



The occupational risks of mining activity for the pulmonary health of the worker

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1 INTRODUCTION

Mining covers the exploration of underground and surface mines, making use of non-renewable goods (SILVA; ANDRADE, 2017). It is, therefore, an economic and industrial activity based on the research, exploration, extraction and processing of ores found underground (SOUSA, 2021).

Mining activities have occupied a prominent place in Brazilian society for centuries, both positively and negatively. It is positively highlighted for its added economic value and in a negative way, for the environmental impacts caused. Although involved in several controversies, mining activity in Brazil has a great contribution to the country's own history.

The mining sector is very diversified and has the production and extraction of various minerals, such as niobium, for example. According to a survey by the Brazilian Mining Institute (IBRAM), Brazil is the world's largest producer of niobium, accounting for about 86% of production worldwide (IBRAM, 2020). However, iron mining is the basis of steel, whose production aims to meet the increase in steel consumption used to meet the needs of economic development that occurred in the process of industrialization and global urbanization (IBRAM, 2020).

Iron ore is considered the most valuable mineral resource (in addition to oil and gas) in the world. Brazil is the world's second largest producer and exporter of iron ore, behind Australia only. Iron ore is one of the main export products in Brazil, with an average annual revenue of US\$25 billion in the current decade (IBRAM, 2020), generating several direct and indirect jobs. From December 2020 to May 2021, the mining sector generated about ten thousand direct jobs (IBRAM, 2021).

The mining sector is responsible for a significant absorption of labor, on the other hand, it is also one of the sectors responsible for the highest number of deaths at work around the world, in addition to triggering various occupational risks and diseases, such as lung diseases, as pointed out in the article



published by Carta Capital, on the Politike page (POLITIKE, 2015). In this sense, this article presents a discussion about the occupational risks of the mining industry to the worker's lung health.

2 METHODOLOGY

This article was based on a qualitative research, which covers an interpretative approach of the world, that is, its explorers analyze the objects in their corresponding scenarios, seeking to understand the phenomena in terms of the meanings designated to them (DENZIN; LINCOLN, 2006).

For the preparation of the research, we based on a bibliographic consultation of several materials available in some databases such as Periódicos Capes, Google Acadêmico and Scielo, for example.

OCCUPATIONAL RISKS OF MINING ACTIVITY

Occupational risks can be defined as any risk to which the worker is exposed in the work environment, that is, any condition that provides a risk of damage to the worker's health. The Ministry of Labor, through Ordinance No. 25/1994, classifies occupational risks into five types: physical risks, chemical risks, biological risks, ergonomic risks and accidental risks (BRASIL, 1994).

Mining-related activities expose workers to various occupational risks, such as exposure to chemical, physical, biological agents, silica dust and asbestos fibers, noise, mechanical vibrations, as well as constant work accidents involving work overload with repetitive movements, inadequate postures, among others (FUNDACENTRO, 2014).

Mining activity is characterized by exposure to various risks that lead to the illness of workers (SOUSA; QUEMELO, 2015). According to a study developed by the Social Service of Industry (SESI), the extractive sector of non-metallic minerals represents 1% of the total number of workers, and is classified as a risk grade 4, according to NR-4 2008 (BRASIL, 2008).

A study conducted by Sousa and Quemelo (2015) identified, through a search in the literature, the main occupational risks for workers' health in mining activity. The research showed that mining activity is developed in environments with improper lighting and ventilation, with high temperatures, humidity and risk of accidents, high exposure to dust, improper positions, permanent noise, lack of personal and collective protection equipment and chemical risks due to contact with various substances. The studies have pointed to several studies reporting the risks of lung problems, in particular lung cancer and that, altitude mining has been reported for accelerating silicosis and other pneumoconiosis, the analyses also suggest that the risk rate increases with age, being more critical between 40 and 65 years (SOUSA; QUEMELO, 2015).

OCCUPATIONAL LUNG DISEASES OF MINING ACTIVITY

Mining is not a homogeneous industry, given that miners operate in formal and formal labor operations with various air exposures. Another factor that should be considered is the emergence of diseases only after a long latency, such as coal pneumoconiosis, asbestos-related diseases, lung cancer and other



occupational respiratory diseases that continue to have considerable importance, even after the end of mining operations (ROSS; MURRAY, 2004).

Pneumoconiosis

Pneumopathies originally related to inhalation of dust in workplaces are designated as pneumoconiosis (greek conion = dust). Airway reactions such as asthma, bronchitis and emphysema are not included in this denomination. According to the potential of dust to produce reactional fibrosis, pneumoconiosis can be divided into fibrogenic and non-fibrogenic (BRASIL, 2006).

Several branches of activities expose workers to the risk of inhalation of pneumoconiosis-causing dust. The mining and mining industry exposes workers to various dusts such as iron, bauxite, zinc, manganese, limestone, potassium and phosphatic rocks, asbestos, granite, quartz, quartzite, feldspar, clays and other minerals containing free silica, which can lead to the development of diseases such as asbestosis and silicosis (BRASIL, 2006).

Silicosis is a pneumoconiosis caused by inhalation of crystalline free silica (usually resulting from the mineral extractive industry), which arises after a long period of exposure, commonly longer than ten years, qualified by progressive fibrosis of the pulmonary parenchyma (BRASIL, 2006).

Coal Workers Pneumoconiosis (CWP), also known as 'black lung disease' or simply 'black lung', is caused by inhalation of coal dust. Dust deposition causes the appearance of dust-filled macrophages around the bronchiolus, causing focal bronchiolar emphysema. Commonly, CWP does not cause any symptoms, but can progress to progressive massive fibrosis, leading to impaired lung function (MSD, 2020). CWP is increasingly common and sometimes requires lung transplantation (BLACKLEY et al., 2018).

The concept pneumoconiosis, although it encompasses most pulmonary alterations involving the parenchyma, the term pneumoconiosis may not be suitable for certain pneumopathies mediated by hypersensitivity processes reaching the pulmonary parenchyma, such as allergic alveolitis by exposure to organic dust and other agents, beryllium lung disease, or cobalt pneumopathy (BRASIL, 2006).

Metal Lung Disease (DPMD) and Berylliosis

Carbide lung disease (DPMD) is a relatively rare disease that is caused by exposure to particles of carbide alloys, whose main composition is tungsten carbide and cobalt or cobalt and diamond. Some other metals are also used, only to a lesser extent, such as niobium, tantalum, chromium, titanium and nickel (MIZUTANI et al., 2016).

Workers' exposure to cobalt-rich particles, in ionized form, and tungsten carbide, occurs both in the production of cobalt powder and in the use of the tools formed by alloys of the same. These particles are absorbed by the lungs and gastrointestinal tract, causing different forms of lung disease, from asthma to various interstitial patterns in the lung. When combined, cobalt and tungsten exhibit synergistic effect and cause greater tissue inflammation (MIZUTANI et al., 2016).



Berylliosis is caused by inhalation of dust or vapors from compounds and products containing beryllium. It can manifest itself in two distinct forms: acute berylliosis, which is the rarest form; and chronic berylliosis, which is characterized by the formation of granulomas throughout the body, especially in the lungs, intrathoracic lymph nodes and skin. Beryllium exposure is the common cause of the disease, but little recognized, in many industries, including mining (MSD, 2020).

Chronic Obstructive Pulmonary Disease (COPD)

Occupational exposure to dust can induce the emergence of several lung diseases, including pneumoconiosis and chronic obstructive pulmonary disease (COPD), which is highly prevalent in patients with pneumoconiosis, especially patients with silicosis and CWP (ANA et al., 2020).

Chronic obstructive pulmonary disease can be defined as persistent narrowing (blockage or obstruction) of the airways, which occurs with emphysema, chronic obstructive bronchitis, or both concomitant disorders (MSD, 2020).

In the United States, about 16 million people have chronic obstructive pulmonary disease (COPD). It is the third most common cause of death, accounting for more than 140,000 deaths each year. From 1980 to 2000, the number of deaths from COPD increased by 64%, but since then, the number of deaths has remained stable. More than 97% of all COPD-related deaths occur in people over 64. COPD affects women more often than men, but men and women die as a result of COPD at almost equal rates (MSD, 2020).

COPD is characterized by chronic airflow limitation that is not fully reversible. This limitation is associated with the exaggerated inflammatory response of the lung to inhalation of toxic particles and/or gases. It has prevention and treatment. One of the main risk factors is occupational dust, in addition to individual factors such as bronchial hyperresponsiveness, malnutrition and prematurity (CEARÁ, 2010).

Lung cancer

According to the National Cancer Institute (INCA), lung cancer is the second most common type of cancer in Brazil (not counting non-melanoma skin cancer). Since 1985, it is the first type of cancer in the world, both in incidence and mortality. Approximately 13% of all new cases of cancer in the world are lung cases (INCA, 2021).

Cancer, according to a consensus of the researchers, is the result of the action of external environmental factors acting together with individual susceptibility, and the former play the main role in the cause of cancers and genetic factors play a secondary role. Among the risk factors for the occurrence of lung cancer, occupational risks represent the most relevant cause, after smoking (TERRA FILHO; KITAMURA, 2006).

According to an INCA survey, in 2015 in Brazil, lung cancer was responsible for 26,498 deaths, being one of the main causes of preventable death at the end of the 20th century (INCA, 2021).



A research conducted by Terra Filho and Kitamura (2006) pointed out the main substances that cause lung cancer in the context of mining activities:

- a) Asbestos – from 1979, IARC began to consider all types of asbestos as carcinogens for the lung;
- b) Beryllium – this chemical element was included in group 1 of iarc (carcinogens) in 1987;
- c) Coque coal – evidence related to the carcinogenic effect of coction (pure coal) production is widely reported and the carcinogenic action of soot has also been proven in relation to the lung;
- d) Nickel – nickel , nickel oxides and nickel sulfides have been considered carcinogenic since 1952. Nickel was included in group 1 of iarc carcinogens in 1990;
- e) Radon – the main risks of occupational exposure to radon and its decay products occur in the mining of uranium, hematite (iron ore) and gold;
- f) Silica – the most consistent studies on the effect of silica on the lung emerged in 1986. However, only in 1996, silica in the forms of quartz and cristobalite was inserted in group 1 of the IARC.

As seen, several substances found during the occupational activities of the mining industry (exploration, extraction, processing, among others) are potential cause of lung cancer. The risks to the worker's health are greater as the time and degree of exposure to carcinogens increases.

3 FINAL CONSIDERATIONS

The research conducted in this study showed that occupational diseases of respiratory nature, related to the mining sector, are diverse and can be triggered by different causatous agents. The most common pneumoconiosis among mining workers are coal workers' pneumoconiosis, asbestosis, silicosis, and other pneumopathies such as hard metal lung disease, berylliosis, chronic obstructive pulmonary disease, and lung cancer, which is usually associated with other pneumopathies already housed.

Mining-related activities present different occupational risks that compromise workers' health in different aspects, including pulmonary health risks, which may manifest themselves even after the worker's leave or retirement. In this sense, it is necessary to establish safer forms of work, which, in addition to not compromising the worker's health, promote a quality of work for them.



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