**Title: Silico-tuberculosis amidst COVID-19 Pandemic: Global Scenario and Indian Perspective**

**Author details**

Mainak Bardhan1**,** Shubhajeet Roy2, Utkarsh Singh2, Timil Suresh2, Priyanka Roy3\*

**Affiliations:**

1**Mainak Bardhan,** Indian Council of Medical Research(ICMR), India, email: [bardhan.mainak@gmail.com](mailto:bardhan.mainak@gmail.com)

2**Shubhajeet Roy,** MBBS Final Year Student, Faculty of Medical Sciences, King George’s Medical University, Lucknow, India **Email:**[shubhajeet5944.19@kgmcindia.edu](mailto:shubhajeet5944.19@kgmcindia.edu) ORCID: 0000-0003-1092-9668

2**Utkarsh Singh,** MBBS Final Year Student, Faculty of Medical Sciences, King George’s Medical University, Lucknow, India. **Email:** [utkarsh0058.19@kgmcindia.edu](mailto:utkarsh0058.19@kgmcindia.edu)

ORCID: 0000-0001-9229-2394

2**Timil Suresh.** MBBS 3rd(1) Year Student, Faculty of Medical Sciences, King George’s Medical University, Lucknow, India. **Email** [limitunsure131@gmail.com](mailto:limitunsure131@gmail.com) ORCID**:** 0000-0002-4988-9053

3\***Priyanka Roy,** Deputy Chief Inspector of Factories/ Deputy Director (Medical) and Certifying Surgeon

Directorate of Factories, Department of Labour, Government of West Bengal, Email: [priyankaroysskm@gmail.com](mailto:priyankaroysskm@gmail.com)

**Corresponding author**

3\***Priyanka Roy** MBBS, MPH, MOSH, PhD

Deputy Chief Inspector of Factories/ Deputy Director (Medical) and Certifying Surgeon

Directorate of Factories

Department of Labour

Government of West Bengal

Email: [priyankaroysskm@gmail.com](mailto:priyankaroysskm@gmail.com)

**Abstract:**

**Purpose**: Inhalation of crystalline silica-rich dust particles can result in the deadly occupational lung disorder called silicosis. The risk of contracting tuberculosis and the potential for lung cancer increase as a result of silicosis. This review article aims to bring to light the state of Silicosis and TB scenario in the world and India for evaluating hurdles in the present and future to achieve the elimination road map, and assess these conditions in the backdrop of the COVID-19 pandemic.

**Methods:** A PubMed Central search was conducted using the keywords “silico-tuberculosis” and “prevalence” and the time period of the last 20 years, which yielded 15 studies, out of which only the following were found to be relevant in terms of exemplifying the prevalence of Silico-tuberculosis at various geographical locations around the world.

**Results:** A patient with silicosis has a 2.8-2.9 times higher risk of developing pulmonary tuberculosis and 3.7 times that of extrapulmonary tuberculosis. Incidences of missed cases when tuberculosis was misdiagnosed with silicosis due to indifferent clinical manifestations of the two in the initial stages aren’t uncommon. The duration of exposure to silica and the severity of silicosis, have a direct relation with the propensity to develop tuberculosis. As per a study, an average gap of 7.6 years has been noticed in a South African population for Silico-tuberculosis to develop post silicosis. In a study done on mine workers at Jodhpur, Rajasthan, it was seen that there is no definitive relation between patient with silicosis and possibility of having Covid-19.

**Conclusions:** This paper has focused on the coexistence of silicosis and tuberculosis. It has been seen that the risk of tuberculosis is highly increased with pre-existing silicosis. There is a big need for the integration of the Silicosis control programme with Tuberculosis elimination programme for the government. A few of the steps that can include assessing the workplaces, periodic monitoring of the workers’ health, active case surveillance, identification of hotspots, and introducing reforms to curb the spread of dust and particulate matter from industrialized areas be taken in this regard.

**Key words:** Silicosis, Tuberculosis, COVID-19, Silico-tuberculosis, Occupational health

**Highlights**

* Silicosis and tuberculosis have very similar presentation and misdiagnosis is very common.
* A patient with silicosis has a 2.8-2.9 times higher risk of developing pulmonary tuberculosis and 3.7 times that of extrapulmonary tuberculosis.
* Silicosis and tuberculosis programme would not be successful if not addressed in integrated manner.
* The COVID-19 pandemic has the potential to exacerbate the risks and prevalence of silicosis and silico-tuberculosis by reducing access to healthcare, increasing the risk of exposure, and compromising immune systems.

**Introduction**

Silicosis, an often fatal occupational lung disease, is caused by inhaling dust particles laden with crystalline silica (silicon dioxide, a component of sand and quartz) particles. Silica dust can accumulate in the alveolar walls leading to scarring, which resists its clearance by mucous or coughing, thus hindering gaseous exchange. The symptoms of Acute Silicosis comprise fever, shortness of breath, and cyanosis, visible more commonly over the ear lobes and the lips. Chronic patients may experience fatigue, extreme shortness of breath, loss of appetite, and chest pain with a risk of respiratory failure. Accelerated silicosis, although rare, is a unique and aggressive form of silicosis that primarily affects those who work with engineered stone. The symptoms tend to progress more quickly than chronic silicosis, often developing within 3-10 years of exposure. Besides lung transplantation, no known treatment is currently for halting accelerated silicosis progression [(1)](https://www.zotero.org/google-docs/?oHjzSF). Since silica exposure is commonly occupation-restricted, construction workers, miners, sandblasters, ceramics and porcelain manufacturers, marble workers, and demolition experts are particularly susceptible. There are 227 million workers worldwide who are estimated to be most at risk of developing silicosis, and they are mainly migrants. Among these, more than 80 nations employ 40.5 million artisanal small-scale miners worldwide [(2)](https://www.zotero.org/google-docs/?9tccv6). The attributed risk of Silicosis in certain occupations can be controlled, but the disease in itself is incurable. Crystalline silica was recently identified as a human carcinogen by the International Institute for Research on Cancer (IARC) (Group I) and hence National Institute for Occupational Safety and Health (NIOSH) has stated that *“Silica is not just dust but it is dangerous dust”*. The risk of contracting tuberculosis and the potential for lung cancer increase as a result of silicosis. Scleroderma and rheumatoid arthritis are thought to have a substantial correlation with silicosis. [(3,4)](https://www.zotero.org/google-docs/?9LFJNe).

Tuberculosis (TB), on the other hand, is an infectious bacterial disease caused by the *Mycobacterium tuberculosis* complex. The endogenous risk factors contributing to the development of progressive symptoms include compromised cell-mediated immunity, senility, and gender, wherein women of 25-34 years are more susceptible, while men face greater risk at older ages. HIV-positive, genetically predisposed, smokers, intravenous drug abusers, infants, elderly, diabetics, and alcoholics are the ones who face the most risk. It is transmitted mainly through respirable aerosols and fomites from an infected source and primarily affects the lung parenchyma leading to pulmonary manifestations. In the patients’ lungs, alveolar macrophage cells phagocytize the bacteria before invading the underlying epithelium. As the immune system works to fend off the illness, monocytes from surrounding blood arteries create the first stages of a granuloma in this location. This is a defining feature of TB. The caseous center tends to liquefy and cavitate as it releases thousands of *M. tuberculosis* bacilli into the airway, despite immunologically appearing to be confined. The infected lungs generate a cough containing the extremely contagious infectious droplet nuclei. The lymphatic system then transports infected macrophages to the pleura, peritoneum, pericardium, genitourinary tract, meninges, and epiphyses of the long bones, lungs, lymph nodes, skin, and other parts of the body leading to a composite variety of complications. The primary signs and symptoms of pulmonary tubercular etiology include fever, night sweats, chronic cough, sputum production, weight loss, fatigue, and hemoptysis. Chest X-ray and Sputum Cultures for the acid fast bacilli (AFB) staining are of utmost diagnostic importance.

This review article aims to bring to light the state of Silicosis and TB scenario in the world and India for evaluating hurdles in the present and future to achieve the elimination road map of both the diseases, and assess these conditions in the backdrop of the COVID-19 pandemic.

**Current disease burden**

The World Health Organization (WHO) and International Labor Organization (ILO) started a public awareness and preventive campaign in 1995 with the goal of eradicating silicosis from the planet by 2030. Although the elimination targets seem virtually impossible to be met, it is essential to note that silicosis has been recognized as an important predisposing factor for TB, next only to HIV infection [5]. In 2019, there were over 12,900 deaths reported from silicosis worldwide and 6,55,700 silicosis-related DALYs were recorded. Middle-SDI (Socio-Demographic Index) countries recorded 5,500 mortalities with a crude death rate of 0.23 in 2019 [6].

According to WHO reports, an estimated 10.6 million people contracted TB, while 1.6 million persons worldwide died due to it in 2021 (including 1,87,000 HIV-positive patients) [7]. Following COVID-19, TB is the second most infectious fatal etiology globally and the 13th largest overall cause of mortality. The areas of South-East Asia (44%), Africa (25%), and the Western Pacific (18%) reported the highest numbers of TB cases. Eight countries made up the majority of the global total: India (26%), Indonesia (8.5%), China (8.4%), the Philippines (6%), Pakistan (5.7%), Nigeria (4.4%), Bangladesh (3.6%), and South Africa (3.6%). While there has been some progress, it has been very slow, and it is anticipated that the globe will not be able to meet the End TB Strategy's target of completely eradicating tuberculosis as a threat to public health by the year 2035. For instance, the planned incidence reduction during 2015-2020 was 20% but could be limited to only 9%. Simultaneously, the projected mortality rate reduction for the same period was 35%, where only a 14% change could be managed [8].

**Coexistence of TB and Silicosis**

**Prevalence**

It is challenging to estimate the global prevalence of silico-tuberculosis since there is inadequate surveillance and access to medical treatment, and it is unclear how many people in resource-poor countries actually contract the disease (9). In any case, due to inadequate safety laws, a lack of preventative instruments, and lower levels of knowledge, low-income countries have higher incidence of silicosis and silico-tuberculosis (10).

A survey carried out in the Indian state of Rajasthan, on a group of 174 mine workers, where mean age was 39.13±11.09 years and among which three fourth were mining for more than 10 years, reported a history of tuberculosis in 30% of them. It was found that 10.0% of miners had contracted tuberculosis, 7.4% had developed silico-tuberculosis, 37.3% showed features of silicosis, and 4.3% had other respiratory illnesses such as emphysema and pleural effusion [(11)](https://www.zotero.org/google-docs/?dDLbof). A similar study conducted in the sandstone mines of Rajasthan performed the evaluation of 529 chest X-rays (CXRs) of mine-workers. 275 (52%) CXRs presented with radiological evidence of silicosis. 61 (12.4%) of the silicosis patients also developed tubercular changes, known as silico-tuberculosis [(12)](https://www.zotero.org/google-docs/?PrxcJY).

A recent meta-analysis showed that silicosis in parts of Zimbabwe and Egypt had a threefold higher chance of developing tuberculosis. [(](https://www.zotero.org/google-docs/?pkEHee)13).

Due to increment in the stone benchtop industry and handling of artificial stone there is an increased exposure of silica to mine workers and this also increased the risk of other pulmonary diseases especially tuberculosis.

A PubMed Central search was conducted using the keywords “Silico-tuberculosis” and “prevalence” and time period of last 20 years, which yielded 15 studies, out of which only seven were found to be relevant in terms of exemplifying the prevalence of silico-tuberculosis at various geographical locations around the world. (Table 1) [14-20]

**Risk factors**

Exposure to silica is also linked to an increased risk of developing silicosis as well as pulmonary and extrapulmonary tuberculosis [21]. It can last for years after the exposure is over [22], increases with disease severity, and is more common in those with acute and rapid forms of silicosis [23]. According to reports, silicosis patients have a 2.8–2.9 times higher chance of acquiring pulmonary TB than the general population and a 3.7 times greater risk of developing extra pulmonary tuberculosis [24].

In a research including 2255 South African gold miners who were followed up for 24-27 years, the length of exposure and the severity of silicosis (where present) were associated to the chance of getting pulmonary TB. Moreover, the study found a mean gap of 7.6 years between the cessation of silica dust exposure and the diagnosis of pulmonary tuberculosis [25].

HIV infection, another potent risk factor for TB, causes increased reactivation of the latent *Mycobacterium*, thus increasing the incidence and progression of the disease. A lack of early diagnosis and treatment regimens may contribute to a rise in the rate of TB infection. In contrast, prior TB therapy may be linked to more than half of individuals acquiring silico-tuberculosis, increasing with age (>40 years), which may further increase the rate of infection [26].

**Presentations (Fig1**)

Regarding silico-tuberculosis, the prognosis is primarily influenced by the tuberculous component. In the early stages, the presence of typical symptoms of pulmonary TB, such as fever, persistent cough, weight loss, or hemoptysis, does not provide substantial evidence of any coexisting silicosis in the patient since these clinical features are not distinguishable from pre-existing silicosis. Additionally, new opacities appearing rapidly on radiological imaging and the presence of pleural effusion or excavations may be observed. The presence of a cavitated conglomerate mass strongly suggests silicosis associated with tuberculosis. Although detecting active disease clinically in patients with silicosis is difficult, some patients may exhibit symptoms of constrictive pericarditis in later stages [27-29]. Primarily, after exposure over 10-30 years, the patients slowly and insidiously develop progressive nodular, fibrosing pneumoconiosis, which is characterized by the accumulation of abundant lipo-proteinaceous material inside the alveoli, which can be very much similar to the findings of alveolar proteinosis. Although dose and race are believed to have a role to play in the development of the symptoms African-Americans are at higher risks than Caucasians. Several studies have shown that owing to a patient's prolonged exposure to silica there are high chances for the development of complications like broncholithiasis, pneumothorax, and aspergillosis [30-32]. In certain rare cases, broncho-esophageal fistulas were seen in workers having tuberculosis with pre-existing silicosis [33]. Patients of silicosis are prone to tuberculosis because the crystalline silica tends to inhibit the pulmonary macrophages from destroying the phagocytosed bacilli [34]. SARS-CoV2 is mostly transmitted by respiratory droplets, while touch, aerosols, and fomites have all been reported as possible transmission routes. According to estimates, the median incubation time for COVID-19 infection is expected to be 5.1 days (95% CI, 4.5-5.8 days), and 97.5% of those infected experience symptoms within 11 days (95% CI, 8.2-15.6 days) following exposure [35,36]. Fever and chills, cough, dyspnea, exhaustion, myalgia, headache, loss of taste and smell sense, sore throat, rhinorrhea, nausea, vomiting, and diarrhea are among the symptoms [37].

**Diagnosis**

Chest X-rays and smear samples are the most popular investigations in patients with pulmonary TB and silicosis [38]. Sputum testing is less effective than routine radiography screening for early detection. The greatest sign of silico-tuberculosis is cavitation, which may result from ischemic abnormalities in the fibrotic mass of silicosis [39]. Chest X- rays of silicosis patients show fine nodularity, mostly in the upper part of the lungs. In addition, a computerized tomography (CT) scan can be of significant diagnostic value [40]. During the initial phase of the disease, pulmonary function is either not affected or moderately affected. Only when there is progressive massive fibrosis, does shortness of breath develop. The disease remains in progression, even after the exposure to Silica is curtailed. So, due to suboptimal pulmonary function, there are severe limitations to person's activity, although death might be a very late outcome [39]. Spirometry can be performed at the time of diagnosis to assess the level of lung function impairment. Biomarkers are the more advanced diagnostic options. As per a research conducted by the Indian Council of Medical Research (ICMR), Club Cell protein 16 (CC16), which is a potential anti-inflammatory protein, secreted by non-ciliated bronchoalveolar epithelium, is found to be reduced in case of long-term exposure to silica and hence can be used as an early detection tool. Certain other biomarkers, like Neopterin, serum selenium, heme oxygenase, etc. can also be used for detection [41]. Cases of Interstitial Lung Diseases (ILDs) or ILDs with TB, are very frequently misdiagnosed and treated with ATT alone. In a study from Karachi, Pakistan, it was seen that 3 out of 3 (100%) (2 had sputum-positive TB in the past, i.e., they had silico-tuberculosis) silicosis patients were initially treated as TB. The authors further go on to say that a great degree of clinical suspicion is needed to diagnose ILDs. Cough and dyspnea, with which the patients most commonly present, are overlooked in most cases and are erroneously thought to be due to a history of smoking, increasing age, or some other co-infections, the most common of which is TB. The reason behind this is the less aware physicians. Due to such instances, patients are subjected to unnecessary ATT treatments, which carry a spectrum of side effects, and the actual disease remains undiagnosed. All these lead to increased mortality rates in such groups of patients [42]. Molecular identification of SARS-COV-2 by polymerase chain reaction (PCR) of nasopharyngeal specimens, deep nasal swabs, throat swabs, or lower respiratory samples is currently the best method for precise diagnosis [43].

**Management**

To reduce the risk of recurrence, standard anti-tuberculosis medications plus DOT (directly observed treatment) are advised to be used for at least eight months. The chemotherapy used in TB patients has proved equally effective in silico-tuberculosis patients [44]. The introduction of CC16 protein has highly improved the management of silico-tuberculosis as a potential biomarker for silicosis which helps in deciding the treatment regimen for the patients. The patients with silicosis must be monitored for developing or redeveloping tuberculosis.

The emphasis should also be on preventing the incidence of silico-tuberculosis, and uplifting the quality of the workplace for workers working in the silica industries. These measures include decreasing the exposure to silica dust, ensuring completion of treatment of ATT, reducing oscillating migration of workers, compensating workers properly, training and educating occupational health to the working community, alleviating the quality of life of laborers, intensified medical surveillance system and TB screening during scheduled health check-ups, which should be made mandatory to be conducted by the mine or factory owners or the government, as the case might be, and proper policy framing to reduce inhalation of dust by workers or employees, to bring down the incidence of silico-tuberculosis [45]. Patients with mild disease should self‐isolate, and can often be managed in the community by home-based care. They must also be able to keep an eye on their own health, know which signs call for a doctor's attention, and know how to voice any concerns [46–49]. In general, hospitalisation is necessary for patients with moderate to severe sickness. This includes people who have extensive pulmonary infiltrates that are visible on chest imaging, who are tachypneic at rest (respiratory rate > 22 breaths/min), who are dyspneic on light exertion, who have pulse oximetry [SpO2] 94% on room air, who are hypoxemic (pulse oximetry [SpO2] 94%), and who have an acutely altered mental status [47–49]. The requirement for immediate admission and consideration of intensive care, if necessary for a particular patient, are dictated by severe sickness, which is indicated by, among other aspects, a respiratory rate > 30 breaths/min, SpO2 92% on room air, or prolonged hypotension [47,49]. Treatment includes antivirals like Nirmatrelvir with Ritonavir, Remdesivir, and Molnupiravir. Immunocompromised patients or those on immunosuppressants may also benefit from convalescent plasma therapy [50].

**Impact of COVID-19 on Silicosis and Silico-tuberculosis**

Silicosis and silico-tuberculosis are lung diseases caused by long-term exposure to crystalline silica dust in the workplace. The COVID-19 pandemic has raised concerns about the impact of the virus on these diseases, which already pose significant health risks to workers in high-risk occupations.

**Reduced Access to Healthcare**

The pandemic has led to a strain on healthcare systems worldwide, leading to reduced access to healthcare services. Workers suffering from silicosis and silico-tuberculosis may find it difficult to access healthcare services, including diagnosis and treatment [51]. This could lead to delayed diagnosis and progression of these diseases, resulting in poorer outcomes. There was substantial drop in patients from primary and workplace based occupational health care during covid19 [52]. India, a country with a high prevalence of silicosis as well as tuberculosis, found that the pandemic has led to reduced access to healthcare services for these patients, leading to delays in diagnosis and treatment. The shortage of health workers caused the constraints to give the institutional care for COVID-19 affected patients [53].

According to the International Labour Organization (ILO), lockdown measures have touched 2.7 billion individuals, or 81% of the world's employment, with 61% of employees belonging to informal sectors in poor and middle-income countries. Inadequate healthcare access with no economic protection made those workers more vulnerable and marginalised [54].

**Increased Risk of Exposure**

The epidemic of COVID-19 has also raised demand for personal protective equipment (PPE), such as respirators. This has resulted in a lack of PPE in some places, thereby increasing the danger of workers being exposed to silica dust [55]. Workers may also be reluctant to wear PPE due to discomfort and the increased risk of contracting COVID-19 when wearing a respirator for long periods. Also social distancing which was one of the main preventive measure to followed in COVID-19 is hard to pursue in a mine and by people involved on a daily basis working sector.

**Changes in Working Patterns**

The pandemic has also led to changes in working patterns, such as remote working, which may reduce the exposure to silica dust for some workers. However, for others, such as essential workers in the factory, mining and construction industries, the risk of exposure may remain high. Poor living condition, migrant category of workers traveling from various hot spots [56].

Although the pandemic some people had shifted to different working pattern like remote working but millions of workers had no choice for those job which can be done at home. Essential workers, beyond health care, were forced to work at factories and other enterprises often without any provision of PPE [54].

Migrant workers had to come back to their home during lockdown, mostly in the rural part, spreading the viral infection from urban ‘hotspot’ to the villages. But, the existing health care institutions had not enough infrastructure for testing, tracking and preventing the disease [57].

**Compromised Immune Systems**

People with silicosis and silico-tuberculosis may have compromised immune systems, which may increase their susceptibility to COVID-19 [58-60]. A study conducted in South Africa found that SARS-COV-2 infection rate among mine workers who are at high risk for silicosis, silico-tuberculosis exceeded than the normal population. Existing Interstitial lung diseases has been associated with severe COVID-19 outcome [56]. A multicentric study conducted in the USA has shown that individuals with Interstitial lung diseases are at increased risk of morbidity and mortality from COVID-19 infection [61].

Whereas a study from India showed that subjects from silicosis prone area were not at a higher risk of COVID-19 may be due to already pre-existing inflammation [62]. Further studies are needed to assess the long-term impact of the pandemic on these diseases. The COVID-19 pandemic has the potential to exacerbate the risks and prevalence of silicosis and silico-tuberculosis by reducing access to healthcare, increasing the risk of exposure, and compromising immune systems. It is crucial to ensure that workers in high-risk occupations have access to adequate healthcare and PPE to minimize the risk of exposure to silica dust and to prevent the spread of COVID-19.

**Lessons Learnt Till Now**

This paper aimed to shed light on the coexistence of silicosis and tuberculosis in workers exposed to crystalline silica dust. Silicosis is highly prevalent in mine workers and as per the various studies carried out till now, it has been seen that the risk of tuberculosis is highly increased with pre-existing silicosis. There had been some incidences of missed cases when tuberculosis was misdiagnosed with silicosis due to indifferent clinical manifestations of the two in the initial stages. There is a big need to integrate the Silicosis control programme with the Tuberculosis elimination programme for the government to improve the health status of workers and achieve the goal of tuberculosis elimination from the country.

**The Way Ahead**

The honorable National Human Rights Commission (NHRC) of India has directed and recommended the Governments of the states and union territories to provide the complete information regarding the magnitude of the problem of silicosis and action taken to prevent and mitigate that disease [63,64]. Ministry of Health and Family Welfare has already identified the co morbidity of TB-HIV, TB and diabetes, TB and nutrition, TB and tobacco but comorbidity of TB and silicosis is not identified yet [63,64]. As prevention of silicosis is identified as a national challenge this is high time to work on silico-tuberculosis.

Rajasthan came up with this policy first in India followed by the state of Haryana and West Bengal. There is a need to formulate policy of Silicosis prevention, treatment and rehabilitation in all states.

Silicosis is an age old occupational disease and remains difficult to deal with when it gets complicated with tuberculosis. The success of prevention and mitigation of both issues needs active cooperation of all the stakeholders. A systematic mechanism needs to be placed under department of labour and department of health and family welfare and the other agencies dealing with tuberculosis to address the problem for the sake of healthy and productive workforce and alleviation of human suffering.

Assessment of the workplaces where silica dust is in abundance, should be done at regular intervals, and the local bodies should monitor and grade such reports. In this regard, both private sector firms and the government need to come together and work towards framing a set pattern of rules. Monitoring of the workers’ health periodically at silica dust-prone places should be given utmost priority. Efforts should be made to incorporate and integrate such efforts with the ongoing Revised National Tuberculosis Control Program (RNTCP). Active surveillance to detect cases of Silico-tuberculosis should be taken up as one of the urgent goals in hotspot areas of silica dust production so as to ensure active case detection, that too in the early stages of the disease pathogenesis. What is imperative before that is to identify such hotspots at all levels, beginning right from ward level, and escalating that to block level, followed by city level, division level, district level, state level and ultimately at a pan India level. Manpower and officials who are specially trained and deputed for Silico-tuberculosis detection and reporting should be employed at all levels, within the prevalent similar system for Tuberculosis (**Fig2**).

It should be made essential for the government and local councils of a state or a city to introduce reforms to curb the spread of dust and particulate matter from industrialized areas. The Delhi Government took one such initiative to keep in check the steadily decrementing Air Quality Index (AQI) of the Indian Capital. The ruling made it mandatory for construction sites spanning over an area of more than 20,000 sq. feet to install at least three air quality monitoring systems to control dust pollution and limit workers' time in potentially exposure-laden environments. These systems will detect levels of PM2.5 (finer particles-more invasive) and PM10 (coarse particles-less invasive) particles being emitted, and will report the data to the Delhi Pollution Control Committee (DPCC) for analysis and effect [51]. In India, inadequate primary healthcare facilities in rural parts of several states, unregulated private healthcare, a lack of political will, and administrative loopholes are major impediments to TB management.

**Ethic statement**: Not applicable.

**Acknowledgement**: We acknowledge the workers and their vulnerability we tried to elucidate through our write up.

**References** :

[1. Physicians TRAC of. The Royal Australasian College of Physicians [Internet]. The Royal Australasian College of Physicians [cited 2022 Dec13]. Available from:](https://www.zotero.org/google-docs/?5ZHvVh) <https://www.racp.edu.au/advocacy/division-faculty-and-chapter-priorities/faculty-of-occupational-environmental-medicine/accelerated-silicosis/overview>

[2. Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues [Internet]. International Institute for Sustainable Development. [cited 2022 Dec11]. Available from:](https://www.zotero.org/google-docs/?5ZHvVh) <https://www.iisd.org/publications/report/global-trends-artisanal-and-small-scale-mining-asm-review-key-numbers-and>

[3. International agency of research on cancer. silica dust, crystalline, in the form of quartz or cristobalite [Internet]. NIOSH 2002. [cited 2022 Dec13]. Available from:](https://www.zotero.org/google-docs/?5ZHvVh) <https://monographs.iarc.who.int/wp-content/uploads/2018/06/mono100C-14.pdf>

[4.](https://www.zotero.org/google-docs/?5ZHvVh) Sato T, Shimosato T, Klinman DM. Silicosis and lung cancer: current perspectives. Lung Cancer (Auckl). 2018;9:91-101. doi:10.2147/LCTT.S156376

5. Lanzafame M, Vento S. Mini-review: Silico-tuberculosis. J Clin Tuberc Other Mycobact Dis. 2021;23:100218. doi:10.1016/j.jctube.2021.100218

6. Chen S, Liu M, Xie F. Global and national burden and trends of mortality and disability-adjusted life years for silicosis, from 1990 to 2019: results from the Global Burden of Disease study 2019. BMC Pulmonary Medicine 2022;22:240. Doi: 10.1186/s12890-022-02040-9

7. Tuberculosis [Internet]. World Health Organisation. [cited 2023 Apr4]. Available from: <https://www.who.int/news-room/fact-sheets/detail/tuberculosis>

[8.](https://www.zotero.org/google-docs/?5ZHvVh) Bagcchi S. WHO's Global Tuberculosis Report 2022. The Lancet Microbe. 20203;4(1):e20. doi: 10.1016/S2666-5247(22)00359-7

9. [Farazi A, Jabbariasl M. Silico-tuberculosis and associated risk factors in central province of Iran. The Pan African Medical Journal [Internet]. 2015 Jul 4 [cited 2022 Dec 13];20(333). Available from:](https://www.zotero.org/google-docs/?5ZHvVh) <https://www.panafrican-med-journal.com/content/article/20/333/full>

10. [Sharma N, Kundu D, Dhaked S, Das A. Silicosis and silicotuberculosis in India. Bull World Health Organ. 2016 Oct 1;94(10):777–8.](https://www.zotero.org/google-docs/?5ZHvVh)

11. [Silico-tuberculosis, silicosis and other respiratory morbidities among sandstone mine workers in Rajasthan- a cross-sectional study | PLOS ONE [Internet]. [cited 2022 Dec13]. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0230574](about:blank)

12. [Silicosis, progressive massive fibrosis and silico-tuberculosis among workers with occupational exposure to silica dusts in sandstone mines of Rajasthan state: An urgent need for initiating national silicosis control programme in India - PMC [Internet]. [cited 2022 Dec13]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8138390/](https://www.zotero.org/google-docs/?5ZHvVh)

13. [Ehrlich R, Akugizibwe P, Siegfried N, Rees D. The association between silica exposure, silicosis and tuberculosis: a systematic review and meta-analysis. BMC Public Health. 2021 May 20;21(1):953.](https://www.zotero.org/google-docs/?5ZHvVh)

14. Moyo D, Zishiri C, Ncube R, Madziva G, Sandy C, Mhene R, et al. Tuberculosis and Silicosis Burden in Artisanal and Small-Scale Gold Miners in a Large Occupational Health Outreach Programme in Zimbabwe. IJERPH 2021;18(21):1-11. doi: 10.3390/ijerph18211103

15. Moyo D, Ncube R, Kavenga F, et al. The Triple Burden of Tuberculosis, Human Immunodeficiency Virus and Silicosis among Artisanal and Small-Scale Miners in Zimbabwe. Int J Environ Res Public Health. 2022;19(21):13822. doi:10.3390/ijerph192113822

16. Nandi SS, Dhatrak SV, Sarkar K. Silicosis, progressive massive fibrosis and silico-tuberculosis among workers with occupational exposure to silica dusts in sandstone mines of Rajasthan state: An urgent need for initiating national silicosis control programme in India. J Family Med Prim Care. 2021;10(2):686-691. doi:10.4103/jfmpc.jfmpc\_1972\_20

17. Farazi A, Jabbariasl M. Silico-tuberculosis and associated risk factors in central province of Iran. Pan Afr Med J. 2015;20:333. doi:10.11604/pamj.2015.20.333.4993

18. Tiwari RR, Sharma YK. Respiratory health of female stone grinders with free silica dust exposure in Gujarat, India. Int J Occup Environ Health. 2008;14(4):280-282. doi:10.1179/oeh.2008.14.4.280

19. Bhagia LJ, Sadhu HG. Cost-benefit analysis of installing dust control devices in the agate industry, Khambhat (Gujarat). Indian J Occup Environ Med. 2008;12(3):128-131. doi:10.4103/0019-5278.44694

20. Tiwari RR, Narain R, Sharma YK, Kumar S. Comparison of respiratory morbidity between present and ex-workers of quartz crushing units: Healthy workers' effect. Indian J Occup Environ Med. 2010;14(3):87-90. doi:10.4103/0019-5278.75695

21. Shafiei M, Ghasemian A, Eslami M, Nojoomi F, Rajabi-Vardanjani H. Risk factors and control strategies for silicotuberculosis as an occupational disease. New Microbe and New Infect 2019; 27: 75–77. <https://doi.org/10.1016/j.nmni.2018.11.002>

22. Hnizdo E, Murray J Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners. Occupational and Environmental Medicine 1998;55:496-502.

23. Adverse effects of crystalline silica exposure. American Thoracic Society Committee of the Scientific Assembly on Environmental and Occupational Health. American journal of respiratory and critical care medicine 1997;155(2):761–768. <https://doi.org/10.1164/ajrccm.155.2.9032226>

24. Cowrie RL. The epidemiology of tuberculosis in gold miners with silicosis. American journal of respiratory and critical care medicine 150(5). <https://doi.org/10.1164/ajrccm.150.5.7952577>

25. Hnizdo E, Murray J Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners. Occupational and Environmental Medicine 1998;55:496-502.

26. Factors associated with extended treatment among tuberculosis patients at risk of relapse in California. Qin F, Barry PM, Pascopella L. The International Journal of Tuberculosis and Lung Disease 2016; 20(3):363-369(7). https://doi.org/10.5588/ijtld.15.0469

27. Udwadia Z.F., Sen T. Pleural tuberculosis : an update. Curr Opin Pulm Med. 2010;16:399–406. doi: 10.1097/MCP.0b013e328339cf6e.

28. Diagnostic standards and classification of tuberculosis in adults and children. Am J Respir Crit Care Med 2000;161:1376–95. doi: 10.1164/ajrccm.161.4.16141.

29. Ortbals D.W., Avioli L.V. Tuberculous pericarditis. Arch Intern Med. 1979;139:231–234.

30. Silicosis [Internet]. NHS. [cited 2023 Apr4]. Available from: <https://www.nhs.uk/conditions/silicosis/#:~:text=Silicosis%20can%20also%20increase%20your,heart%20failure>

31. Chouchane A, Brahem A, Maoua M, Aroui H, Kacem I, Guedri SE, et al. EuropeanRespiratoryJournal 2018;52:PA1214. doi**:** 10.1183/13993003.congress-2018.PA1214

32. Silicosis Symptoms and Diagnosis [Internet]. American Lung Association. [cited 2023 Apr4]. Available from: <https://www.lung.org/lung-health-diseases/lung-disease-lookup/silicosis/symptoms-diagnosis>

33. Zhang H, Li L, Xiao H, Sun XW, Wang Z, Zhang CL. Silicotuberculosis with oesophagobronchial fistulas and broncholithiasis: a case report.J Int Med Res. 2018 Feb; 46(2): 612–618. doi: 10.1177/0300060516680440

34. Kumar V, Abbas AK, Aster JC, editors. Robbins basic pathology. 16th ed. Philadelphia: Elsevier Saunders; c2013.

35. Brewster DJ, Chrimes NC, Do TBT, et al. Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID‐19 adult patient group. Med J Aust 2020; 212: 472–481.

36. Lauer SA, Grantz KH, Bi Q, et al. The incubation period of coronavirus disease 2019 (COVID‐19) from publicly reported confirmed cases: estimation and application. Ann Intern Med 2020; 172: 577–582.

37. Symptoms of COVID-19 [Internet]. Centers for Disease Control and Prevention. [cited 2023 Apr4]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>

38. Ryu YJ. Diagnosis of pulmonary tuberculosis: recent advances and diagnostic algorithms. Tuberc Respir Dis (Seoul) 2015;78:64–71. doi: 10.4046/trd.2015.78.2.64.

39. Chong S, Lee KS, Chung MJ, Han J, Kwon OJ, Kim TS. Pneumoconiosis: comparison of imaging and pathologic findings. Radiographics. 2006;26:59–77. doi: 10.1148/rg.261055070.

40. Naha N, Muhamed JCJ, Pagdhune A, Sarkar B, Sarkar K. Club cell protein 16 as a biomarker for early detection of silicosis. Indian J Med Res. 2020;151(4):319-325. doi:10.4103/ijmr.IJMR\_1799\_18

41. Akhter N, Rizvi NA. Interstitial Lung Diseases Misdiagnosed as Tuberculosis. Pak J Med Sci. 2018;34(2):338-341. doi:10.12669/pjms.342.14407

42. Escreet RL, Langton BC, Cowie ME. Short-course chemotherapy for silicotuberculosis. 1984 Available from: <https://journals.co.za/doi/abs/10.10520/AJA20785135_11250>

43. Zhang W, Du R‐H, Li B, et al. Molecular and serological investigation of 2019‐nCoV infected patients: implication of multiple shedding routes. Emerg Microbes Infect 2020; 9: 386–389.

44. Shafiei M, Ghasemian A, Eslami M, Nojoomi F, Rajabi-Vardanjani H. Risk factors and control strategies for silicotuberculosis as an occupational disease. New Microbe and New Infect 2019; 27: 75–77. <https://doi.org/10.1016/j.nmni.2018.11.002>

45. Snider DE, Dewberry G, Gretz H. An attempt to eradicate silicotuberculosis in Ottawa County, Oklahoma. 2011.

46. Interim guidelines for the clinical management of COVID‐19 in adults [Internet]. Australasian Society for Infectious Diseases Limited. [cited 2023 Apr4]. Available from: <https://www.asid.net.au/documents/item/1873>

47. Clinical management of COVID‐19: interim guidance [Internet]. World Health Organization. [cited 2023 Apr4]. Available from: <https://apps.who.int/iris/handle/10665/332196>

48. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID‐19) outbreak in China. JAMA 2020; 323: 1239–1242.

49. Caring for people with COVID‐19: living guidelines [Internet]. National COVID‐19 Clinical Evidence Taskforce. [cited 2023 Apr4]. Available from: <https://covid19evidence.net.au/#living-guidelines>

50. COVID-19 Treatments and Medications [Internet]. Centers for Disease Control and Prevention. [cited 2023 Apr4]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/your-health/treatments-for-severe-illness.html>

51. Jeleff M, Traugott M, Jirovsky-Platter E, Jordakieva G, Kutalek R. Occupational challenges of healthcare workers during the COVID-19 pandemic: a qualitative study. BMJ Open. 2022;12(3):e054516. doi:10.1136/bmjopen-2021-054516

52. Ho C, Macfarlane J, Tedd H*, et al*. P76 Impact of the COVID-19 pandemic on referral processes to a regional Occupational lung disease service – a single centre experience. Thorax 2022;**77:**A122.

53. The Lancet. India under COVID-19 lockdown. Lancet. 2020;395(10233):1315. doi:10.1016/S0140-6736(20)30938-7

54. The Lancet. The plight of essential workers during the COVID-19 pandemic. Lancet. 2020;395(10237):1587. doi:10.1016/S0140-6736(20)31200-9

55. Shortage of personal protective equipment endangering health workers worldwide [Internet]. World Gealth Organisation. [cited 2023 Apr4]. Available from: <https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide>

56. Naidoo RN, Jeebhay MF. COVID-19: a new burden of respiratory disease among South African miners?. Curr Opin Pulm Med. 2021;27(2):79-87. doi:10.1097/MCP.0000000000000759

57. Iyengar KP, Jain VK. COVID-19 and the plight of migrants in India. Postgraduate Medical Journal 2021;**97:**471-472.

58. Myall KJ, Martinovic JL, West A. How COVID-19 interacts with interstitial lung disease. Breathe 2022 18: 210158. doi**:** 10.1183/20734735.0158-2021

59. Valenzuela V, Waterer G, Raghu G. Interstitial lung disease before and after COVID-19: a double threat? European Respiratory Journal 2021 58: 2101956. doi**:** 10.1183/13993003.01956-2021

60. Konečný P, Ehrlich R, Gulumian M, Jacobs M. Immunity to the Dual Threat of Silica Exposure and *Mycobacterium tuberculosis*. Front Immunol. 2019;9:3069. doi:10.3389/fimmu.2018.03069

61. Esposito AJ, Menon AA, Ghosh AJ, et al. Increased Odds of Death for Patients with Interstitial Lung Disease and COVID-19: A Case-Control Study. Am J Respir Crit Care Med. 2020;202(12):1710-1713. doi:10.1164/rccm.202006-2441LE

62. Dhikav V. Are Silicosis Patients at Risk of Developing COVID-19?. *Indian J Occup Environ Med*. 2022;26(2):133-134. doi:10.4103/ijoem.ijoem\_146\_21

63. TB Notification Order [Internet]. Ministry of Health and Family Welfare, Government of India. [cited 2023 Apr4]. Available from: <https://tbcindia.gov.in/showfile.php?lid=3136>

64. TB Statistics India [Internet]. TBFACTS.ORG. [cited 2023 Apr4]. Available from: <https://www.tbfacts.org/tb-statistics-india/>

**Legends**

Table 1: Burden of silico-tuberculosis at various geographical locations around the world

Figure1 : Clinical Presentation of Silico tuberculosis

Figure 2: Silico-tuberculosis detection and reporting steps within the prevalent similar system for Tuberculosis