevalence of radiographic abnormalities consistent with silicosis in a group of 600 granite workers & found a significant association between the duration of employment and these abnormalities⁽¹⁹⁾. The association between smoking level & the diagnosis of silicosis by suggestive radiographic findings also found statistically not significant in our study, this finding is compatible with the results of Mathur, M.L. and his group in 1999. The fact that 25 % of the workers whom diagnosed as silicosis by their x-ray findings and had past histories of bronchitis may be explained by the impact of bronchitis on lung tissue or individual susceptibility^(18, 20). We tried to find the best combination (agreement) of diagnostic measures for silicosis i.e. clinical, spirometric &/ or radiographic findings which can be used for screening or follow up. The results showed best agreement in the combination between spirometry and radiography (**Kappa**=85.7%, excellent agreement) which is higher than other agreements. There are four limitations worth mentioning in this study .Firstly the actual concentrations of the insulted dust and individual daily exposures are not available. Secondly we did not find any dependable medical recording system for the working staff. Thirdly there is no distinctive or pathognomonic criterion could be used as a gold standard in the diagnosis of silicosis. And fourthly we were encountered by the shortage in the national studies and researches in this field.

CONCLUSION:

This study concluded that silicosis is an important and common health hazard affecting quarrying workers, the ill health effects of silicosis are more prevalent in workers with direct exposure or have more than 10 years exposure, smoking is not a risk factor for silicosis, bronchitis, as a past history, is an important risk factor to develop silicosis and the combination of radiograph and spirometry findings had the best agreement in the diagnosis of silicosis which can be used for proper approach to ascertain the diagnosis. We recommended the implementation of accurate and scientific medical supervision of the workers i.e. pre-employment and periodic interviewing's including proper history taking, reasonable clinical assessment, spirometric and radiographic examinations besides

Appropriate health education about the adverse health effects of direct and prolonged exposures and encouraging the use of active and proper preventive measures including the personal equipments.

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