



The occupational risks of the mining activity for the worker's lung health

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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 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. Standing out positively for its added economic value and negatively, for the environmental impacts caused. Although involved in several controversies, mining activity in Brazil has made a great contribution to the country's history.

The mining sector is quite diversified and relies on the production and extraction of various minerals, such as niobium, for example. According to a survey carried out by the Brazilian Institute of Mining (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 the steel industry, whose production aims to meet the increased consumption of steel used to meet the needs of economic development that occurred in the process of world industrialization and urbanization (IBRAM, 2020).

Iron ore is considered the most valuable mineral resource (besides oil and gas) in the world. Brazil is the second largest producer and exporter of iron ore in the world, after Australia. Iron ore is one of Brazil's main export products, with an average annual revenue of 25 billion dollars in the current decade (IBRAM, 2020), generating several direct and indirect jobs. From December 2020 to May 2021, the mining sector generated around 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 risks and occupational diseases, such as lung diseases, according to points to 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 for the worker's pulmonary health.

2 METHODOLOGY

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

For the elaboration of the research, it was based on a bibliographical consultation of several materials available in some databases such as Periódicos Capes, Google Scholar, and Scielo, for example.

3 THE OCCUPATIONAL RISKS OF THE 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 poses a risk of damage to the worker's health. The Ministry of Labor, through Ordinance No. 25/1994, classifies occupational hazards into five types: physical hazards, chemical hazards, biological hazards, ergonomic hazards, and accidental hazards (BRASIL, 1994).

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

The mining activity is characterized by exposure to various risks that lead to workers becoming ill (SOUSA; QUEMELO, 2015). According to a study carried out by the Social Service of Industry (SESI), the extractive sector of non-metallic minerals represents 1% of all workers and is classified as risk level 4, according to the NR-4 of 2008 (BRASIL, 2008).

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



4 OCCUPATIONAL LUNG DISEASES FROM MINING ACTIVITY

Mining is not a homogeneous industry, given that miners work in formal and informal labor operations with various aerial exposures. Another factor that must be considered is the emergence of diseases only after a long latency, such as coal workers' pneumoconiosis, asbestos-related diseases, lung cancer, and other occupational respiratory diseases that continue to be of considerable importance even after the end of operations. mining (ROSS; MURRAY, 2004).

4.1 PNEUMOCONIOSIS

The pneumopathies originally related to the inhalation of dust in workplaces are designated as pneumoconiosis (from the Greek, conion = dust). Airway reactions such as asthma, bronchitis, and emphysema are not included in this designation. 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 inhaling dust that causes pneumoconiosis. The mining and prospecting industry exposes workers to various specks of dust such as iron, bauxite, zinc, manganese, limestone, potassium and phosphate rocks, asbestos, granite, quartz, quartzite, feldspar, clays, and other minerals containing free silica, which can lead to developing diseases such as asbestosis and silicosis (BRASIL, 2006).

Silicosis is a pneumoconiosis caused by the inhalation of free crystalline silica (generally resulting from the mineral extraction industry), which arises after a long period of exposure, usually over ten years, qualified by progressive fibrosis of the lung parenchyma (BRASIL, 2006).

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

Although the concept of pneumoconiosis encompasses most pulmonary alterations involving the parenchyma, the term pneumoconiosis may not be appropriate for certain pneumopathies mediated by hypersensitivity processes affecting the pulmonary parenchyma, such as allergic alveolitis due to exposure to organic dust and other agents, pulmonary disease by beryllium, or pneumopathy by cobalt (BRASIL, 2006).



4.2 HARD METAL PULMONARY DISEASE (DPMD) AND BERYLLIOSIS

Carbide lung disease (DPMD) is a relatively rare disease that is caused by exposure to particles of carbide alloys, the main component of which is tungsten carbide and cobalt or cobalt and diamond. Some other metals are also used but in a smaller proportion, such as niobium, tantalum, chromium, titanium, and nickel (MIZUTANI et al., 2016).

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

Berylliosis is caused by inhaling the dust or vapors of beryllium-containing compounds and products. 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, particularly in the lungs, intrathoracic lymph nodes, and skin. Beryllium exposure is a common but underrecognized cause of disease in many industries, including mining (MSD, 2020).

4.3 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 (FAN et al., 2020).

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

In the United States, about 16 million people have the chronic obstructive pulmonary disease (COPD). It is the third most common cause of death, accounting for over 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 age 64. COPD affects women more often than men, but men and women die from COPD at nearly 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 the 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).



4.4 CÂNCER DE PULMÃO

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 worldwide, both in incidence and mortality. Approximately 13% of all new cases of cancer in the world are lung cancer (INCA, 2021).

Cancer, according to a consensus among researchers, is the result of the action of external environmental factors acting together with individual susceptibility, with the former playing the main role in causing cancer and genetic factors playing a secondary role. Among the risk factors for the occurrence of lung cancer, occupational risks represent the most relevant cause, after the habit of 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 preventable causes of death at the end of the 20th century (INCA, 2021).

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

- a) a) Asbestos – from 1979, the IARC started to consider all types of asbestos as carcinogenic to the lung;
- b) b) Beryllium – this chemical element was included in group 1 of the IARC (carcinogenic agents) in 1987;
- c) c) Coal – evidence related to the carcinogenic effect of coking coal production (pure coal) is widely reported and the carcinogenic effect of soot has also been proven about the lung;
- d) d) Nickel–metallic nickel, nickel oxides, and sulfides have been considered carcinogenic since 1952. Nickel was included in group 1 of carcinogenic agents by the IARC in 1990;
- e) 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) f) Silica – the most consistent studies on the effect of silica on the lung appeared in 1986. However, it was only in 1996 that silica, in the forms of quartz and cristobalite, was included in group 1 of the IARC.

As seen, several substances found during occupational activities in the mining sector (exploration, extraction, processing, among others) are potential causes of lung cancer. The risks to workers' health are greater as the time and degree of exposure to carcinogens increase.

5 FINAL CONSIDERATIONS

The research carried out in this study showed that occupational respiratory diseases related to the mining sector are diverse and can be triggered by different causative agents. The most common pneumoconioses 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 often associated with other pneumopathies already lodged.



Mining-related activities present different occupational risks that compromise the worker's health in different aspects, including risks to pulmonary health, which can manifest even after the worker leaves the job or retires. In this sense, it is necessary to establish safer ways of working, which, in addition to not compromising workers' health, promote quality of working life for them.



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