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Pulmonary Function and Lung Radiography of Rockwool Exposed Workers

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ABSTRACT

Background: *Synthetic fibers of rockwool are deciphered from Basalt stone. Chemical, physical and biological similarities with asbestos detain scientists to consider effects and complications caused by rockwool in lung. This historical cohort research was designed to state impact of rockwool on radiographic findings of lung and its spirometric changes.*

Materials and Methods: *Encountered group, "Iran Rockwool Factory" was selected by simple random sampling technique and matched with comparison group, "Minoo Confectionery Factory", regarding age and cigarette smoking. Medical and occupational histories, clinical examinations and all spirometries were carried out in health centers of the two factories. Chest x- ray was taken for all subjects of the two groups. All data were gathered and registered in designed questionnaires.*

Results: *Although a significant discrepancy existed in dyspnea, non cardiac chest pain and wheeze, there was not any statistically significant difference in radiographic findings and spirometric parameters between the two groups.*

Conclusion: *We do not have enough evidence to support the adverse effects of rockwool on respiratory function and significant observable radiographic changes in chest x-ray.* ***(Tanaffos 2005; 4(14): 25-29)***

Key words: *Rockwool, Pulmonary function, Chest x-ray, Lung*

INTRODUCTION

Rockwool is one of the major components of man-made vitreous fibers (MMVF) (1). Many people are either repeatedly or intermittently in contact with these fibers. In particular, exposed population are workers in the rockwool production industries and insulation workers, due to longer exposure periods and hence higher accumulated fiber exposures. Fiber dimension and chemical compositions of rockwool fibers are very similar to those found in asbestos (2,3). This has led to concern that exposure to rockwool fibers can augment the possibility of respiratory problems. There is no firm impact fact about relation between the exposure to rockwool fibers and lung fibrosis, pleural lesions, or non-specific respiratory disease in humans (4). The potential for causing non-malignant respiratory disease was considered in a few contradictory studies. In this historical cohort study, we examined the respiratory health of the "Iran Rockwool Factory" (IRF) workers which had not previously been studied in Iran. We aimed to evaluate lung function parameters changes and radiological findings in this

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workforce with similar data on a comparison group of Minoo Confectionery Factory (MCF) workers with no exposure to MMVF.

MATERIALS AND METHODS

A total of 207 subjects in exposed group, Iran Rockwool Factory (IRF), and unexposed group, Minoo Confectionary Factory (MCF) were selected randomly.

Subjects and Setting:

The study population was consisted of 105 exposed workers who had direct contact with rockwool fibers in production section of IRF and 102 unexposed workers in MCF. The sample size of study was calculated by the formula $n= Z^2\ p.q\ /d^2$. Initially, all participants signed an informed consent and local ethical committee approved the study. All subjects of the two groups were male. Unexposed group in MCF had not any history of working in MMVF industries or chemical factories. By taking history, we checked other confounders and did not find any usage of considerable ones such as asbestos, polycyclic aromatic hydrocarbon or metal fumes in the two factories. All subjects of the two groups who had any history of respiratory diseases or active diseases were excluded. A history was taken from all subjects and the patients underwent physical examination, chest x- ray and spirometry. After performing the spirometries of exposed group at the IRF health center, all equipments were transferred to health center of MCF where the spirometries of the comparison group were obtained. Only 93 subjects in each group had acceptable spirometry. This sequence did not allow the technician to be aware of the occupational status of the subjects. Subsequent analyses were done on this group with acceptable spirometry.

History taking and physical examination

All physical examinations and history taking including a detailed working history and respiratory signs and symptoms were performed by a general practitioner under the supervision of an occupational disease specialist. Demographic and medical data were entered in designed questionnaires.

Questionnaire

The major components of the questionnaire covered the following data: demographic (age, sex, height, cigarette smoking), medical history (diseases and surgery of the lung), working history (direct working history with chemical substances that have known to be toxic for the lung), respiratory signs and symptoms (cough, sputum, dyspnea, wheeze, rale, and ronchi), and spirometrical indices (FEV1, FVC, …).

Radiographic examination

Simple chest x- ray was taken from all 186 subjects of the two groups in a private radiology. All radiographs were interpreted by a radiologist according to the ILO classification for pneumoconiosis (5).

Spirometry

An expert spirometry technician carried out all lung function tests using a vitalograph 2120 system,. The device was calibrated daily and values were printed and added to each worker's questionnaires. Each subject had to complete a dynamic spirometry with at least 3 acceptable and 2 reproducible maneuvers in accordance with American Thoracic Society (ATS) methods (6). FEV 1, FVC, PEF, $FEF_{25\text{-}75\%}$, FEV1/FVC, and FEV1/ PEF were used to define respiratory function changes. The highest FEV1 and FVC were recorded.

Statistical Analysis

Demographic, clinical, spirometrical, and radiological data were compared between the two groups. Mean and range of demographic data were calculated and compared between the two groups using t-test. Number of subjects and percentage of each sign and symptom were compared between the two groups using Mann Whitney-U test. The 95%

confidence interval for the mean of each spirometrical index was calculated and compared by Mann Whitney-U test. Radiographic reports were considered as normal or abnormal. Comparison was carried out by Chi-square test. Statistical significance with 95% CI was considered to be demonstrated by a p-value (two-sided) of less than 0.05. All statistical analyses were performed by SPSS software, released version 10.05.

RESULTS

Demographic characteristics of exposed and unexposed groups are summarized in table 1. Age and cigarette consumption had already been matched between the two groups. There was not any significant difference in height between the two groups. The mean length of employment period in the exposed group was 106.22 (95% CI, 95-117.5) months. Among clinical signs and symptoms, significant differences were observed in dyspnea (Z=3.11, p= 0.002), non cardiac chest pain (Z= 3.8, p<0.000) and wheeze (Z=2.2, p=0.031).

Table 2 presents the respiratory signs and symptoms of the two groups. Comparative results of all spirometrical indices were revealed in table 3. No significant differences were found between the two groups.

From a total of 93 subjects of exposed group, 40 (43%) subjects had abnormal findings in their chest radiographs. From 93 subjects of unexposed group, 47 (50.5%) persons had noticeable radiographic changes. All radiographic findings of the two groups are summarized in table 4.

Table 1. Demographic data of exposed and unexposed groups.

variables	IRF	MCF	p- value
Study Population (person)	105	102	-
Included (person)	93	93	
Excluded (person)	12	9	
Sex	male	male	-
Age (year)	35.5 (95%CI, 34.04-37.04)	36.7 (95%CI, 35.2-38.3)	0.278
Working length	21.4 (95%CI: 20.2- 23.2)	21.7 (95%CI: 20.2-23.1)	0.298
Height (cm)	167.17 (95%CI, 165.82- 168.52)	169.2 (95%CI, 167.7-170.7)	0.163
Smoking, Pack-years	4.87 (95%CI, 3-6.47)	4.50 (95%CI, 2.7-6.3)	0.777
Smoker (person)	49(52.7%)	48(51.6%)	-

Table 2. Respiratory signs and symptoms.

Signs & Symptoms	IRF	MCF	Z	p- value
Cough	14 (15.1%)*	10 (10.8%)	0.873	0.383
Sputum	11 (11.8%)	17 (18.3%)	1.227	0.22
Dyspnea	27 (29.0%)	10 (10.8%)	3.114	0.002*
Non cardiac chest pain	16 (17.2%)	1 (1.1%)	3.806	0.000*
Rale	0	0	-	-
Wheeze	7 (7.5%)	1 (1.1%)	2.163	0.031
Ronchi	1 (1.1%)	2 (2.2%)	0.580	0.562
Coarse Crackle	2 (2.2%)	2 (2.2%)	0	1.000
Clubbing	0	0	-	-

* Significant

Table 3. Mean measured and range of FEV1, FVC, PEF, $FEF_{25-75\%}$, FEV1/FVC, FEV1/PEF and significance of their differences between the two groups

Variables	IRF	MCF	Z	p- value
FVC	4.26 (95%CI, 4.02-4.43)	4.20(95%CI, 4.04-4.36)	0.428	0.669
FEV1	3.41(95%CI, 3.27-3.56)	3.40(95%CI, 3.25-3.53)	0.309	0.757
FEV1/FVC	79.6 (95%CI, 78.04-81.14)	80.13(95%CI, 65.83-94.43)	0.554	0.580
FEV1/PEF	0.41 (95%CI, -1.23-2.05)	0.40(95%CI,-1.32-2.12)	1.414	0.157
PEF	508.63(95%CI, 482.43-534.83)	512.11(95%CI, 498.23-545.99)	0.921	0.357
$FEF_{25-75\%}$	3.17(95%CI, 2.92-3.43)	3.26(95%CI, 3.01-3.51)	0.704	0.481

Table 4. Results of simple chest x-ray (P.A) in exposed and unexposed groups.

	IRF	MCF
Normal	53 (57%)	46 (49.5%)
Abnormal*	40 (43%)	47 (50.5%)
Fine Reticular shadow, Low profusion	11 (11.6%)	9 (9.7%)
Fine Reticular shadow, Moderate profusion	0	2 (2.2%)
Moderate Reticular shadow, Low profusion	2 (2.2%)	2 (2.2%)
Moderate Reticular shadow,Moderate profusion	5 (5.4%)	1 (1.1%)
Coarse Reticular shadow, Moderate profusion	0	2 (2.2%)
1cm< Tumour <5cm	0	2 (2.2%)
Nodule< 1.5mm, low profusion	4 (4.3%)	13 (13.6%)
Nodule< 1.5mm, moderate profusion	10 (10.8%)	7 (7.5%)
1.5mm< Nodule< 3mm, low profusion	3 (3.2%)	2 (2.2%)
1.5mm< Nodule< 3mm, moderate profusion	5 (5.4%)	6 (6.5%)
3mm< Nodule< 10mm, low profusion	0	1 (1.1%)

*p value =0.278

DISCUSSION

This study showed that workers in IRF with a considerable duration of exposure to rockwool fibers had respiratory health comparable to an unexposed workforce. This is in accordance with a large body of negative evidences regarding the effect of MMVF on health which have been published till now. For example, Weill and colleagues studied 1028 male workers and found no pulmonary symptoms or adverse lung function related to exposure (7) or in Australia Woolcock and Mellis found no evidence of occupational pleural disease, asthma, pulmonary fibrosis or lung cancer in 671 rockwool and glasswool factory workers (8). Wright in 1968(9), Utidijan and De Treville in 1970 (10), Nasr et al. in 1971 (11) and Hill in 1973 (12) could not show any negative effect of rockwool on pulmonary health as well. In contrast, Kilburn and associated in 1992 (13) and Clausen et al. in 1993 (14) found reduced expiratory flows or notably lower value of FEV1 in the exposed group to MMVF.

Complaint of dyspnea, non cardiac chest pain and also important sign as wheeze was higher in exposed group. The reason might be the non-significant respiratory changes that were not shown by spirtometry or chest x-ray. Multiple regression models fail to correlate employment length to an increase in the prevalence of respiratory signs and symptoms. Although Hansen et al. believed that employment length was not a good indicator of exposure duration but we used employment length in place of total exposure length (15). Smokers exposed to rockwool fibers seem to have o extra risk of airflow obstruction compared with subject with a similar smoking history in unexposed group. In general, spirometric results were normal and almost similar in the two groups. Because of resource limitation, the airborne respirable rockwool fiber concentration was not measured. Multiple regression model failed to correlate employment length to a decrease in lung function test values. Although some changes in chest x-rays were found in both groups, there was no statistically significant difference between them.

In summary, our study could not be able to show any harmful effect of exposure to rockwool fiber. Further follow-up and more sensitive radiological imaging like high-resolution computerized tomography (HRCT) would seem to be necessary in detecting lung function deficits and radiological changes in the exposed group.

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REFERENCES

1. Hesterberg TW, Hart GA. Synthetic vitreous fibers: a review of toxicology research and its impact on hazard classification. ***Crit Rev Toxicol*** 2001; 31 (1): 1- 53.
2. Foa V, Basilico S. [Chemical and physical characteristics and toxicology of man-made mineral fibers]. ***Med Lav*** 1999; 90 (1): 10- 52.
3. Berrigan D. Respiratory cancer and exposure to man-made vitreous fibers: a systematic review. ***Am J Ind Med*** 2002; 42 (4): 354- 62.
4. Hansen ES. No effect or no information? Comments on a nested case-control study of lung cancer among European rock and slag wool production workers. ***Int J Occup Environ Health***. 2002; 8 (3): 281- 3.
5. Shipley RT. The 1980 ILO classification of radiographs of the pneumoconioses. ***Radiol Clin North Am*** 1992; 30 (6): 1135- 45.
6. Standardization of spirometry--1987 update. Statement of the American Thoracic Society. ***Am Rev Respir Dis*** 1987; 136 (5): 1285- 98.
7. Weill H, Hughes JM, Hammad YY, Glindmeyer HW 3rd, Sharon G, Jones RN. Respiratory health in workers exposed to man-made vitreous fibers. ***Am Rev Respir Dis*** 1983; 128 (1): 104- 12.
8. Woolcock AJ, Mellis CM. Respiratory health of workers in the Australian glasswool and rockwool manufacturing industry. Final report prepared for Insulation Wools Research Advisory Board by Institute of Respiratory Medicine, Royal Prince Alfred Hospital, Sydney, Australia. 1994.
9. Wright GW. Airborne fibrous glass particles. Chest roentgenograms of persons with prolonged exposure. ***Arch Environ Health*** 1968; 16 (2): 175- 81.
10. Utidijan HMW, De Treville RTP. Fibrous glass manufacturing and health: Report of an epidemiological study, in: Proceeding of the 35th Annual Meeting of the Industrial Health Foundation, Pittsburgh, 1970.
11. Nasr ANM, Ditebeck T, Scholtens PA. The presence of radiographic abnormalities in the chest of fiberglass workers. ***J.O.M*** 1971; 13:371.
12. Hill JW, Whitehead WS, Cameron JD, Hedgecock GA. Glass fibres: absence of pulmonary hazard in production workers. ***Br J Ind Med*** 1973; 30 (2): 174- 9.
13. Kilburn KH, Powers D, Warshaw RH. Pulmonary effects of exposure to fine fibreglass: irregular opacities and small airways obstruction. ***Br J Ind Med*** 1992; 49 (10): 714- 20.
14. Clausen J, Netterstrom B, Wolff C. Lung function in insulation workers***. Br J Ind Med*** 1993; 50 (3): 252- 6.
15. Hansen EF, Rasmussen FV, Hardt F, Kamstrup O. Lung function and respiratory health of long-term fiber-exposed stonewool factory workers. ***Am J Respir Crit Care Med*** 1999; 160 (2): 466- 72.