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Mining Work and Health Problems in the Eastern Region of Morocco

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Abstract
Silicosis, due to the inhalation of silica dust, is by far the most common form of pneumoconiosis, and is also one of the most important occupational diseases, killing thousands of people every year worldwide. This is a retrospective study of the records of 50 silicosis patients from the city of Jerada, whose follow-up and management are carried out in the Diagnostic Center for Tuberculosis and Respiratory Diseases in Oujda. The age of declaration of the disease of these former coal miners who are all male, is between 23 and 69 years with a peak of frequency is between 30 and 39 years. The average duration of exposure to the silicogenic risk is about 14 years, with a peak frequency between 11 and 20 years. The duration of follow-up and management is between one year and 50 years, with a peak frequency between 20 and 29 years. This study is also interested in pulmonary tuberculosis at the level of the laboratory of anti-tuberculosis Oujda, the collection of results is from the supports of analysis carried out at the laboratory, and whose traceability is made on registers and a computerized database. The results of our study show that pulmonary tuberculosis is more frequent in men (71.42%) than in women (28.57%), with a sex ratio (male/female) of 2.49. The rate of positive slides is 8.89% in 2020 and 6.96% in 2021, while the GeneXpert shows a rate of 67% of positive cases in 2020 and 52% in 2021. Finally, GeneXpert is more specific than bacilloscopy and culture, it is the most reliable diagnostic method of pulmonary tuberculosis, as it detects the bacteria of tuberculosis complex with more accuracy, in addition to an advantage of detecting the rate of resistance to Rifampicin, which is the prescribed antituberculosis treatment in current medicine.

Keywords: Silicosis, Tuberculosis, Respiratory Diseases, Mining, Morocco

1. Introduction

The respiratory tract and the skin are the body surfaces most exposed to contact with external toxic substances. Diseases of the respiratory tract can be caused by exposure to toxic substances in the environment of the most varied professions. Toxic substances can be in the form of dusts (fibers or grain-like particles), vapors, gases or smoke. Infectious germs can also be transmitted in aerosols. The range of consequences for the respiratory tract and lung parenchyma is very wide. In addition to the type of harmful agent, the consequences also depend on the concentration, the depth of the attack in the respiratory tract, the size of the droplets or particles of dust inhaled, etc

Silicosis, due to the inhalation of silica dust, is by far the most common pneumoconiosis, and it is also one of the most important occupational diseases, which kills thousands of people every year all over the world. Workers exposed without appropriate prevention to a polluted professional environment are sub-

ject to respiratory diseases, of which silicosis is the most serious. All the treatments recommended in the long term only allow an improvement in the life expectancy of patients and their tolerance to effort.
Silicosis mainly occurs in workers working in underground mining operations. It is also seen in gravel pits and quarries and in the stone processing industry. It can be observed among workers in the ceramics industry, industrial kilns, foundries and in the glass and building materials industry.
Tuberculosis is an infectious and contagious disease caused by a mycobacterium, called *Mycobacterium tuberculosis* or Koch's bacillus. This disease is a major public health problem worldwide. In fact, more than a third of the world's population is infected with BK. The lung is the most common location of tuberculosis. Thus, pulmonary tuberculosis is the only contagious form of the disease. Tuberculosis treatment is well codified. However, the emergence of resistant strains constitutes a major challenge for the management of this disease.
Tuberculosis is one of the top 10 causes of death worldwide, with 99% of deaths recorded in developing countries. Tuberculosis is spread through the air from person to person. Tuberculosis bacteria are put into the air when a person with lung or throat tuberculosis coughs, sneezes, talks or sings. People nearby can breathe in these bacteria and become infected. In many industrialized countries, the number of cases is recorded each year, including 1 million children (WHO, 2019).

Main objectives :

- Study the prevalence of pulmonary tuberculosis infections at the Diagnosis Center for Tuberculosis and Respiratory Diseases (DCTRD) Oujda (for 400 cases).
- Research the relationship of the dose-effect of toxic products in former coal miners of the Jerada mine (Silicosis) (for 50 cases)
- The impact of the environment in mine workings on the health status and quality of life of former Jerada coal miners.

Specific objectives:

- Determine the frequency of pulmonary tuberculosis infections within DCTRD Oujda.
- Determine the age group most affected by pulmonary tuberculosis.
- Knowledge of means of diagnosis of pulmonary tuberculosis.
- Determine the age group most affected by silicosis.
- Determine the sex ratio in the patients studied.

2. General information on pneumoconiosis and silicosis

The professional air environment can be responsible for various respiratory diseases (Ben M'rad *et al.*, 2004). A large number of professional activities expose people to repeated and prolonged inhalation of aggressive substances which induce the appearance of so-called "occupational" diseases'' (Grignet, 2011).
In general, the activities at risk remain those relating to work in the mines. At this level, despite better awareness, so-called "airway obstruction" diseases, such as pneumoconiosis (silicosis and asbestosis), continue to claim victims. (El ghazi, 2012).
Pneumoconiosis is the most common occupational diseases. The difficulty of implementing preventive measures means that these conditions continue to increase in our country, affecting multiple sectors of activity and in this case the mining sector. (Ben M'rad *et al.*, 2004). The mining sector in Morocco is

considered one of the pillars of the economy; thus, many minerals are exploited: phosphate, coal, silver, gold, zinc, copper…. etc. The contribution of the mining sector to national exports amounts to an annual average of 30%, driven by phosphate. The mining sector provides a quarter of Moroccan exports, contributes 10% of the national GDP and employs around 40,000 people (Akoudad, 2015).

Occupational lung diseases are caused or aggravated by exposure to harmful substances in the workplace. "Pneumoconiosis" is the term used for diseases associated with the inhalation of mineral dust. Although many of these broad-spectrum substances can be found in the general environment, many of them are present in greater quantities in the workplace due to industrial processes; therefore, a range of pulmonary reactions may occur following workplace exposure (Karkhanis & Joshi, 2013).

Pneumoconiosis is set in slowly and varies according to the nature of the particles. For example, silica dust (SiO_2) can cause silicosis, while asbestos fibers can develop asbestosis. The retention of particles in the respiratory system will lead to different types of reactions depending on the nature of the particles (Benhassine & Bensekhira, 2012).

Pneumoconiosis can be active, progressive and fibrosing leading, like silicosis, to progressive massive fibrosis. Or be inert and non-fibrogenic, which are less severe performing a simple lung tattoo. However, certain professions, such as dental technicians, iron coal miners, etc., are exposed to multiple pneumoconiosis risks (mixed pneumoconiosis). Pneumoconiosis lesions grow slowly and silently; and it is very difficult to demonstrate a cause-and-effect relationship because of this latency between exposure and pathological manifestations (El ghazi, 2012).

When inhaling a mixture of particles of variable harmfulness, in the workplace we speak of mixed pneumoconiosis: the most common is coal miners' pneumoconiosis, linked to the retention of mineral dust of complex composition, containing the free silica in variable concentration (Tiokeng, 2010). Silicosis is a chronic respiratory disease attributable to the inhalation of free particles of crystalline silica (INSPQ, 2012).

Anthracic-silicosis is coal miner's pneumoconiosis; it is mixed because secondary to the inhalation of silica and carbon particles. Silicosis is linked to the inhalation of dust containing silica dioxide crystals. The most common and purest form of crystalline silica is quartz. Other forms of silica dioxide are cristobalite and tridymite. Silica is ubiquitous and found in coal mines (Chahboun, 2020).

Whatever their origin, they stem from the same pathophysiological mechanism; retention of foreign particles within lung tissue. Two parameters characterizing aerosols are particularly important: the particle size and the nature of the particles. The risk of silicosis is related to the duration and intensity of exposure, as well as the geometry, aerodynamic, chemical and surface properties of the particles influence. Those capable of inducing silicosis are small enough (spherical from 0.5 to 5 µm) to reach the bronchioles and settle there. There is also an individual susceptibility; two individuals exposed throughout their working lives to the same dust conditions develop lesions of different severity (Tiokeng, 2010).

These particles with a diameter greater than 5 µm will be able to benefit from rapid mucociliary purification. Particles with an aerodynamic diameter of less than 5 µm reach the exchange zone: respiratory bronchioles and alveoli, these particles will be phagocytosed by alveolar macrophages and, for the most part, be conveyed to the pulmonary interstitial then be drained to the lymphatics; this process lasts several months or years (El ghazi, 2012).

The elimination of particles deposited at the alveolar level is slow and lasts for several years: in coal miners for example, the alveolar macrophages taken 10 to 15 years after the end of exposure to the risk, always contain mineral particles in quantity important (Tiokeng, 2010). The development of tissue le-

sions characteristic of silicosis and pneumoconiosis involves complex biological mechanisms, the starting point of which is the macrophage response to the phagocytosis of dust inhaled in the workplace (Tiokeng, 2010). Macrophage alveolar alveolitis is a reaction characterized by the retention of fibrotic mineral dust. Alveolitis is defined as an increase in the number of activated alveolar macrophages, which release large quantities of mediators: oxidants, chemotaxis, fibroblast growth factors.

Fibroblast growth factors move into the interstitial where they induce fibroblast replication and increase collagen production. Fibroblasts move, organize themselves and settle in the form of a fibrous tissue around the fine particles, thus forming nodules of scar tissue in the lungs, responsible for disruption of the broncho-alveolar and vascular architecture leading in the long term to pulmonary sclerosis. The accumulation of scar tissue affects gas exchange and eventually leads to dyspnea (El ghazi, 2012).

Silicon and oxygen are the most abundant elements in the earth's crust, mainly in the form of silica (silicon dioxide, SiO_2) and silicates (complex compounds formed between silica and various cations or their oxides). Silicon dioxide is often referred to as free silica while silicates are sometimes referred to as "combined silica". The distinction between the two is important because it is the free silica whose inhalation causes the significant fibrous lesions. Crystalline silica exhibits a tetrahedral structure in which each tetrahedral unit (SiO_4) contains a central silicon ion connected to the four oxygen ions occupying the vertices of the tetrahedron. All forms of crystalline silica exhibit a pathogenic effect. The word “silica” is systematically used to designate free crystalline silica (WHO, 1986).

The list is long but in Morocco specific trades are exposed to silicosis, namely:

- Masonry: masons working on a construction site or on their own account.
- Well diggers: traditional, often associated with the profession of Fellah, or modern using sounding to dig wells (MDSSEFP, 2000).

Generally, silicosis is slow and progressive onset, the diagnosis is based on the notion of the history of exposure, the clinic and radiology.

The functional signs often set in after a latency period, without clinical signs of appeal, while the radiological signs are already present, this period can last from ten to thirty years. The general condition has been preserved for a long time. Its alteration suggests the occurrence of a complication such as neoplasia or infection. (El ghazi, 2012).

The chest X-ray represents an essential step allowing the detection of the disease before the appearance of clinical symptoms. Radiological signs are the basis of the diagnosis of pneumoconiosis. The reference examination remains the standard frontal chest X-ray. The elementary radiological lesions observed during silicosis are round, micro-nodular or nodular opacities, usually bilateral and symmetrical, predominant in the middle and upper thirds of the two pulmonary fields. They are characterized by their size, profusion and extension. They can evolve towards a confluence and produce large opacities, pseudotumoral (Tiokeng, 2010).

The detection of particles in the sputum or in the bronchoalveolar lavage fluid is constant during mixed dust pneumoconiosis. Their presence reflects the durability of alveolar purification. However, it cannot constitute a diagnostic argument in the absence of a characteristic radiological image. (Tiokeng, 2010).

Tuberculosis is the greatest radiological imitator, that is to say capable of resembling almost all other lung diseases; yet there are several highly suggestive radiological features. On the chest X-ray, tuberculosis activity is evidenced by parenchymal, nodal or pleural abnormality with or without associated calcification (Leung, 1999). The explanation seems to be the greater intra-alveolar oxygen pressure favorable to Koch's bacilli (Meyssonnier, 2012). Confirmation of these results is based on microscopic identi-

fication of acid-fast rods and culture of bacteria. Mycobacteria, due to the structure of their wall, are not stained by the usual dyes such as those used for Gram staining. They are colored by fuchsin or auramine and retain these dyes despite the joint action of acid and alcohol. They are called Bacillus Acid-Alcohol Resistant (BAAR). The sample must be taken before instituting anti-tuberculosis treatment. This represents the major drawback of this technique for the serial observation of new smears. The Mycobacteria appear as fine, more or less regular bacilli; roses on a blue, blue-green background (Niansan, 2017).

The bacteriological diagnosis of tuberculosis is made when the positivity of the biological sample has been established by smear microscopy, culture or other tests approved by WHO. Culture has a higher sensitivity than direct examination of sputum under a microscope.

Culture media are used which are rich in nutrients and promote the growth of most species of mycobacteria. Löwenstein-Jensen medium is a selective egg-based medium specially used for the cultivation and isolation of Mycobacterium species, including Mycobacterium tuberculosis, from clinical specimens. Colonies of Mycobacterium tuberculosis grow on average between 21 to 28 days during the first culture (Niansan, 2017). The cultures are declared positive when the established colonies appear after microscopic verification of AFB. The results are expressed quantitatively in number of colonies per tube (Manual cultural mycobacteria., 2017).

The GenXpert MTB/RIF Test is a system that can detect MTB DNA and mutations that confer resistance to RIF in less than two hours (Helb *et al.*, 2010). According to the same organization, the number of workers dying each day from work-related illnesses "runs into the hundreds". The WHO also adds that between 40 and 50% of the world's active population is exposed to the risk of occupational disease, and the situation is tending to worsen, since nearly 68 million new cases appear each year.

Along the same lines, another report published by the International Labor Office (ILO) highlights the seriousness of the problem in developing countries. The low number of statistical studies, combined with illiteracy and poverty, on the one hand, and the predominance of the informal sector on the other hand, make it difficult to determine the situation of silicosis (El ghazi, 2012).

Silicosis in Morocco is not a new occupational pathology, since the legislation concerning this subject has been instituted for a long time. The Dahir of Jumada I (26, 1382) (May 31, 1943) established a table of occupational diseases, where silicosis is found under number 29, recognized when there are radiological signs accompanied by disorders confirmed by Respiratory Function Tests (RFT). This legislation has undergone constant development. Currently, the compensation of pneumoconiosis is governed by the decree, of the Minister of Labor and Social Affairs, number 101-68 which dates from May 20, 1967, published in the official bulletin number 2899 of May 22, 1968 (El ghazi, 2012).

In 2013, of all the 403 occupational diseases declared in Morocco, silicosis accounted for almost 90% (Chahboun, 2020). Tuberculosis and mycobacteria show increased frequency and severity in subjects with silicosis or mixed dust pneumoconiosis. All forms of the disease can be observed, regardless of the radiological stage of pneumoconiosis, with a high frequency of ulcerative-caseous lesions. Revealed by an alteration in general condition, an unexplained infectious state, hemoptysis, or by the development of suggestive radiological abnormalities, the recognition of this complication is based on the demonstration of the tubercle bacillus or atypical mycobacteria, in the sputum or in secretions taken by fibroscopy in suspect territories. These bacteriological investigations must be implemented and if possible repeated three times before the start of anti-tuberculosis treatment. (Tiokeng, 2010).

Tuberculosis is a chronic bacterial disease caused by slow-growing aerobic bacteria. It generally affects the lungs but can also affect other parts of the body such as the brains, intestines, kidneys, etc. (Zaman,

2010). The mycobacterium most often at the origin of human tuberculosis is *Mycobacterium tuberculosis* (or Koch's bacillus isolated by Robert Koch in 1882), which is part of the mycobacteria of the tuberculosis complex also including: *Mycobacterium bovis, Mycobacterium africanum, Mycobacterium microti* and *Mycobacterium canettii.* (Van Ingen *et al.*, 2012).

Mycobacterium bovis is responsible for tuberculosis in domestic and wild bovids. It can be transmitted to humans through unpasteurized or unboiled milk (Brosch & Guilhot, 2015).

M tuberculosis only exists in the human species, but can be transmitted from humans to pets such as dogs or cats (Souidi, 2014). It needs oxygen to grow, does not produce spores and is immobile. *M. tuberculosis* divides every 18 to 24 hours. This is extremely slow compared to other bacteria, which tends to have division times measured in minutes *(Escherichia coli* divides every 20 min).

M. tuberculosis is a small bacillus that can withstand weak disinfectants and can survive dry for weeks. Its unusual cell wall is rich in lipids such as mycolic acid, is likely responsible for its desiccation resistance and is a key virulence factor (Murray *et al*., 2016). This mycolic acid does not absorb Gram stains, so other acid fasts such as Ziehl-Neelsen stain or fluorescent stains are used, (Cudahy & Shenoi, 2016).

Recently, many studies have focused on the impact of vitamin D deficiency or deficiency on the increased risk of developing tuberculosis (Kelechi & Aileen, 2008).

Tuberculosis bacteria spreads through the air from person to person with humans. When a person with pulmonary tuberculosis coughs, talks or sings, a droplet containing the bacteria is deposited in the air, and when a person breathes in the bacteria, the bacteria can settle in the lungs and begin to multiply (CDCTB, 2016). The droplets emitted by these patients are transformed into microscopic nuclei (1 to 10 micrometers) remaining suspended in the ambient air for a long time (Souidi, 2014). When it reaches the lungs, it cannot be killed and digested by alveolar macrophages before being phagocytosed (Keane *et al*., 1997).

More recently, *M. tuberculosis* has been shown to secrete and coat itself with 1-tuberculosinyladenosine (1-TbAd), a special nucleoside that acts as an antacid, allowing it to neutralize pH and cause swelling of lysosomes preventing fusion with the latter, which contains a multitude of antibacterial factors. Therefore, the bacteria multiply unchecked in the macrophage (Weijie *et al*., 2019). Then the apoptic pathway in the macrophages is controlled by the bacteria causing the suppression of apoptosis. This provides M. tuberculosis with a good replication condition so the bacterium is able to maintain a latent state for an extended period of time (Schaaf *et al*., 2017). Signs and symptoms suggestive of TB include: Severe cough that lasts 3 weeks or more; Chest pain; Hemoptysis, sputum (Productive cough); Asthenia; Weight loss; Anorexia; Chills; Pyrexia; Night sweats (Ait-Khaled & Enarson, 1999). The first penetration of the KOCH bacillus into an unaffected organism will constitute the Primary Tuberculosis Infection (PTI) ("Tuberculosis Control Guide," 2011). The inhaled bacilli will cause a cell-type immune reaction that results in the formation of a granuloma or inoculation chancre. This immune response develops within 2 to 6 weeks of infection and results in positive tuberculin reactions. Primary tuberculosis infection is usually clinically silent. For a certain number of subjects only, it can lead directly to tuberculosis disease in 5 years: 6% of children under five years old and 9% of 10- to 25-year-olds. For another group of subjects, tuberculosis disease will appear from quiescent tuberculosis foci, contemporaneous with the primary infection, after a more or less long delay (reactivation of dormant lesions). This primary infection may be responsible for general signs, respiratory symptoms and/or radiological abnormalities (Souidi, 2014). The risk of the onset of the disease, apart from any immunosuppression, is estimated

between 5 and 10% in the years following infection, then 5% for the rest of life. This disease follows either a primary infection, or a reactivation of dormant post-primary lesions, or most often a reinfection. However, it would seem that the risk of progressing to a disease after reinfection is five times lower than during a first infection. It is currently well established that the risk of progressing to the disease is completely modified in the case of a HIV infection (Human Immunodeficiency Virus): It would seem to be around 30% (Bendada, 2003). Patients with latent Tuberculosis infection have the bacteria in their body but usually do not show symptoms because the bacteria are not active. If the bacteria become active and multiply, the symptoms of tuberculosis will become evident in the patient. For this reason, patients with known latent tuberculosis are prescribed preventive pharmacological interventions.

The drugs currently used for the treatment of latent tuberculosis are isoniazid, rifampicin and rifapentine (CDC, 2021).

Treatment regimens for non-resistant tuberculosis have an initial phase of 2 months, followed by a continuation phase of 4 to 7 months in general. The 6-month regimen consists of Isoniazid, Rifampicin, and Pyrazinamide given for 2 months, followed by Isoniazid and Rifampicin for 4 months. Ethambutol or streptomycin is added during the first 2 months in patients with advanced disease. The success rate with the 6-month regimen in sputum conversion (conversion defined as a negative culture in 3 consecutive samples taken 1 day apart) is well over 90% during the first two months of treatment. Relapse rate after 3 to 5 years about 0-3% (WHO, 1997).

It is very important to complete the treatment regimen because the bacteria could still be active and become resistant to these first-line drugs if the treatment is stopped prematurely. For this reason, physician supervision and follow-up become important to ensure patient compliance (Brode *et al*., 2015).

Tuberculosis is a major cause of morbidity and mortality in many countries around the world. About one third of the world's population is infected with Mycobacterium tuberculosis. According to the 2012 WHO annual report, the global incidence rate of TB is globally decreasing (Mjid *et al*., 2015).

According to the WHO (2020), around 10 million people fell ill with tuberculosis in 2019 worldwide, a number that has been decreasing very slowly in recent years. The TB report revealed that in 2020 some 1.5 million people died from TB, more than in 2019 (UN, 2021). Drug-resistant tuberculosis continues to pose a threat to public health. Worldwide in 2019, nearly half a million people developed rifampicin-resistant tuberculosis, 78% of whom had multidrug-resistant tuberculosis (WHO, 2020).

Due to the novel coronavirus pandemic, “challenges” that have made it impossible to provide and access essential TB services have left many people undiagnosed in 2020. Worryingly, WHO noted that the number of people newly diagnosed with the disease fell from 7.1 million in 2019 to 5.8 million in 2020, meaning far fewer people were diagnosed, treated or received preventive treatment for TB compared to 2019. Overall spending on essential TB services has also declined, WHO said, adding that the countries that saw the biggest drop in TB notifications between 2019 and 2020 were India (minus 41%), Indonesia (14%), the Philippines (12%) and China (8%), 2021). Morocco is unfortunately no exception to this trend; with an incidence of 82 new cases per 100,000 inhabitants per year. Tuberculosis in Morocco is mainly concentrated in urban areas, around the country's major cities (Casablanca, Sale, Fez, Tangier, Tetouan, Kenitra and Inzgane).

The incidence of tuberculosis in Oujda Angad has remained relatively stable (around 10 cases per 100,000 inhabitants). Men are the most affected, 57% against 43% among women. It generally develops in young adults aged between 15 and 45 from the most disadvantaged social classes (Souidi, 2014).

3. Materials and Methods

1. Collection of data

For each patient suspected of tuberculosis, two sputa are collected in two days:

- A first sputum collected on the day of the consultation, outdoors, away from other patients; A second sputum collected the next day by the patient himself on waking, on an empty stomach;
- The laboratory staff must explain to the patient the procedure to follow in order to produce a quality sputum. Put the subject in confidence by explaining the reasons for this examination.
- When the patient arrives with the examination request form, give him a hermetically sealed spittoon, clearly identified with the patient's surname and first name, indicating sample number one. Always identify the spittoon on its wall and no on the lid.
- An examination request form must accompany each sample. The information entered on the form must be the same as that on the spittoon.
- Collect the spittoon and check the quantity and quality of the sample.
- Note the appearance of the sputum on the examination request form.
- Noting that saliva and nasopharyngeal discharges are not considered ideal specimens. Nevertheless, they must be examined.
- Give the second well-identified spittoon with the patient's surname and first name, indicating sample number two.

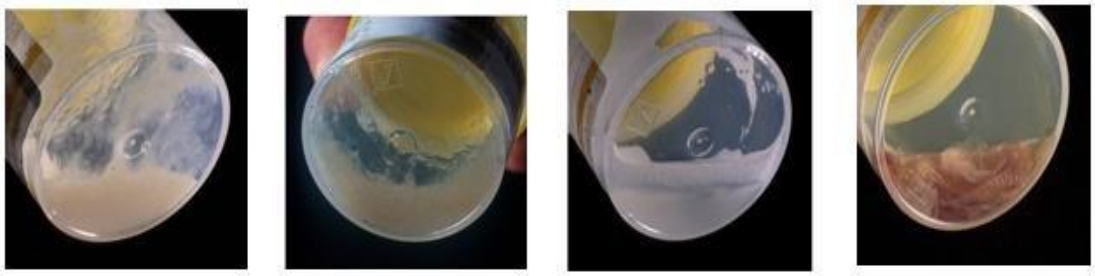

Figure 1: Sputum from left to right, purulent, mucosal, salivary, hemorrhagic sample.

2. Practical technique

- Type of study: Retrospective descriptive.
- Mode of investigation : Quantitative approach.
- In this study, the data is collected using an exploitation grid, which allowed us to better exploit the registers and the database to obtain information on the positive cases of tuberculosis and the cases of silicosis. This information will help us to classify them, thus to draw conclusions on these diseases in eastern Morocco. The data obtained was processed in an Excel file and transformed into representative graphs and tables.
- 400 patients registered in the registers, between the years of 2018 until 2021, for pulmonary tuberculosis.
- 50 silicosis patients registered in the registers, and who are undergoing medical follow-up.
- The number of bacilli observed in a smear reflects the severity of the disease and the contagiousness of the patient. It is therefore important to note the number of bacilli observed on each smear. The table below shows the method of scoring results.
- Reading is done under an optical microscope using the 100x objective; BAAR appear in the form of red sticks, fine straight or curved, with regular or grainy coloring,

Table 1: Interpretation of slide results (Ziehl-Neelsen).

Number of BAAR observed	Champs examined	Responses to declare
0 BAAR	300 fields	Negative
1-9 BAAR	100 fields	Weak positive
10-99 BAAR	100 fields	1+
1-10 BAAR	50 fields	2+
More than 10 BAAR	20 fields	3+

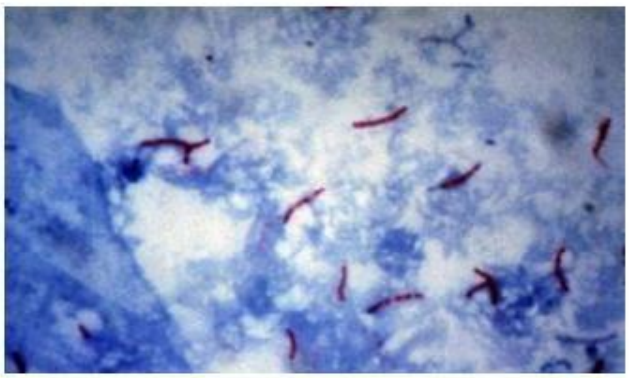

Figure 2: Microscopic image of BAAR by coloration to Ziehl-Neelsen

- Cultivation of mycobacteria by the Petroff method: The process consists of treating the sputum in order to eliminate the associated undesirable flora, this is based on the high resistance of the tubercle bacillus to the various chemical agents (NaOH, H_2SO_4 and detergents) which destroy the other germs contained in sputum. The processing of samples requires several steps which expose to risks of contamination between samples processed in the same series. Precautions should be taken to prevent and minimize this risk.
- The samples, stripped of any associated flora, are inoculated on specific media for tuberculosis bacilli, meeting their nutritional requirements, solid Löwenstein-Jensen, then incubate the tubes, lying in an inclined position.

Figure 3: Seeding and incubation of mycobacteria on the medium Lowenstein-Jensen.

The GeneXpert MTB/RIF test; the result appears on the screen in less than two hours. The latter is interpreted by GeneXpert from the measurement of fluorescent signals and integrated calculation algorithms

gorithms. The result is semi-quantitative on the presence of *M.tuberculosis* complex DNA and indicates the detection, or not, of resistance to rifampicin.

- The MTB result will be displayed as high, medium or very low depending on the Ct (Concentration) value of the MTB target present in the sample (Drug Susceptibility Testing Manual, 2017).

Table 2: Semi-quantitative result of GeneXpert.

MTB Result	Gamme Ct
High	<16
Medium	16-22
Low	22-28
Very Low	>28

3. Results and discussions

a. Silicosis of former coal miners (Jerada).

- Distribution of former coal miners according to age of declaration: for a sample of 50 cases of silicotics, they were all male and from the province of Jerada with the following characteristics: Age of declaration of the disease to these former coal miners is between 23 and 69 and peak frequency between 30 and 39 years.

Table 3: Distribution of patients according to reporting age.

Age groups	Number of cases	Percentage
20-29 years	2	4
30-39 years	**14**	**28**
40-49 years	12	24
50-59 years	12	24
60-69 years	10	20
Total	50	100

- Distribution of former coal miners according to duration of exposure: In our study, we note that the average duration of exposure to silicogenic risk is around 14 years, and a peak frequency is between eleven and twenty years. The short but dangerous exposure duration, limited to one year, affects four cases.

Table 4: Distribution of patients according to the duration of exposure.

Exposure time	Number of cases	Percentage
1-10 years	18	36
11-20 years	**19**	**38**
21-30 yeas	13	26
Total	50	100

- The duration of follow-up and care is between one year and 50 years, with a peak frequency between 20 and 29 years. This explains the long duration of care, in fact, in the absence of curative treatments

for serious illnesses linked to exposure in the workplace, essentially silicosis, and the existence of few or no prognostic factors that indicate on the evolution of a respiratory disease of occupational origin, prevention and compliance with working conditions are essential in all professional sectors where the employee is exposed to particles that are dangerous to his health.

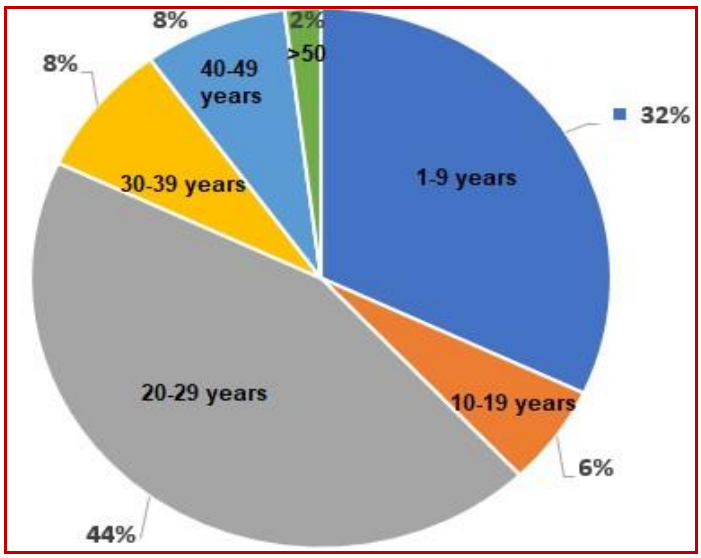

Figure 4: Distribution of silicosis according to the duration of follow-up and treatment by the silicosis service within the CDTMR Oujda.

b. Pulmonary tuberculosis in eastern Morocco

- Distribution of pulmonary tuberculosis according to sex: Pulmonary tuberculosis is more common in men (71.42%) than in women (28.57%), with a sex ratio (male/female) of 2.49.

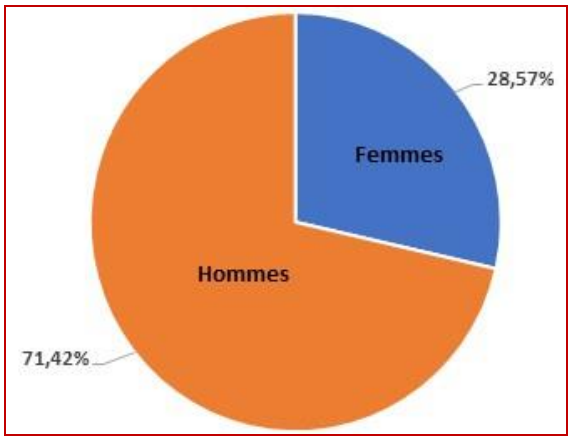

Figure 5: Distribution of pulmonary tuberculosis according to sex (CDTMR Oujda)

- Distribution of pulmonary tuberculosis according to age: Over the period of one month, the male/female sex ratio of cases of pulmonary tuberculosis was 2.33. The most affected age group is between 30 and 39 years old.
- Distribution of patients according to the result of the search for Mycobacterium tuberculosis by the Ziehl-Neelsen technique, shows a positivity rate in 2020 and in 2021 higher than the standard declared by the WHO which is 5% ("Guide Lutte Anti Tuberculosis," 2011). The rate of positive slides

was 8.89% in 2020.

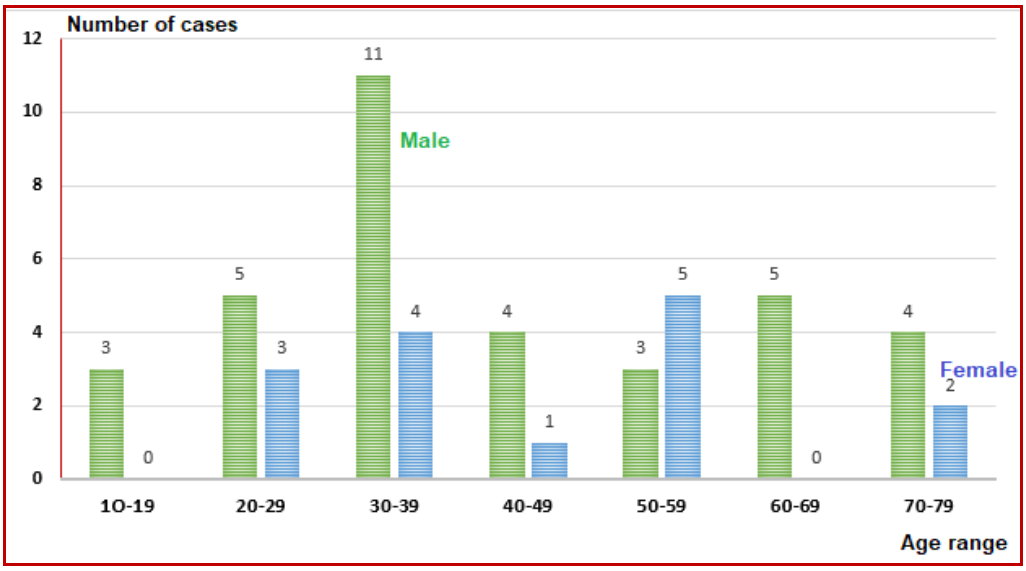

Figure 6: Distribution of pulmonary tuberculosis according to sex and age group in Oujda.

Table 5: The positivity rate of slides from the Oujda Anti-Tuberculosis Laboratory

Years	Blades tested	Number and percent
2014	Total slides	5200
	Positive slide	185
	Positivity rate	3,55%
2015	Total slides	4245
	Positive slide	177
	Positivity rate	4,17%
2016	Total slides	4157
	Positive slide	125
	Positivity rate	3%
2017	Total slides	4130
	Positive slide	115
	Positivity rate	2.78%
2018	Total slides	4451
	Positive slide	135
	Positivity rate	3.03%
2019	Total slides	3277
	Positive slide	156
	Positivity rate	4,76%
2020	Total slides	3867
	Positive slide	344
	Positivity rate	**8.89%**
2021	Total slides	2684
	Positive slide	187

	Positivity rate	**6.96%**

From a sample of 400 individuals (100 individuals for each year), from 2018 to 2021 we were able to draw these results. We note a high positivity rate for the years 2020 (67%) and 2021 (52%).

Table 6: GeneXpert activities of the Oujda Anti-Tuberculosis Laboratory

Years	Positives	Negatives	Positivity rate
2018	47	53	47%
2019	33	67	33%
2020	67	33	67%
2021	52	48	52%

Silicosis is caused by the inhalation of respirable crystalline silica and has been recognized as a separate disease since the late 19th century. However, silicosis prevention efforts continue because silicosis is still present worldwide, even in developed countries (Calvert *et al*., 2003). Silicosis is the most common occupational pneumoconiosis disease. It is one of the oldest known occupational pathologies and kills thousands of people every year all over the world. Crystalline quartz, also called free crystalline silica (SiO_2), is considered the most widespread crystalline form of silicon dioxide. Several trades expose to the inhalation of free silica particles and the occurrence of pulmonary pathologies. For this, several epidemiological surveys have been carried out among underground miners, tunnel boring workers, slate workers, metallurgy workers, polishers and porcelain, earthenware, glass and ceramic workers (Elidrissi, 2016).

According to the results of our study, we find that all of the patients who are former coal miners are male from Jerada, this is linked to the fact that the profession is exclusively exercised by men. The age of declaration of the disease of silicosis is between 23 and 69 years; this can be explained by the fact that pneumoconiosis are slow onset conditions, appearing after many years of exposure. We note that it is mainly young adults, an economically active segment, who are affected. The maximum frequency is observed in patients between 30 and 39 years old. For the study by (Chahboun, 2020) conducted on the silicosis of Jerada, they found that the age of former coal miners is between 21 and 67 years old. A work done on silicosis well diggers in Morocco in Casablanca, they are also all male, with an average age of 50 years and extremes ranging from 34 to 82 years (Elidrissi, 2016). These results are close to those of the work carried out among well diggers who suffer from the same disease in Mali, finding an age interval of declaration ranging from 33 to 66 years (Tiokeng, 2010).

According to Souidi's results, coal miners in Jerada are affected at a relatively early age (32 years) (Souidi, 2014). The average duration of exposure to silicogenic risk in our study is about 14 years, with a peak frequency between 11 and 20 years. These results are similar to that of Souidi who showed an average duration of 13 years; exhibition of silicotics in Jerada. Studies carried out on well diggers, Tiokeng (Mali) observed a duration of exposure ranging from 2 to 34 years (Tiokeng, 2010), while the average duration of exposure of well diggers in Casablanca was 13 years (Elidrissi, 2016). It is noted that there is a significant duration of exposure and this causes an accentuation of the disease especially when a young worker engages in these mining works until his retirement. Unfortunately, most of the time, although presenting signs, almost all patients only go to the hospital when these signs worsen, leading to a limitation of their daily activities (Tiokeng, 2010).

In Elidrissi's study of well diggers in Morocco, smoking was found in 66% of cases (Elidrissi, 2016). Thus 76.5% of silicotic patients in Mali; all consumed tobacco in the form of cigarettes and a minority used chewing tobacco in addition (Tiokeng, 2010).

And according to data from the literature, smoking silicotics have a higher risk of developing lung cancer compared to non-smoking silicotics (Westerholm *et al.*, 1986).

According to our results, we see that the duration of follow-up and care is between one year and 50 years, with a peak frequency between 20 and 29 years. Silicosis is an incurable, chronic and progressive disease. There is no effective treatment to reverse the lesions or slow their progression; efforts therefore remain focused on the 3 levels of primary, secondary and tertiary prevention. In case of failure of prevention, and development of silicosis, the treatment is mainly aimed at the complications of the latter. Therapeutic measures are the same as those commonly used to treat airway obstruction, infections, pneumothorax, hypoxia, and respiratory failure complicating other respiratory diseases. Like any chronic, debilitating disease, respiratory rehabilitation plays a key role in the management of silicosis and aims to improve patient participation and quality of life (Chahboun, 2020; Hajjioui & Fourtassi, 2019; Souidi, 2014).

In the absence of primary prevention, it is not possible to eliminate silicosis, or reduce its incidence. We must not forget that when silicosis is identified on the x-ray, it is too late: the lung does not will never return to its normal state. Indeed, it is essential to assess the consequences of exposure to silica dust, and to take appropriate measures. It can be carried out by using ventilation, suction and water spraying systems at the dust production stations.

You can also reduce the number of hours of exposure.

The effectiveness of such measures can be monitored by regular measurements of dust concentrations in the air. Regular clinical and radiological monitoring of exposed personnel is imperative, allowing early detection of pneumoconiosis and professional reorientation towards less exposed positions.

Environmental lung diseases result from inhaling dust, allergens, chemicals, gases or environmental pollutants. Respiratory rehabilitation is a comprehensive care of patients involving a multidisciplinary team (doctors, physiotherapists, nurses, psychologist, nutritionist, occupational therapists, etc.) to improve the quality of life of patients (Hajjioui and Fourtassi, 2019).

Tuberculosis is one of the deadliest diseases in the world, representing the 13th leading cause of death and the second due to an infectious disease, behind COVID-19 (and before AIDS). This mortality rate is aggravated by the emergence of antibiotic-resistant strains. The WHO estimates that 35 million will die from tuberculosis between 2000 and 2020 if no improvement is made in the control of this infection (WHO, 2012)

Table 7: The sex of tuberculosis patients according to the literature

Studies	place of study	Sex	
		Male	Female
Our study	CDTMR Oujda	71,42%	28,57%
(Jebari, 2021)	Tanger (Maroc)	61 %	39%
(Bentaier, 2020)	El Kelaâ of Sraghna (Maroc)	78%	22%
(Larbani *et al.*, 2017)	Algeria	66%	34%
(Ben Amar *et al.*, 2016)	Tunisia	68,80%	31,20%

Out of a population of 400 patients (100 patients for each year from 2018 to 2021), our study shows a predominance of the male sex (71.42%) with a sex ratio M/F of 2.49. This agrees with data from the literature that studies show a male predominance. This male predominance can be explained by the high

consumption of tobacco in men compared to women. Risk factors associated with this disease such as poor living conditions, poor diet and overcrowding. This means that TB rates are higher in large cities, where these problems are more common. Migrants as well as socially marginalized people are particularly vulnerable.

This disease is linked to the social determinants of health, namely the conditions in which we live and work. From a sample of 35 cases during the month of January 2021, the average age of the patients was 39 years old (range 10 to 79 years old). More than half of them belonged to the age group between 21 and 40 years old. These results are consistent with data from the literature highlighting that tuberculosis mainly affects young adults, hence its economic impact. It can be concluded that tuberculosis affects the most active population of society.

In 2018 the age distribution in Morocco showed that tuberculosis predominates among people between 15 and 44 years old, with a percentage of 60%. This selection of active population induces a very significant economic impact which is summarized by the loss of income throughout the duration of treatment in addition to the costs of diagnosis and management of the disease.

This confirms data from the literature that tuberculosis is "a disease of the poor" (Jebari, 2021; Sbayi *et al*., 2020; Piersimoni *et al*., 2006).

Table 9: The medium age of tuberculosis patients according to the literature.

Studies	Our study	(Bentaier, 2020)	(Larbani *et al*., 2017)	(Ben Amar *et al*., 2016)
Medium Age	39 years	39 years	52 years	42 years

In our study, the distribution of patients according to the result of the search for *Mycobacterium tuberculosis* by the Ziehl-Neelsen technique, shows a high positivity rate in 2020 and 2021, the rate of positive slides was 8.89% in 2020 and 6.96% in 2021. As well as the results of GeneXpert, show a high positivity rate in 2020 (67%) and in 2021 (52%). There is a concordance between the results of the direct examination and the GeneXpert since both showed a high positivity rate for the years 2020 and 2021.

A study carried out in sub-Saharan Africa, more precisely in the east of the Democratic Republic of Congo, its aim was to evaluate the performance of the GeneXpert MTB/RIF with respect to conventional Ziehl-Neelsen microscopy after 10 months of use. The present study confirms the superiority of GeneXpert MTB/RIF over Ziehl-Neelsen staining in the detection of tuberculosis and in the prediction of multidrug resistance. Its systematic use coupled with Ziehl-Neelsen would allow better control of tuberculosis in sub-Saharan Africa (Lupande *et al*., 2017). Another study in Tunisia confirms that the GeneXpert test detected a greater proportion of the M. tuberculosis complex. It does not replace conventional diagnostic methods but is a useful complement to obtain better sensitivity and rapid results (Marouane *et al*., 2016).

Over the past 10 years, Morocco has recorded an average rate of therapeutic success of 87%, while the world average rate is 82%. The appearance of multi-resistant strains remains a public health crisis and a threat to health security. A total of 206,030 cases of multidrug resistant tuberculosis or rifampicin-resistant tuberculosis were detected and notified worldwide in 2019, an increase of 10% compared to the 186,883 cases recorded in 2018. 530 cases of resistant tuberculosis and multi resistant notified in Morocco in 2018 (Jebari, 2021).

4. Conclusion

Despite the shutdown of the Jerada mine, complications due to silicosis continue to appear on miners despite the end of exposure. Our study, even if it concerns only a small number of people, we have drawn conclusions concerning the suffering and the quality of life in silicosis.

Tuberculosis is a contagious infectious disease whose causative agent is *Mycobacterium tuberculosis*; pulmonary tuberculosis is the most common localization. This work makes it possible to mention that in the eastern region of Morocco, pulmonary tuberculosis is more common in men than in women. The average age of the patients was 39 years.

GeneXpert, bacilloscopic and culture are diagnostic methods for pulmonary tuberculosis. Bacilloscopic highlights the presence of all Mycobacteria, tuberculous and nontuberculous. Indeed, GeneXpert detects bacteria of the *Mycobacterium tuberculosis* complex so it is more specific and also has the advantage of detecting resistance to rifampicin. Knowledge of means of diagnosing pulmonary tuberculosis allows better treatment efficiency and reduces the occurrence of resistance.

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