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Mine dust - as a cause of respiratory diseases of miners

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Piotr MOCEK [1*], **Kinga MOCEK** [2]

Author's affiliations and addresses:

[1] Silesian University of Technology, Faculty of Mining, Safety Engineering and Industrial Automation, Akademicka 2a, 41-100 Gliwice, Poland

[2] Pomeranian Medical University in Szczecin, Faculty of Medicine and Dentistry, Rybacka 1, 70-204 Szczecin, Poland

*** Correspondence:**

e-mail: piotr.mocek@polsl.pl

Abstract:

The risk of industrial dust in the work process is one of the greatest challenges not only in Europe but also in the modern world, where over a million people die each year from pneumoconiosis and other respiratory diseases. In Poland, one of the most numerous groups of employees constantly exposed to polluted air at the workplace are miners employed in hard coal mines, who in 2021 they accounted for 89.8% of all exposed persons in Poland (34,876 employees). In order to assess the impact of industrial dust hazards on the health of miners, employees of the Department of Safety Engineering of the Silesian University of Technology, in cooperation with students of the Pomeranian Medical University in Szczecin and a pulmonology specialist, conducted a pilot assessment of the effects of long-term exposure of employees of the preparatory departments of mine X to mine dust. The scope of diagnostic tests included: interview with the patient, physical and spirometric tests. Among the surveyed miners, 18.4% had various disorders and changes in the respiratory system, including the diagnosed pneumoconiosis. The article describes the health effects of long-term exposure of miners to mine dust and the partial results of the diagnostic tests.

Keywords: mine, hazard, mine dust, preparatory departments, pneumoconiosis, respiratory diseases, preventive measures, diagnostic tests, spirometry

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1. Introduction

The report of the Central Statistical Office [1] published in 2021 shows that in Poland, among the factors related to the work environment, dust is the greatest risk right after noise to which 60.4 thousand people were exposed in 2020, i.e. 18.3% of all exposed to harmful substances in Poland (an increase by over 10,000 employees compared to 2019). For years, the greatest dust hazard has traditionally been recorded in the Silesian Voivodeship, where 74.3% of all persons exposed to dust in Poland work there. The dust hazard is mainly related to the mining process. In mining and extraction PKD section, 38,823 employees worked in dusty conditions in 2020 (an increase by 39% compared to 2019), most of which worked in the hard coal mining industry - 34,876 (89.8%), i.e. more than every second case of a person exposed to dust in Poland. The hard coal mining industry also has the highest dust hazard ratio per 1,000 employees in the plants covered by the research work, which has increased by 175.5% over the last 5 years, from 263.6 in 2016. to 462.5 in 2020. Hard coal miners are most often employed under the risk of fibrotic dusts - 20,479 people - 70.2% exposed to fibrotic dust in Poland and carcinogenic dust -14,397 people - 69.4% exposed to carcinogenic dust in Poland (Table 1). The sharp increase in the area of the risk of carcinogenic dusts appeared due the change in European regulations on the protection of workers against the risk of exposure to carcinogenic or mutagenic agents at work and the implemented Directive of the European Parliament and of the Council (EU) 2017/2398 of December 12, 2017, pursuant to which "work related to exposure to crystalline silica - the respirable fraction generated during work." [2, 3] is classified as carcinogenic.

Table 1. Number of people employed in the areas threatened by harmful dust in Poland [1]

People employed in hazardous conditions	Years				
	2020	2019	2018	2017	2016
Dust					
In Poland – total	60383	50353	50236	53381	54513
– per 10000 employees	10.1	8.3	8.4	9.0	9.5
in industry: – total	54269	43086	42108	45337	46524
– per 10000 employees	20.3	15.9	15.6	17.0	18.0
in the mining industry: – total	38823	27927	27033	28572	29228
– per 10000 employees	291.9	202.8	195.9	206.1	209.9
in the hard coal mining industry – total	34876	23764	22036	22935	23488
– per 10000 employees	462.5	302.7	281.5	290.8	263.6
Fibrotic dust					
In Poland – total	29178	34201	34291	36694	36314
– per 10000 employees	4.9	5.6	5.7	6.2	6.6
in industry: – total	25661	29400	28850	30983	31348
– per 10000 employees	9.6	10.9	10.7	11.6	12.1
in the mining industry: – total	23307	27071	26091	27415	27122
– per 10000 employees	175.2	196.6	189.1	197.8	194.8
in the hard coal mining industry – total	20479	23109	21504	22381	21605
– per 10000 employees	271.6	294.3	274.7	283.7	269.7
Cancerogenic dust					
In Poland – total	20736	2372	2567	2699	2961
– per 10000 employees	3.5	0.4	0.4	0.5	0.5
in industry: – total	19660	2086	2352	2546	2756
– per 10000 employees	7.4	0.8	0.9	1.0	1.1
in the mining industry: – total	14397	10	4	0	30
– per 10000 employees	190.9	0.1	0.1	-	0.2
in the hard coal mining industry – total	14397	10	4	0	30
– per 10000 employees	190.9	0.1	0.1	-	0.2

Due to the change in the regulations, the employees of the Department of Safety Engineering of the Silesian University of Technology in cooperation with the "Stanisław Bielaszka" Central Laboratory for Testing the Work Environment from Jastrzębie Zdrój took measurements of airborne dust at the workstations of the preparatory departments in mine X, from which it resulted that the concentration of airborne dust and carcinogenic crystalline silica in many cases significantly exceeded the new health and safety standards, both when working with shearers and with explosives (Table 2).

To supplement the collected results of measurement at workstations, the voluntary anonymous examination of the respiratory system was conducted among 87 employees of preparatory departments (GRP-1. GRP-2. GRP-3) of the X mine related to drilling the roadways with use of roadheaders and explosives to assess the rate of respiratory disorders among the examined miners and to describe the pulmonary changes in the respiratory system of the workers resulted from long-term exposure to fibrotic and carcinogenic dust.

Table 2. Measured concentration of dust and crystalline silica at workstations of preparatory departments of X mine

Position	Range of airborne dust concertation [mg/m^3]		Average exceedance of MAC		Range crystalline silica concentration in dust [mg/m^3]	Average exceedance of MAC
	inhal.	resp.	inhal.	resp.	respirable	respirable
roadheader operator	0.71-48.68	0.35-15.12	4.6	7.3	0.046-0.621	6.0
assistant of roadheader operator	0.68-46.13	0.30-14.65	4.4	7.1	0.038-0.610	5.9
miner constructor	0.44-39.48	0.15-11.31	3.4	5.2	0.026-0.555	5.1
miner in transportation	0.25-24.14	0.07-8.30	4.2	6.4	0.009-0.214	2.0
conveyor staff	0.32-34.20	0.13-10.38	3.0	4.2	0.028-0.582	5.6
miner in a face	0.12-26.30	0.04-6.33	2.5	3.7	0.025-0.430	4.0
blasting miner	0.31-8.96	0.03-1.43	0.8	0.6	0.060-1.110	9.8
driller	0.26-7.38	0.02-1.26	0.7	0.6	0.067-1.126	10.9
MAC for inhalable dust is -10 mg/m^3, for respirable dust – 2 mg/m^3 MAC for crystalline silica – 0.1 mg/m^3						

2. Materials and Methods

MINE DUST AND ITS PROPERTIES

Mine dust is the dust with particles below 1mm, generated mainly during mining work, i.e. mining, drilling, crushing, grinding as well as during the mechanical processing and transport of hard coal and accompanying rocks. It consists of coal particles, crushed minerals, e.g. anthracite, metal particles, rock particles and substances that protect it against explosion. It also contains chemicals such as aluminosilicates, beryllium, copper, cobalt, selenium and sulfur. The dust generated during mining processes in hard coal mines can be a coal dust, or rock dust, however, it is a multicomponent airborne mixture in the mine atmosphere and is transported along with air stream along the network of mining roadways, where it may pose a threat to all people who come into contact with it [4-7].

Due to the grain size and its settling, mine dust can be classified as: inhalable, tracheal and respirable (Fig. 1).

Inhalable dust is dust visible to the naked eye, nominally less than 0.1 mm in diameter, known as PM10. In mining conditions, it enters the miner's respiratory system with each breath, but most of this dust, due to its size above 30 µm, is caught in the nose, mouth and upper respiratory tract of the worker, from where it is expelled with mucus (sputum).

Tracheal dust is a dust not exceeding 20 µm that penetrates into the middle part of the respiratory tract, including the trachea, bronchi and bronchioles.

Respirable dust is dust smaller than 0.004 mm (PM4) and therefore invisible to the human eye. This type of dust can enter the miner's lungs. In the case of fine dust fraction smaller than 0.0025 mm (PM2.5), it reaches the deepest parts of the lungs, where it can penetrate into the small alveoli where oxygen is exchanged between the inhaled air and the blood. The time of dust removal from the alveoli is long, it amounts to approx. 50% per month, however, with constant exposure in mining conditions, its total removal is practically impossible [8].

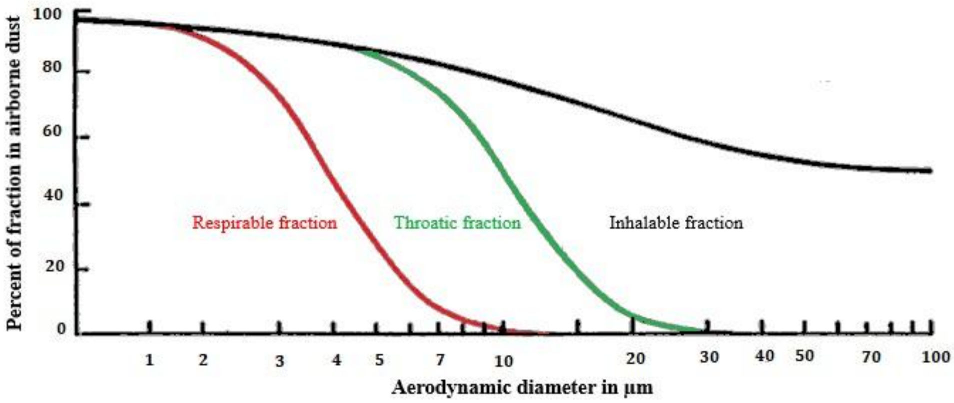

Fig. 1. Inhalable, tracheal and respirable fraction as a percentage of total airborne particles [9, 10]

Negative health effects of exposure to mine dust depend on the following:

- type of dust,
- size of dust particles (dust fraction),
- dust concentrations in inhaled mine air,
- exposure time,
- sensitivity of the exposed person,
- type technological process.

Mine dust can enter the miner's body through inhalation (inhalation exposure) or by settling on the skin, where it is absorbed by hair follicles and sebaceous glands, especially in the mine workings of high temperature and high humidity, when the harmful substances are absorbed directly through the skin.

Based on epidemiological observations, clinical studies of miners exposed to dust in the work environment and the effects that dust in hard coal mines may cause, dust can be divided into [11, 12]:

- irritating dust – these include dust of organic origin, mainly from decaying wood, dust of some plastics devoid of toxic effect, dust of coal, graphite, manganese, tin, iron oxides generated during blasting. These types of dust cause mechanical irritation to the mucosa or respiratory tract of miners.
- dust with a pneumoconiosis effect – this include dust of mineral origin, containing mainly hard coal particles.
- carcinogenic dust – this include mineral dust containing free silica. Crystalline silica particles, after penetrating the respiratory system, can cause a strong growth of connective tissue in the lungs, leading to silicosis. It develops over a few or even dozen or so years. Currently, this type of dust is classified as a carcinogenic chemical substance.

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In the literature [13-15] we can also find a different classification of dust in the mine environment due to the etiology of pneumoconiosis, i.e. non-collagen dust and collagen dust. Non-collagen-free dust accumulates only in the alveoli, causing changes in the body (pure coal dust). Part of this dust is eliminated by the body's lymphatic system as a result of phagocytosis. Collagen dust exhibits biological activity, causing focal fibrosis of lung tissue through toxic effects on macrophages. Silicosis is caused by the crystalline form of silica (SiO_2) [16].

TYPES OF MINERS PNEUMOCONIOSIS AND ITS CONSEQUENCES

Pneumoconiosis as an accumulation of dust in lungs and the response of lung tissue to its presence was described by the International Labour Organization at the 4th International Pneumoconiosis Conference in Bucharest in 1971 [17]. On this basis, six types of occupational pneumoconiosis, two of which are most often diagnosed among employees of Polish hard coal mines, i.e. hard coal pneumoconiosis (774 cases in 2020) and silicosis - (239 cases in 2020) - Fig. 2 were the amendment to the list of occupational diseases [18]. Increased mortality from lung cancer has been also observed among the miners exposed to airborne dust [19].

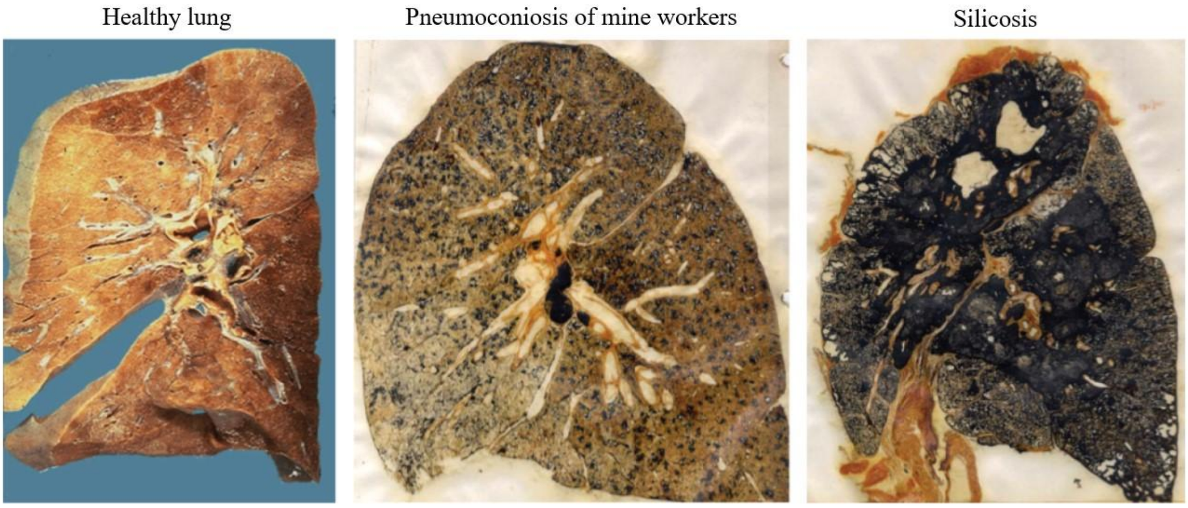

Fig. 2. Lung sections with lesions [20]

Coal mine workers pneumoconiosis is a focal fibrosis of the lung tissue caused by inhalation of mine dust after about 20 years of exposure. Numerous macrophages appear in the lungs of miners with evenly spaced, black, star-shaped deposits of coal dust, which penetrate through the walls of the alveoli, find themselves in the adventitia of the bronchioles and vessels, where they form coal nodules. The nodule is surrounded by small foci of atelectasis and emphysema. As the disease progresses, the type of tissue fibrosis changes from the initially predominant reticulin type to the collagen type (Fig. 3). Over time, mine dust accumulating in the lungs causes local expansion of alveoli and bronchioles in the lungs, i.e. focal emphysema [21, 22]. Long-term exposure to carbon dioxide dust can lead to progressive massive fibrosis (PMF).

Shortness of breath, especially dry cough, loss of appetite, weight loss, and chronic bronchitis and emphysema are the clinical symptoms of miners pneumoconiosis. However, these symptoms usually appear after 5-10 years of continuous exposure to mine dust and are closely related to its fibrotic properties. At the end of the patient's life, the so-called pulmonary heart syndrome is a consequence of chronic respiratory failure. Pulmonary tuberculosis is another fairly common complication of miners' pneumoconiosis. The changes in miners lungs are irreversible and tend to develop spontaneously into large fibrotic areas and the lung tissue scarring. Miners pneumoconiosis, however, develops more slowly than silicosis [23, 24].

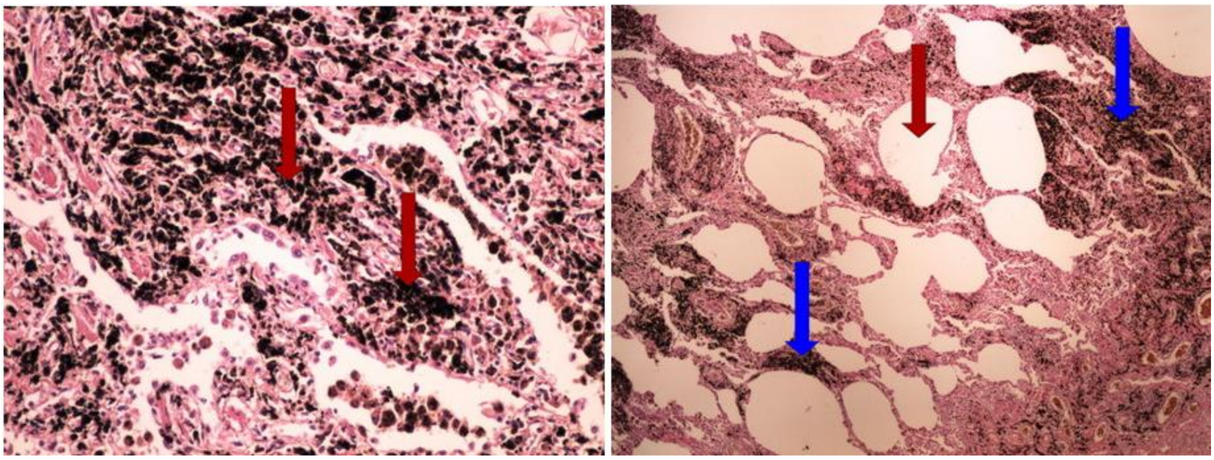

Fig. 3. Miners' pneumoconiosis seen under a microscope with characteristic macrophages and bubbles [21]

Caplan's syndrome is a special form of pneumoconiosis of coal miners [26, 27], considered a variant of spontaneous bone marrow fibrosis (BMF), and in the radiographic image it is visible in the form of oval shadows with a diameter of 0.5 cm to 5.0 cm. These changes are accompanied by symptoms of rheumatoid arthritis and the rheumatoid factor. Pathological changes are mild reticulin fibrosis of the lung tissue (Fig. 4). In addition, Caplan's syndrome is characterized by positive serological reactions for the presence of rheumatoid factor (latex and Waaler-Rose reactions) and rheumatoid arthritis.

Fig. 4. The result of the radiological examination of a patient with rheumatoid arthritis and pulmonary fibrosis in the case of silicosis [27]

Silicosis is caused by inhalation of dust containing crystalline silica (SiO_2), resulting in focal or extensive collagen-like fibrosis of the lung tissue, with a tendency to hyalinization. Usually, pathological changes in lung tissue appear after several years of exposure to silica dust, which penetrates into the interstitial tissue, where it is phagocytosed by macrophages, causing their disintegration and the release of substances responsible for lung tissue fibrosis. With high concentrations of silica in the inhaled air, lung tissue fibrosis may appear after a few or several months. At the initial stage of the disease, there are microbial changes, chronic bronchitis and emphysema.

As fibrosis progresses, the disease develops into small nodules several millimetres in diameter spread across the lungs, usually in the upper and middle parts of the lungs, but over time transforms into larger oval and kidney-shaped tumours that tend to migrate (Fig. 5).

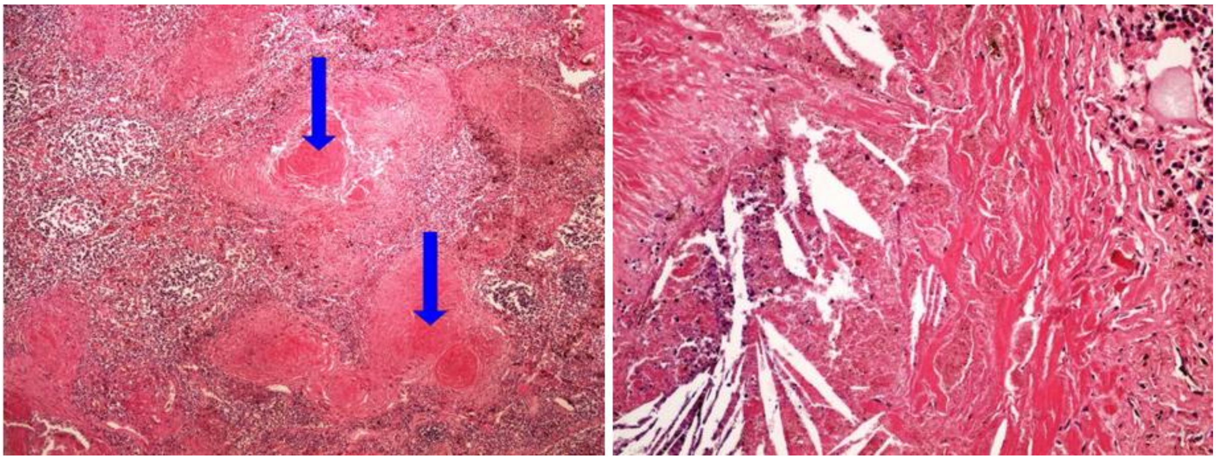

Fig. 5. Silicosis seen under a microscope with characteristic - silicon nodules [21]

There are the following symptoms of silicosis: exertional dyspnoea and cough, which is usually a symptom of chronic bronchitis. As the disease progresses, symptoms worsen and the cough changes from dry to wet. There is also a gradual, significant weight loss [28, 29]. Advanced pneumoconiosis is life-threatening as it can cause blood circulation failure by impaired function of the right ventricle (the so-called pulmonary heart). Complications of silicosis also include tuberculosis and spontaneous pneumothorax. In severe cases of silicosis, chronic obstructive pulmonary disease and lung cancer may develop [30, 31, 32].

3. Results

DIAGNOSTICS OF MINERS FROM PREPARATORY DEPARTMENTS OF X MINE

87 professionally active employees of the preparatory departments (GRP-1, GRP-2, GRP-3) of the X mine participated in a random diagnostic examination for pathological changes in the respiratory system. The departments differed in the work specificity. GRP-1 Division worked in a coal face developed with use of AM-50 roadheader. GRP-2 Division - excavated the stone surface with use of explosives. The GRP-3 division was engaged in a development of the rock and coal mine with an AM-75 shearer. The aim of the study was to assess the frequency of respiratory disorders among the examined miners. The scope of diagnostics covered an interview with an employee, which included the CAT test (Table 3), physical examinations and spirometry.

Table 3. Outcome of CAT test for employees of the mine X preparatory departments

Syndromes	Workstation / number of people per workstation							
	1*	2*	3*	4*	5*	6*	7*	8*
	6	6	12	25	12	18	4	4
	Number of examined people / (average CAT)							
cough	3 (3.3)	4 (2.5)	4 (3.0)	10 (3.8)	4 (2.8)	6 (3.5)	3 (3.2)	1 (3.5)
residual sputum	6 (3.3)	6 (4.0)	10 (3.7)	23 (2.7)	11 (4.3)	18 (3.7)	4 (4.0)	4 (2.5)
tightness in the chest	1 (3.5)	1 (3.0)	2 (2.5)	0 (0.0)	3 (3.3)	2 (3.0)	1 (4.0)	1 (4.0)
shortness of breath	1 (3.0)	1 (3.5)	2 (3.0)	0 (0.0)	3 (3.5)	2 (3.0)	1 (4.5)	1 (3.5)
tiredness	2 (3.5)	2 (3.0)	3 (4.0)	5 (3.6)	4 (4.0)	4 (3.5)	2 (3.5)	2 (3.0)
anxiety and insecurity	1 (2.0)	1 (2.0)	1 (2.5)	0 (0.0)	1 (3.0)	1 (2.5)	1 (3.0)	0 (0.0)
sleep disturbance	1 (2.0)	0 (0.0)	1 (3.0)	0 (0.0)	1 (3.5)	1 (3.0)	2 (3.5)	1 (3.0)
lack of energy	2 (3.0)	0 (0.0)	3 (4.0)	2 (4.0)	4 (3.8)	2 (3.8)	2 (4.0)	2 (3.5)

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CAT outcome	23.6	18.0	25.7	14.1	28.2	26.0	29.7	23

* The following numbers were assigned to each workstation: shearer-operator - 1, shearer-operator assistant - 2, miner-constructor - 3, miner in transport - 4, conveyor staff - 5, miner in the face - 6, blasting miner - 7, driller - 8.

Interpretation of CAT score
1. 5 points - Upper limit of normal for healthy, non-smokers.
2. < 10 points - Little impact of the disease on life. Most good days. Fatigue symptoms
3. 10-20 points - Average impact of the disease on life. Appearing shortness of breath, cough, 1-2 exacerbations a year
4. 21-30 points - Big impact on life. If you are ill, you are unable to do most activities- .
5. > 30 points - Very big impact on life. Difficult to perform basic activities.

Based on the interview and CAT test, severe respiratory system ailments were diagnosed in 12.6% of the surveyed miners, especially shearer operators and transporting staff. Less symptoms manifested by irritation of the respiratory tract and the production of excessive sputum were reported in over 63.4% of the examined people (Table 3).

The results of the interview were also confirmed by physical examinations, especially auscultation, where almost half of the respondents lungs (48.3%) showed murmurs, whistling, whirring, indicating for narrowing of the airways inside or behind the chest and the presence of secretions in the respiratory tract. Auscultation changes were found in workers of all ages and are not only the domain of miners over 40 years of age. Unfortunately, among the surveyed employees there may also be cases of atelectasis, emphysema and reduced aeration of lungs as evidenced by muffled and drum-like percussion sound (7% of respondents). Diagnostic tests also show the possibility of neoplastic changes in 4.6% of the respondents, which is manifested by pleural friction and rod-shaped fingers, which may indicate neoplastic fibrous lesions of the lung tissue (Table 4).

Table 4. Results of examination of employees in preparatory departments of mine X

Recognized symptoms	Workstation / number of employees per station							
	1*	2*	3*	4*	5*	6*	7*	8*
	6	6	12	25	12	18	4	4
	Number of tested people with symptoms							
skin changes	1	-	-	-	-	-	1	1
chest deformity	1	-	1	-	-	1	1	-
stick fingers	1	-	1	-	1	-	1	-
shortness of breath, apnea	2	1	2	1	3	2	1	1
prolonged exhalation	1	-	1	-	-	1	1	-
one-sided weakening of the movements of the klp	2	-	1	-	1	1	2	1
decrease in the number of breaths	2	-	1	-	1	1	2	1
breathing disorders	2	1	2	1	2	2	2	1
lowering the lungs	-	1	1	-	1	1	1	-
a muffled percussion noise	1	-	1	-	1	0	1	-
an eardrum tapping sound	1	-	-	-	-	1	-	1
voice tremor	-	-	-	-	1	1	2	2
bronchial or pulmonary murmurs	2	1	4	7	8	6	2	2
wheezing	-	2	-	3	2	2	0	2
whirring	2	4	2	8	7	3	2	2
pleural friction	-	1	-	1	-	-	1	-

* The following numbers were assigned to each workstation: shearer operator - 1, assistant of the shearer operator - 2, miner-constructor - 3, miner in transport - 4, conveyor staff - 5, miner in the face - 6, blast miner - 7, driller - 8.

This observation was also confirmed by spirometry tests, which in 3.5% of respondents showed a severe degree of respiratory obstruction below 35%. In total, the features of respiratory obstruction were diagnosed in 16 people, i.e. 18.4% of the respondents, which is a high number, especially in a situation where among 87 surveyed employees of the X mine preparation departments only two employees were under the supervision of a pulmonologist, and the rest were unaware of their ailments. Their preventive examinations in the diagnosis of respiratory diseases were mostly limited to a chest X-ray every few years and irregular spirometry tests. All persons with diagnosed respiratory obstruction were sent for further diagnostic tests as part of the examinations conducted by the Department of Safety Engineering at the Silesian University of Technology, students of the Pomeranian Medical University in Szczecin and a pulmonology specialist at mine X.

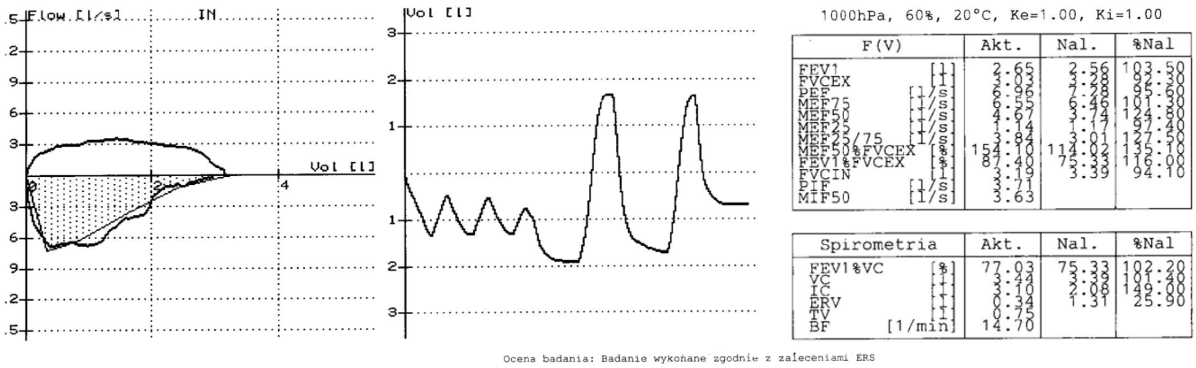
Examples of the results of diagnostic tests and diagnosis of employees who have decided to undergo additional tests are as follows:

Case 1.

Interview: Work position: - shearer miner. Employed in GRP department - 1. Age: - 42 years. Work in mine: - 23 years. Work in GRP department: - 18 years. Weight - 84 kg. Height - 175cm. Stimulants – non-smoker. CAT test result: - 22.0 points, main ailments: dry cough, sputum retention in the respiratory tract, sleep disturbances caused by apnea, symptoms of dyspnea after prolonged exertion. The patient has not been pulmonologically consulted so far.

Examination result: marked symmetrical bronchial whirring caused by residual secretion, muffled percussion sound, respiratory distress at greater exertion.

Spirometry: Spirometry showed no impairment of lung function (Fig. 6).



F(V)		Akt.	Nal.	%Nal
FEV1	[l]	2.65	2.56	103.50
FVCEX	[l]	3.03	3.28	92.30
PEF	[l/s]	6.96	7.28	95.60
MEF75	[l/s]	6.55	6.46	101.30
MEF50	[l/s]	4.67	3.74	124.80
MEF25	[l/s]	1.14	1.17	97.40
MEF25/75	[l/s]	3.84	3.01	127.50
MEF50%FVCEX	[%]	154.10	114.02	135.10
FEV1%FVCEX	[%]	87.40	75.33	116.00
FVCIN	[l]	3.19	3.39	94.10
PIF	[l/s]	3.71		
MIF50	[l/s]	3.63		

Spirometria		Akt.	Nal.	%Nal
FEV1%VC	[%]	77.03	75.33	102.20
VC	[l]	3.44	3.39	101.40
IC	[l]	3.10	2.08	149.00
ERV	[l]	0.34	1.31	25.90
TV	[l]	0.75		
BF	[1/min]	14.70		

Fig. 6. Shearer miner's spirometry result

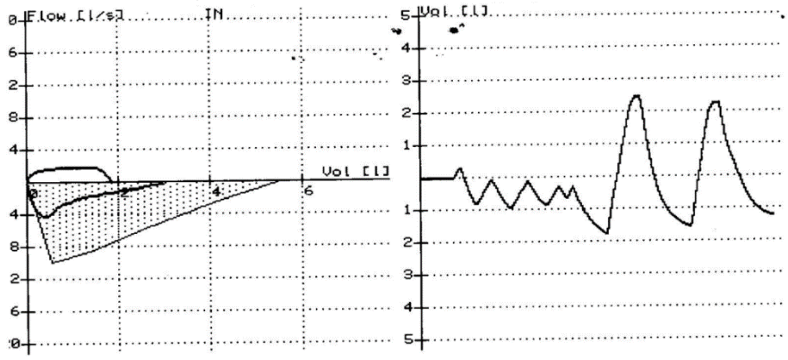
Additional examinations: X-ray. The patience's full-size chest X-ray showed the focal densities corresponding to the effects of fibrotic dust in the form of organic small nodular pneumoconiosis. **HRTC.** Spiral technique with the reconstruction of 0.625 mm layers in transverse planes without contrast enhancement was used during examination. In segment 4 of the right lung, there is an irregular nodular lesion with dimensions of 22 x 24 x 10mm with finger-like protrusions that connect to the pleura with the oblique interlobular fissure. The change causes a narrowing of the end part of bronchus of segment 4. It is necessary to extend the diagnostics by a CT scan of the chest with contrast. Moreover, the trachea and main bronchi are open. In the segment 3 of the right lung, calcification 5mm was found. Minor focal lung parenchyma in segment 5 of the right lung and in the left lung, in segment ½ in segment 5 and in segments 8 and 9. Focal pleural thickening at the apexes of both lungs with a predominance on the right side. Further diagnostics and treatment are recommended.

Case 2.

Interview: Work position: - blasting miner. Employed in GRP department - 3. Age: - 44 years. Work in mine: - 24 years. 8 months before retirement. Work in GRP department: - 20 years. Weight - 60 kg. Height – 180 cm. CAT test result: - 26.0 points. Stimulants: - Non-smoker for 20 years. Main ailments: difficulty breathing, shortness of breath, dry persistent cough, anxiety and respiratory problems, especially at night. The patient has not been pulmonologically consulted so far. He uses an inhaler - recommendation of his family practitioner.

Examination result: wheezing, cyanosis, auscultation changes over the pulmonary fields, poor exercise tolerance associated with frequent shortness of breath, marked weight loss, scoliosis.

Spirometry: Spirometry indicates a severe degree of lung function impairment (Fig. 7).



1000hPa, 60%, 20°C, Ke=1.02, Ki=1.01

F(V)		Akt.	Nal.	%Nal
FEV1	[l]	2.00	4.52	44.20
FVCEX	[l]	3.07	5.56	55.20
PEF	[l/s]	4.27	10.11	42.20
MEF75	[l/s]	2.90	8.74	33.10
MEF50	[l/s]	1.72	5.61	30.60
MEF25	[l/s]	0.96	2.57	37.30
MEF25/75	[l/s]	1.93	4.66	41.40
MEF50%FVCEX	[%]	56.00	100.89	55.50
FEV1%FVCEX	[%]	65.10	80.01	81.30
FVCIN	[l]	1.90	5.82	32.60
PIF	[l/s]	1.95		
MIF50	[l/s]	1.87		

Spirometria		Akt.	Nal.	%Nal
FEV1%VC	[%]	44.54	80.01	55.60
VC	[l]	4.49	5.82	77.10
IC	[l]	3.65	4.18	87.30
ERV	[l]	0.84	1.64	51.20
TV	[l]	0.67		
BF	[1/min]	24.24		

Ocena badania: Badanie wykonane zgodnie z zaleceniami ERS

Fig. 7. Blasting miner's spirometry result

Additional examinations: X-ray. Nodular-fibrous lesions in the upper and partially medial fields, confluent in places in the left lung, with the appearance of post-Tbc lesions. The silhouette of the heart is similar to the pulmonary one. Spine scoliosis. **TK.** The chest was CT scanned using the spiral technique, with 3.75- and 2.5 mm thick layers in the transverse planes, before and after the intravenous administration of the contrast agent. Numerous disseminated nodular changes in both lungs with a tendency to consolidate mainly in the upper lobes were found during examination. In the vicinity of consolidation changes, visible changes covering the pleura and distorting the lungs. The lesion image is consistent with silicosis. Mediastinal lymph nodes without visible calcifications, diameter up to 11 mm, numerous. Subostral lymph node bundle 12 x 40mm. The changes may also correspond to changes in pneumoconiosis. Apart from that, the lungs had no visible pathological changes. Heart, large vessels within normal limits. Spine scoliosis. Patient referred for further examination.

4. Conclusions

Increasing number of employees exposed to industrial dust is a problem not only in Poland, but for the whole world various types of respiratory disorders are the most common effect of long-term exposure to industrial dust as shown in research work cited above. this phenomenon is mostly observed in the rock mining industry, mainly in hard coal mines, where the highest rate of pneumoconiosis has been observed for years. Mine dust is the main cause of morbidity. Dust composition and its particles size is not homogeneous, as it is a mixture of multiple particles, travelling with the mine air current through most of the mine workings. Preparatory departments of mines and mining plants, due to the specificity of work in blind workings, are the place where harmful mine dust is most abundant. Its differentiation also depends on the type of the mined rock and technological process used. Results of measurements of the dust and crystalline silica concentration show that the introduction of new legal regulations on MAC increased the area of hazardous dust zones in mines and the accidences of exceeding the MAC increased. The introduced new regulations impose additional obligations on employers and physicians who watch after the preventive measures for health of employees exposed to harmful dust. These measures consist not only in increasing the dust concentration measurements in the mine air, but also in extending medical prophylaxis.

Students of the Pomeranian Medical University and the pulmonology specialists examined employees of preparatory departments of mine X showed that the problem of hidden occupational morbidity in mine employees exists and will continue to exist despite the prevention widely implemented in mines because people are afraid of losing their jobs and a reduction in earnings due to occupational disease and the need to change job or being transferred to a sickness pension. As long as the law on greater protection of people with symptoms of occupational diseases, who risk their life and health for the future mining retirement pension and protection of their families is not changed, the detection of pneumoconiosis among professionally active employees will be difficult, as shown by the statistics of the Institute of Occupational Medicine in Łódź.

Therefore, it is worth perceiving the change in NDS regulations in Poland and Europe neither as a "witch hunt", which today are the sick miners, nor as a tool against employers, but as an attempt to extend medical prophylaxis to facilitate early detection of pneumoconiosis symptoms and to develop pro-safe behaviour among the miners, who today are diagnosed with pneumoconiosis only after retirement already at a significant degree of its advancement.

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