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DAFTAR ISI

Artikel Penelitian

Tinjauan Pustaka

Correlation of Ceramic Dust Content in Workplace with Lung Function in Ceramics Industry Workers of X Company, Mabar, Medan

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Abstract

***Background**: Workers in the ceramics industry are often exposed to silica content which is unwittingly inhaled and deposited in the lungs. Macrophages will release Interleukin 8 (IL-8), a chemoattractant that causes neutrophil recruitment to the alveoli and releases proteolytic enzymes that damage the lung parenchyma and cause a decrease in lung function. This study aimed to determine whether dust levels correlates with IL-8 serum in ceramic industry workers.*

***Method:** This research is an analytic study with a cross-sectional design conducted in March–June 2019 in the X Ceramic Industry in Mabar, Medan. Personal Dust Sampler was used to measure the dust level of the study subjects at work sites. Lung function was measured by spirometry. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software.*

***Results:** A total of 35 male workers were divided into 3 working sections, 11 workers (31.4%) in the pre-compression section, 13 workers (37.1%) in the compression section and 11 workers (31.4%) in the sintering section. Dust levels at each working section were 24.8, 29.2, and 6.11, respectively. The lung function examination showed restrictive impairment in 21 workers (60%). Statistical analysis showed that the higher the level of dust in the workplace, the lower the value of Forced Expiratory Volume 1 (FEV_1) and Forced Vital Capacity (FVC) values, although this correlation was not statistically significant (r = -0.03 and -0.22 respectively; P>0.05).*

Conclusion:** There was no significant relationship between workplace dust levels and lung function in ceramic workers. **(J Respirol Indones 2021; 41(3): 196–99)

***Keywords:** Ceramics, dust levels, lung function, cigarettes*

Hubungan Kadar Debu Keramik di Tempat Kerja Dengan Fungsi Paru Pada Pekerja Industri Keramik Perusahaan X, Mabar Medan

Abstrak

***Latar belakang:** Pekerja industri keramik sering terpajan dengan silika yang tanpa disadari akan terinhalasi dan terdeposit di dalam paru. Makrofag akan mengekspresikan Interleukin 8 (IL-8), suatu kemoatraktan yang menyebabkan rekrutmen neutrofil ke alveolus dan melepaskan enzim proteolitik yang merusak parenkim paru dan menyebabkan penurunan fungsi paru. Tujuan dari penelitian ini adalah untuk mengetahui hubungan kadar debu dengan fungsi paru pada pekerja industri keramik.*

***Metode:** Penelitian ini merupakan studi analitik dengan desain cross-sectional yang dilakukan pada bulan Maret–Juni 2019 di Industri Keramik X di Mabar, Medan. Pengukuran kadar debu pada subjek penelitian di lokasi kerja dilakukan dengan menggunakan Personal Dust Sampler. Pengukuran fungsi paru dilakukan dengan spirometri. Analisis statistik dilakukan dengan menggunakan perangkat lunak SPSS.*

***Hasil:** Sebanyak 35 pekerja laki-laki dilibatkan sebagai subjek penelitian yang terbagi ke dalam 3 lokasi kerja, yaitu 11 pekerja (31.4%) di bagian prakompresi, 13 pekerja (37.1%) di bagian kompresi dan 11 pekerja (31.4%) di bagian sintering. Kadar debu pada masing-masing lokasi kerja adalah 24.8, 29.2, dan 6.11 berturut-turut. Hasil pemeriksaan fungsi paru menunjukkan 21 pekerja (60%) mengalami kelainan restriksi. Analisis statitsik menunjukkan bahwa semakin tinggi kadar debu di tempat kerja, maka semakin rendah nilai Volume Ekspirasi Paksa detik pertama (VEP_1) dan Kapasitas Vital Paru (KVP), meskipun korelasi ini tidak bermakna secara statistik (r = -0.03 dan -0.22 berturut-turut; P>0.05).*

Kesimpulan:** Tidak terdapat hubungan yang bermakna antara kadar debu di tempat kerja dengan fungsi paru pekerja keramik. **(J Respirol Indones 2021; 41(3): 196–99)

***Kata kunci:** Keramik, kadar debu, fungsi paru, rokok*

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INTRODUCTION

Silica dust exposure is still a worldwide health problem today. Between 1990 and 1993, approximately 600,000 workers in the United Kingdom, more than three million workers in Europe, and more than one million people in the United States were exposed to silica dust.[1] In Asia, it is estimated that nearly 11.5 million people working in India and 23 million people in China are exposed to silica dust.[2] There are no national data on the prevalence of silicosis in Indonesia currently.

The ceramic industry is one of the fastest-growing industries. The physical process of processing raw materials into ceramics tends to produce pollution such as ceramic dust particles, which in the manufacturing process produce silica. Silica is a chemical compound of silicon dioxide (SiO_2), one of the most abundant minerals. Most of the silica is present in the crystalline form, and in the amorphous form in lesser amounts.[3] Silicosis is an occupational lung disease and is a lung parenchymal disease caused by the inhalation of silicon dioxide or silica. It should be borne in mind that in workplaces that are places for collecting, processing and using materials containing silica or sand, there is a risk of suffering from silicosis.[4]

Prolonged exposure to silica dust causes inflammatory cells to secrete mediators such as cytokines, chemokines and chemoattractants, which can cause inflammation leading to an inflammatory cascade. The release of chemoattractants, such as leukotriene-B4 (LTB4) attracts neutrophils to secrete proteolytic enzymes such as elastase, proteinase-3, cathepsin G, and matrix metalloproteinase (MMP), which causes damage to the elasticity of lung tissue, which results in decreased lung function, generally as a restriction disorder. Still, it can also be an obstruction disorder or a combination of both.[5] This study aimed to determine lung function in ceramic industry workers.

METHOD

This research is an analytical study with a cross-sectional design conducted in a ceramic processing industry in Mabar, North Sumatra. Study subjects are workers aged 17–50 years who have worked for at least one year. Subjects who had a history of tuberculosis, diabetes mellitus, and malignancies were excluded from the study.

Subjects were divided into three working sections, precompression, compression and sintering sections. Measurement of dust level in the workplace was carried out at each working section using a *low volume dust sampler* in collaboration with the North Sumatra Company Hygiene and Work Safety Center. Dust measurements were done during working hours (1 hour continuously) and were placed at the average noise level of the worker and the total dust level was measured gravimetrically. All subjects underwent a spirometry examination, in which FVC, FEV_1. FEV_1/FVC and FEF_{25-75} are measured and noted.

RESULT

A total of 35 ceramic industry workers were involved in this study. The characteristics of the subjects are shown in Table 1.

Table 1. Characteristics of study subjects

Characteristics	n	%
Gender		
Male	35	100.0
Female	0	0.0
Age		
20-29 year	10	28.6
30-39 year	17	48.6
≥40 year	8	22.9
BMI		
Normal	12	34.3
Less	3	8.6
More	20	57.1
Smoking		
Yes	28	80.0
No	7	20.0
Use of PPE		
Yes	15	42.9
No	20	57.1
Working section		
Precompression	11	31.4
Compression	13	37.1
Sintering	11	31.4
Length of working		
0-4 year	9	25.7
5-9 year	8	22.9
≥10 year	18	48.6

Note: BMI=Body Mass Index; PPE=Personal Protective Equipment

All research subjects underwent a spirometry examination, then were measured for dust level in the workplace. Table 2 shows that more than half of the workers who were the subjects of the study had restrictive lung impairment.

Table 2. Characteristics of the lung function of the study subjects in ceramics industry workers of X company, Mabar Medan

Characteristics	n	%
Dust Content		
Sintering 6.11 ng/m^3	11	31.4
Precompression 24.82 ng/m^3	11	31.4
Compression 29.28 ng/m^3	13	37.1
Lung Function Test		
Normal	13	37.1
Obstruction	1	2.9
Restriction	21	60.0
Mix	0	0.0
FEV_1 (% Prediction)		
>80	14	40.0
51-80	20	57.1
31-50	1	2.9
<30	0	0.0
FVC (% Prediction)		
>80	14	40.0
51-80	20	57.1
31-50	1	2.9
<30	0	0.0

Furthermore, a statistical analysis was carried out to determine the correlation between the level of dust in the workplace and the lung function of workers. Table 3 shows no significant correlation between dust levels in the workplace and lung function (*P*>0.05). However, because the correlation coefficient value for the three lung function parameters is negative, it can be concluded that the higher the dust level in the workplace, the lower the pulmonary function of the workers.

Table 3. Correlation of Dust with Lung Function of Study Subjects

	Dust level	
	P	**r**
FEV_1 (% prediction)	0.25	-0.22
FVC (% prediction)	0.36	-0.17
FEF_{25-75} (% prediction)	0.28	-0.20

Note: Spearman's Correlation Test

However, because the correlation coefficient value for the three lung function parameters is negative, it can be concluded that the higher the dust level in the workplace, the lower the pulmonary function of the workers.

DISCUSSION

The ceramic industry is one of the rapidly growing industries. The physical process of processing raw materials into ceramics tends to produce pollutions, such as ceramic dust particles. Ceramics have the main raw materials and additional raw materials, the basic ingredients of ceramic floors. The raw materials for ceramic floors are the clay, feldspar, fat removal, and heat resistant materials (Mg and aluminum silicates). Long-term exposure to silica increases the risk of silicosis in ceramic factory workers.[3]

Prolonged exposure to silica dust causes inflammatory cells to secrete mediators such as cytokines, chemokines and chemoattractants, which can cause inflammation, leading to an inflammatory cascade. The release of chemoattractants such as (IL-8) and leukotriene-B4 (LTB4) attracts neutrophils to release proteolytic enzymes such as elastase, proteinase-3, cathepsin G, cathepsin B and (MMP), which cause damage to the elasticity of lung tissue.[5] Increased level of IL-8 causes the number of neutrophil cells to increase. One study showed an increase in inflammatory markers in serum correlated with the severity of airway obstruction.[6]

Based on the Circular of the Minister of Manpower No. 01 of 1997 concerning the Threshold Value (TLV) of Chemical Factors in the Air of the Work Environment, the TLV of dust levels that interfere with work enjoyment is 10 mg/m^3 where the dust does not contain asbestos. The content of free silica is < 1%. The dust levels obtained from the results of this study were 6.11 mg/m^3 in the sintering section, 24.82 mg/m^3 in the pre-compressed section and 29.28 mg/m^3 in the compression section. This means that only workers who work in the sintering section were in a healthy working environment. In contrast, workers in the precompression and compression sections were exposed to dust in concentrations that exceeded normal values throughout the day.

Sintering is a method of compacting ceramic powder at high temperatures to obtain bulk material. During the sintering process, the particles pollinated

by the ceramic will diffuse into each other until they become solid material. If the process is not perfect, the final result of the ceramics will still have pores that can reduce the quality of the ceramic. Lesser ceramic dust are floating in the air during this process because the sintering process aims to compact the semi-finished ceramic products compared to the precompression and compression processes where ceramic dust is still flying freely in the workspace so that its levels exceed the threshold value.

Based on the spirometry examination, the pulmonary function test results showed that as many as 60% of workers experienced restriction pulmonary function disorders. This was similar to the research results obtained by Tsao et al in 2017, which carried out pulmonary function examinations on 221 ceramic workers in Taiwan, where 53% of workers experienced restrictive disorders. Fortunately, most workers (57%) who experienced restrictive lung disorders were still in a mild restrictive degree (FVC=51–80% predictive value).[7]

There are several mechanisms in which silica can damage the lungs. Cytotoxicity of silica particles can trigger reactive oxygen/nitrogen species, secretion of pro-inflammatory factors, cytokines, chemokines, elastase, and fibrogenic factors. This mechanism can initiate changes in lung tissue resulting in respiratory obstruction.[8,9]

Moreover, the silica particles can cause epithelial cell injury, which facilitates the penetration of the silica particles into the walls of the small airways, resulting in localized fibrosis. The restrictive lung impairment is associated with collagen production and fibroblast growth factor, resulting in fibrosis of the alveolar wall and formation of silicotic nodules, all of which will result in restriction of lung function.[8,9]

CONCLUSION

There was no statistically significant correlation between dust level in the workplace and the lung function of ceramic factory workers.

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