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Occupational Health Concerns in Construction -The Battle Against Silicosis

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ABSTRACT : Silicosis, a severe lung disease caused by inhaling crystalline silica, a mineral found in earth-produced materials, predominantly affects workers in industries such as mining and construction, leading to a significant global public health challenge. Since 1968, more than 14000 workers have died in the USA from this disease. In the USA, more than 200 workers die from this disease, while hundreds more become disabled. Over 20,000 incident cases of silicosis were identified worldwide in 2017, and millions of workers still continue to be exposed to respirable crystalline silica. While the incidence has been declining since 1990 due to increased awareness of authorities and the implementation of strict regulations, the disease still remains a threat, and further study on preventive measures is necessary.

***IndexTerms* – Silicosis, Construction, Occupational Disease**

INTRODUCTION

Occupational Safety and Health Administration (OSHA) defines an occupational disease to be any abnormal condition or disorder resulting from a non-instantaneous event or exposure in the work environment [1].

WorkSafeBC says that "occupational diseases are conditions or disorders that result from the nature of one's work." An occupational disease is one that is caused by the work environment or activities that are part of one's occupation. The Canadian Centre for Occupational Health and Safety (CCOHS) states, "In general, health conditions or disorders that occur among a group of people with similar occupational exposures at a higher frequency than the rest of the population are considered occupational diseases." [2]

The masterpiece comedy movie "Modern Times" by Carlie Chaplin (1936) nicely captured the possible occupational hazards in very simplistic form. The International Labor Organization's (ILO) recent estimates present that some 2.78 million workers around the world succumb to work-related accidents or diseases every year, of which 2.4 million are disease-related and an additional 374 million workers suffer from non-fatal occupational accidents. It is estimated that lost workdays globally represent almost 4% of the world's GDP, and in some countries, this rises to 6% or more. this corresponds to over 7500 deaths every single day out of which 1000 deaths are related to occupational accidents and 6500 are disease related (Figure-1). The aggregate figures indicate an overall increase in the number of deaths attributed to work: from 2.33 million deaths in 2014 to 2.78 million deaths in 2017 [3][4][5]. With the changes in technology and work pattern, the nature and intensity of occupational diseases are increasing. Some old occupational diseases are intensifying, and some new abnormalities/diseases are coming into existence as an epidemic. To maintain a sustainable progress and growth in Engineering it has become absolute necessity that Occupational diseases are provided with greater attention.

ILO has published a detailed list of occupational diseases [ILO List of Occupational Diseases(revised 2010)][6]. The diseases may be broadly grouped into six categories based on the target organ system:

- Respiratory Diseases
- Skin Diseases

- Musculoskeletal disorders (MSDs). ...
- Mental and Behavioral Disorders
- Cancer. ...

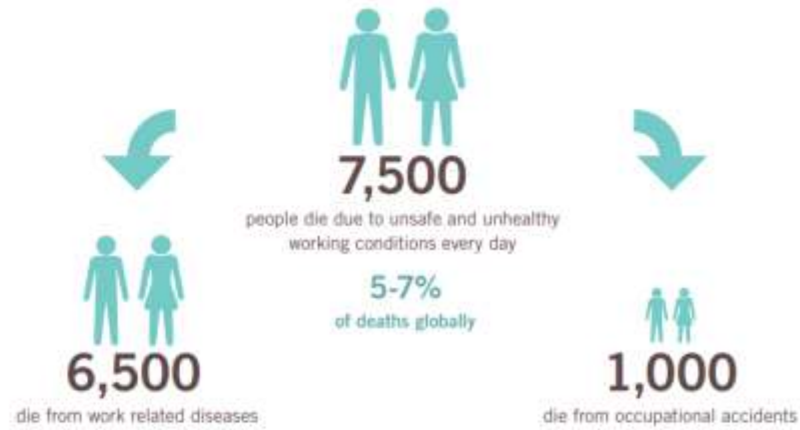

Figure 1. Global Incidence of Occupational Deaths
(Diagram Credit: SAFETY4SEA [3])

The following figure shows the Numbers of global occupationally related deaths in 2015 by WHO region and major disease group:

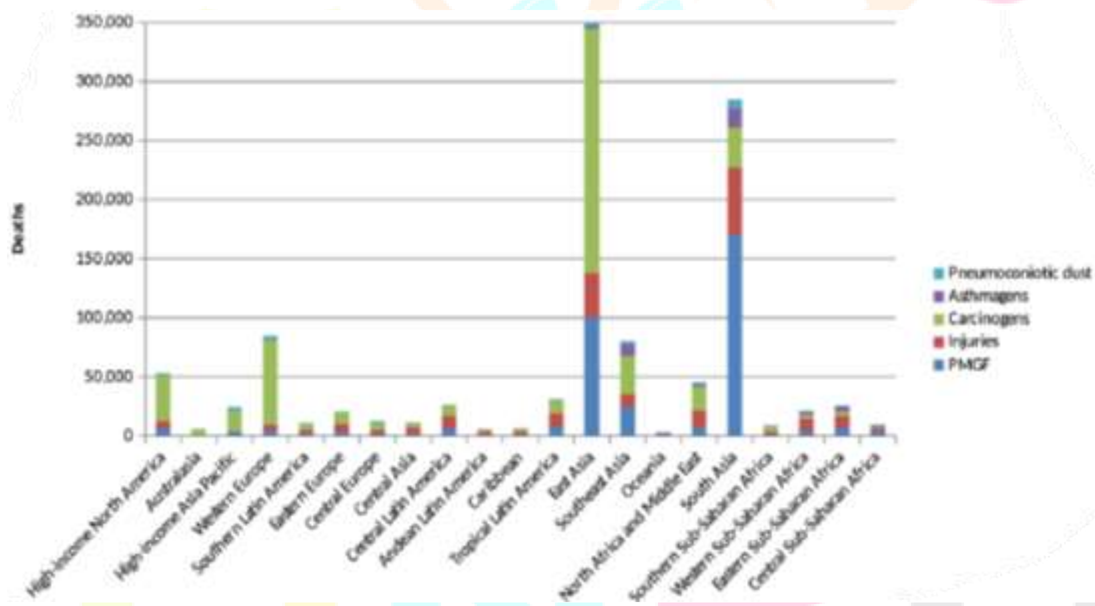

Figure 2. Number of Global occupationally-related Deaths in 2015
(Source: Curr Envir Health Rpt (2017): Springer:www.ncbi.nlm.nih.gov [7])

Mortality does not give a complete picture of the disease burden borne by individuals in different populations. The overall burden of disease can be assessed using the disability-adjusted life year (DALY), a time-based measure that combines years of life lost due to premature mortality (YLLs) and years of life lost due to time lived in states of less than full health, or years of healthy life lost due to disability (YLDs). One DALY represents the loss of the equivalent of one year of full health. The below picture shows the numbers of global occupationally related DALYS in 2015 by WHO region and major disease group.

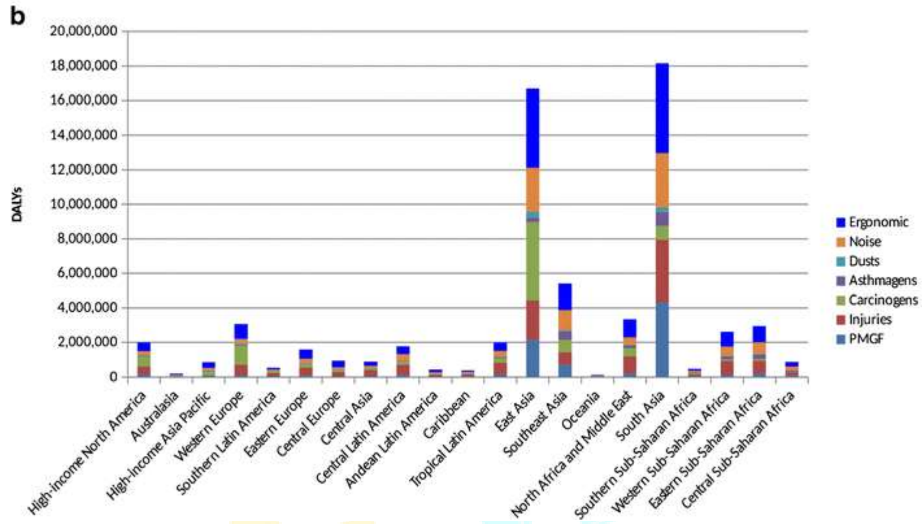

Figure 3. Numbers of global occupationally related DALYS in 2015
(Source: Curr Envir Health Rpt (2017): Springer:www.ncbi.nlm.nih.gov [7])

A study of the reported cases in 183 countries worldwide in 2016 shows the following proportions on DALYs and Deaths.

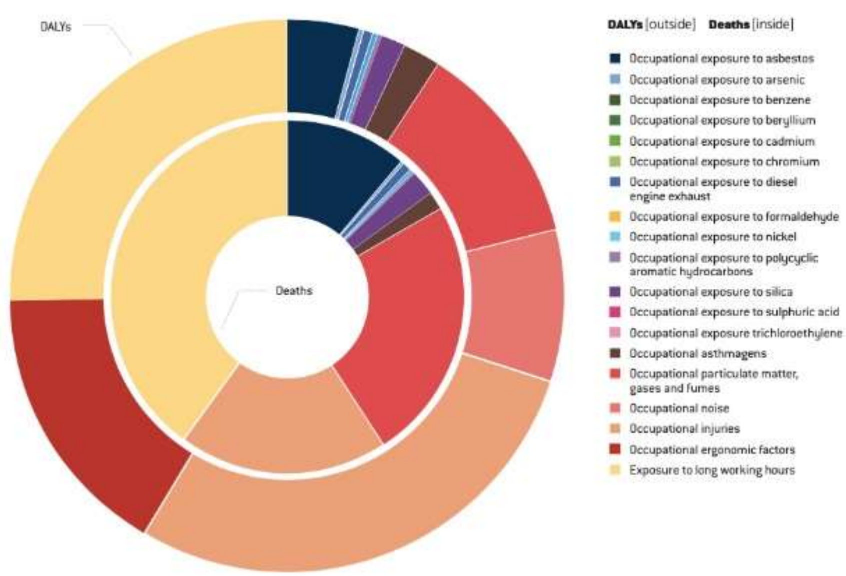

Figure 4. Proportions of total attributable deaths and DALYs by occupational risk factor
(Source: Burden of Occupational Diseases [12])

In 2016 ILO and WHO made an agreement to develop a joint estimation methodology and produce a comprehensive set of estimates of work-related burden of disease. This report [13] estimated Globally, in 2016, a total of 1.88 (95% uncertainty range (UR): 1.84–1.92) million deaths and 89.72 (95% UR: 88.61–90.83) million disability-adjusted life years (DALYs) were attributable to the 41 pairs of occupational risk factor and health outcome. Diseases accounted for 80.7% (1.52 million; 95% UR: 1.47–1.56 million) of the deaths and 70.5% (63.28 million; 95% UR: 62.17–64.39 million) of the DALYs, and injuries accounted for 19.3% (0.36 million; 95% UR: 0.36–0.37 million) of the deaths and 29.5% (26.44 million: 95% UR: 26.42–26.46 million) of the DALYs. All covered diseases are noncommunicable diseases. The occupational risk factor with the largest number of attributable deaths was exposure to long working hours (≥ 55 hours per week) (744 924 deaths; 95% UR: 705 519–784 329), followed by occupational particulate matter, gases and fumes (450 381 deaths; 95% UR: 430 248–470 514) and occupational injuries (363 283 deaths; 95% UR: 358 251–368 315). The health outcome with the largest work-related burden of deaths was chronic obstructive pulmonary disease (450 381 deaths; 95% UR: 430 248–470 514), followed by stroke (398 306 deaths; 95% UR: 369 693–426 919) and ischaemic heart disease (346 618 deaths; 95% UR: 319 524–373 712). A disproportionately large work-related burden of disease is observed in the WHO African Region, Southeast Asia Region, and the Western Pacific Region, males and older age groups.

While the ILO list of occupational diseases provides a broad grouping of occupational illnesses, they can be further regrouped into the finer categories below based on the organ system affected.

Figure 5. Grouping of Occupational Diseases based on the affected organ system (Source: Occupational Disease – Presentation by Mr K Prem Belwin[8])

Pneumoconiosis is one of the major categories that come under the respiratory disorder category as well as the cardiovascular disorder category. At the same time, it may be carcinogenic as well. Pneumoconiosis can result from 1. Silicosis (Silicon dust) 2. Asbestosis (Asbestos dust) 3. Byssinosis (cotton dust)

Silicosis is a typical pneumoconiosis and is common in workers with a significant chance of being exposed to free crystalline silica (SiO_2) during long-term occupational activities. This is one of the oldest occupation diseases which till date is substantially existing and mankind has failed to get a control over. Any occupation requiring exposure to silicon dust or any items with silicon content in a concentration of more than 5%, such as work in rock cement factories, sandblasting of concrete, metals, or any other occupation requiring a similar exposure, may cause silicosis in the workers.[9]

Generally, silicosis is characterized by the development of irreversible and progressive pulmonary fibrosis caused by inhalation of free crystalline silica (SiO_2)[10], a common mineral found in earth materials. These earth materials include but are not limited to, sand, stone, concrete, and mortar due to the number of silica minerals found within them. Non-earth materials are also forged using the crystalline silica mineral. These products include pottery, ceramics, artificial stone, bricks, and glass. Silicosis is historically a disease of miners; however, failure to recognize and control the risk associated with silica exposure in contemporary work practices such as sandblasting denim jeans and manufacturing of artificial stone benchtops, etc. has led to re-emergence of silicosis around the world.

Despite the strict supervision and management of the SiO_2 industry, the number of workers occupationally exposed to silica is up to 1.7 million in the USA and much more worldwide every year [10]. The Indian Government estimates that 10 million people are exposed to silica dust on the job. It is estimated that around 230 million workers worldwide are exposed to Silica dust in their workplaces [11].

According to the ILO report, Compensation costs for respiratory diseases account for almost 9% of the total Compensation Costs spent annually [4].

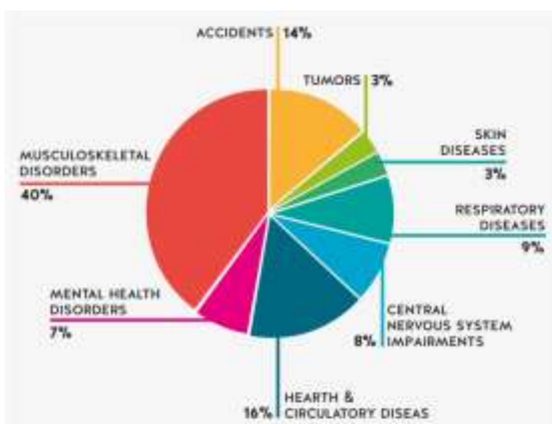

Figure 6. Global Compensation Costs of Occupational and Work-related Accidents and Diseases (Figure Source: Global Trends on Occupational Accidents and Diseases by ILO [4])

Globally, silicosis accounts for a significant proportion of all pneumoconiosis cases and is a serious public health issue. In 2017, the Global Burden of Disease (GBD) study identified 23,695 incident cases of silicosis (age-standardized incidence rate [ASIR] = 0.30 per 100,000), which represents 39% of the 60,055 incident cases of pneumoconiosis (Figure 7) [14] [15] A study by Xianping Song et al. [28] found 66.4% Stage 1 cases of pneumoconiosis were suffering Silicosis, 75.4% of Stage II pneumoconiosis cases were Silicosis and 81.7 % of Stage III were silicosis.

Many efforts have been made in recent years, and besides lung transplantation offered for a few patients, there are still no effective countermeasures to date. It is irreversible in nature.

Despite the critical nature of the disease, the implementation of global silicosis policies has generally been disappointing and more limited than envisaged [16]. 1934 ILO convention circular defined silicosis as a disease occurring in 'industries or processes recognized by national law or regulations as involving exposure to the risk of silicosis.' By its explicit institutional, legal definition, silicosis epitomizes the medicolegal character of 'occupational disease,' which can vary across countries. Finally, in 1995, The International Labour Organization (ILO) and World Health Organization (WHO) responded to this public health crisis by launching an International Program on the Global Elimination of Silicosis in 1995. The program aims to eliminate silicosis in all countries by 2030.[17]

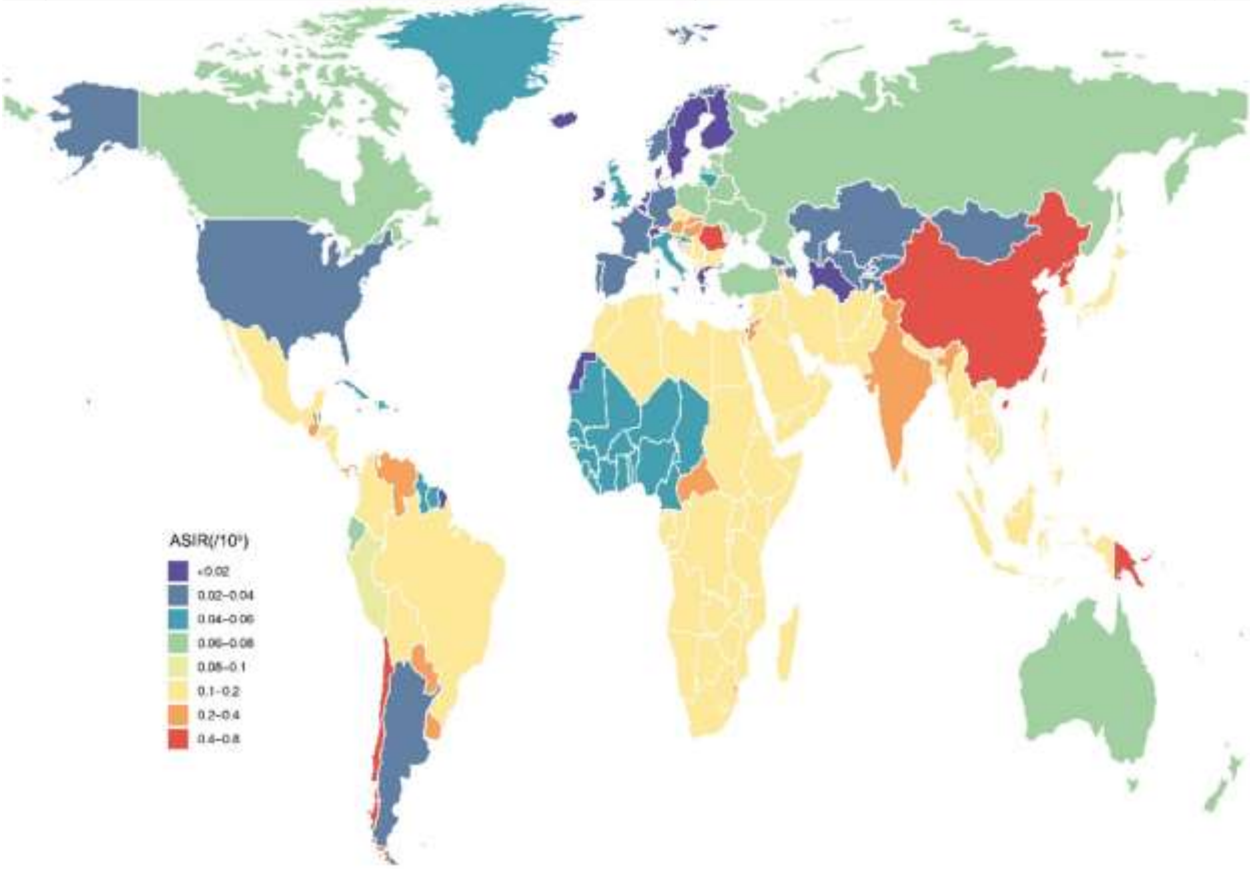

Figure 7. Age-standardized incidence rates (ASIR) for silicosis in 2017 reported by the Global Burden of Disease Study (Source: Department of Occupational and Environmental Health [14])

The prevention and control of silicosis face significant challenges due to under-reporting. Despite all efforts, awareness of silicosis is quite limited. A comprehensive national health program dedicated to silicosis control is absent in most countries, resulting in a lack of coordination among stakeholders. There are number of small entrepreneurs in India who do not even recognize silicosis risk in their plant. Same is the condition with workers – extremely poor awareness. Trade unions in India has grossly failed to pick up such issues. Poverty is another constraint. Sometimes workers despite of being informed of the risk they are ready to work in poor working conditions only to ensure that they earn sufficient to purchase bread and butter for their family. Detection programs, prevention practices and training schedules are not adequately implemented.

Every country has been trying to adopt industry-specific silica exposure control measures. For example, in the UAE, sandblasting had been being used in the past during 1990s in almost all construction sectors to clean metals before painting, to finish concrete nicely etc. etc.. UAE banned sandblasting. Sand or any abrasive blasting media containing more than 1% free silica was prohibited from being used in abrasive blasting operations. All abrasive blasting is to be of recyclable, non-metallurgical abrasive material. No open blasting is allowed to be carried out unless approved by EHS with requisite controls as specified by the Authority [18] Implementation of strict laws has reduced the tendency of sandblasting, but it is not yet zero. Also, this regulation does not address the possible silica-exposure issues in other industries. Change of blasting media do not stop the risk of getting exposed to silica dust from the parent material like stone, concrete etc. which is being processes. Clause 13-1-1-3 of the Code of Construction Safety and Practices by Dubai Municipality [19] stops just mentioning that demolition workers who might get exposed to silica should wear adequate and suitable personal protective equipment (respiratory protection equipment, etc.). There is no mention of the exposure limits, measurement requirements of exposure, or details of respiratory control equipment to be used.

Similarly, in India, the authorities are detecting a major threat in mining and stone-crushing activities. Advisories are being issued for dust suppression. However, some other industries, like Agate workers in Gujrat (Prevalence rate 18%-69%), Stone Grinders in Gujrat (Prevalence rate 12%-25%), Slate Pencil workers in Madhya Pradesh (Prevalence rate 25%-55%), Pottery workers in Gujrat (Prevalence rate 15%) etc. [20] also have a substantial prevalence of silicosis and implementation of preventive regulations/ procedures are equally important for these industries.

The above makes it extremely essential that the causes and preventions of silicosis are discussed in the industry with greater importance and public cautiousness is developed to ensure a sustainably growing society.

SYMPTOMS OF SILICOSIS

When inhaled, tiny bits of silica dust particles become trapped in lung tissue, causing inflammation and scarring - making it hard to breathe. The particles also reduce the lungs' ability to take in oxygen. Figure 8 best illustrates silicosis.[21]

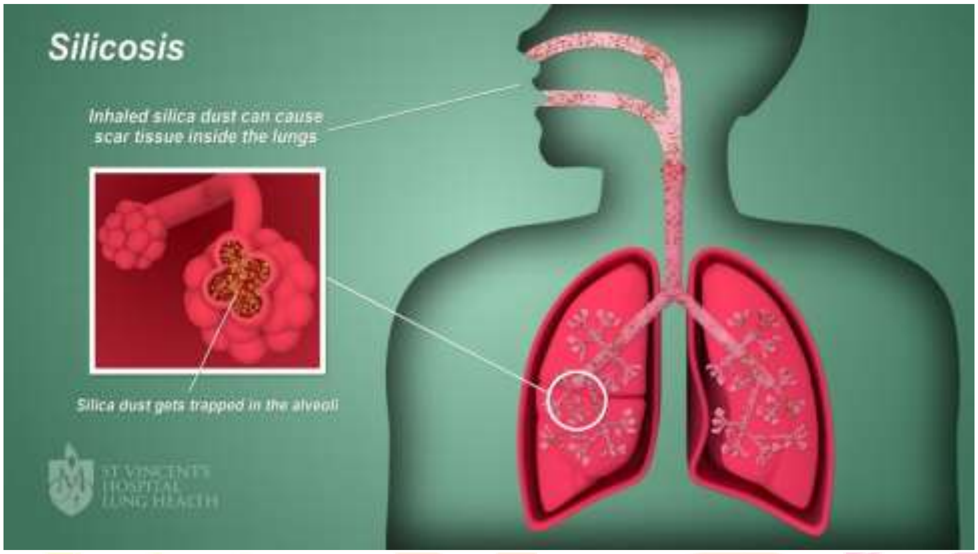

Figure 8. Picture Illustration of Silicosis.
(Source: Silicosis by St. Vincent's Hospital Lung Health[21]).

Silicosis results in permanent lung damage and is a progressive, debilitating, and sometimes fatal disease.

Symptoms of silicosis usually appear after many years of exposure. In the early stages, symptoms are mild commonly include bronchitis-like symptoms such as persistent cough, shortness of breath and difficulty breathing. People also suffer from weakness, fatigue, fever, night sweats, leg swelling and bluish discoloration of the lips. As the scarring continues to worsen, the first real signs of a problem may be an abnormal chest X-ray and a slowly developing cough.

The longer silicosis goes without treatment, the more likely it is to develop a complication. Because the disease affects the immune system, silicosis patients are vulnerable to developing tuberculosis, lung cancer, COPD, and kidney disease.

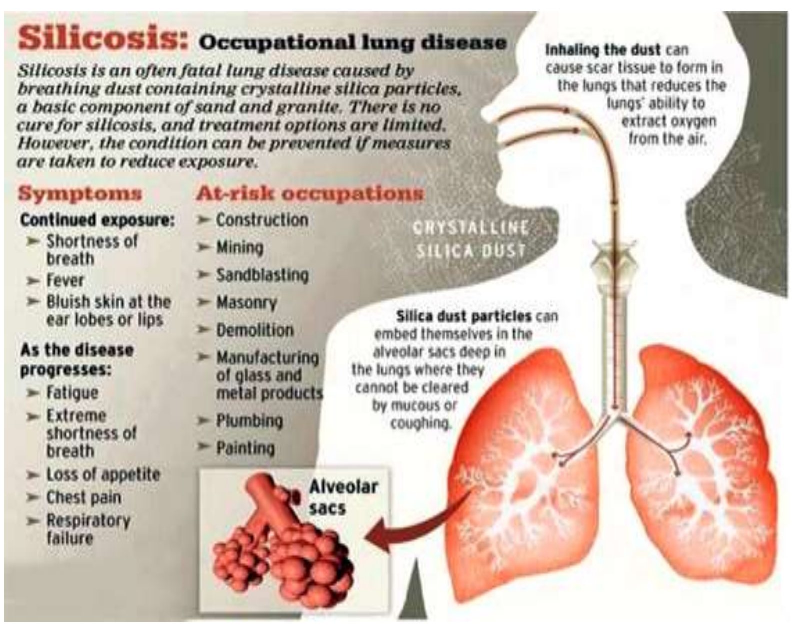

Figure 9. Picture presentation of Silicosis causes, symptoms, and risked professions.
(Source: drishtiias[24])

There are three types of silicosis: acute, chronic, and accelerated. Each type of silicosis affects the body somewhat differently:

- In **acute silicosis**, the lungs become swollen (inflamed) and can fill with fluid. This causes severe shortness of breath and low blood oxygen.
- In **chronic silicosis**, the silica dust causes areas of swelling in the lungs and chest lymph nodes, which makes breathing more difficult.
- In **accelerated silicosis**, inflammation in the lungs and symptoms occur faster than in chronic silicosis.

Table 1. Symptoms of different types of Silicosis.

Type	Occurs when	Symptoms
Acute silicosis	Within a few weeks or years of silica exposure	Cough Weight loss Tiredness Sharp chest pain Breathlessness
Chronic silicosis	10 to 30 years after silica exposure	Inflamed lungs Fluid build-up Breathlessness Low blood oxygen
Accelerated silicosis	Within 10 years of frequent silica exposure	Swelling in the lungs Swelling in the chest lymph nodes Difficulty breathing

(Source: Silicosis by St. Vincent's Hospital Lung Health[21]).

DIAGONISIS OF SILICOSIS

In clinical examinations for silicosis, doctors first check the patient's breathing during rest and working conditions. Try to determine possible exposure to silica. The following aspects are essential.[21][22]

- The symptoms and the time they started
- Treatments given before for the symptoms and how they helped
- Professional history of the patient.
- The products the patient was in contact with at work and whether or not the patient wore protective equipment
- Smoking history
- Any old medical records, including chest X-rays or CT scans

Further, the following tests may be performed to determine silicosis:

- Imaging Tests (Chest X-ray or CT scan)
- High-Resolution Computed Tomography (HRCT)
- Lung Function Test – Spirometry and Diffusion capacity test
- Sputum Test
- Bronchoscopy
- Surgical Lung Biopsy

GLOBAL INCIDENCE, PREVALENCE AND DISEASE BURDEN

A Global Study on available data from 204 countries carried out by Xin Liu, Quingtao Jiang, Peihong Wu, Lei Han, and Peng Zhou [10] shows that incident cases of silicosis increased by 64.6%, from 84,821 cases in 1990 to 138,965 cases in 2019. Prevalent cases of silicosis grew from 1,383,913 in 1990 to 2,648,973 in 2019, which showed an increase of 91.4%. DALYs due to silicosis rose by 20.8% from 577,390 to 1990 to 655,763 in 2019.

However, the age-standardized incidence rate (ASIR) was found to have decreased by an average of 0.5% per year ($p < 0.05$) in the same period (from 1.86/100,000 in 1990 to 1.65/100,000 in 2019, and the age-standardized prevalence rate (ASPR) declined from 33.13/100,000 in 1990 to 31.60/100,000 in 2019 by an average of 0.2% each year. The age-standardized DALY rate (ASDR) was reduced from 13.88/100,000 in 1990 to 7.87/100,000 in 2019, with an AAPC of 2.0%

Table 2. Global Trends on Incidence of Silicosis 1990 to 2019

Location	ASIR, 1990 (×1/10^5)	ASIR, 2019 (×1/10^5)	Percentage changes, 1990–2019 (%)	AAPCs, 1990–2019 (%)	Incident cases, 1990	Incident cases, 2019
Global	1.86(1.51–2.29)	1.65(1.36–1.98)	-11.29	-0.5*(-0.7~-0.3)	84,421	138,965
High SDI	0.62(0.48–0.81)	0.42(0.36–0.50)	-32.26	-1.5*(-1.9~-1.1)	6320	6841
High-middle SDI	2.69(2.19–3.32)	2.53(2.08–3.02)	-5.95	-0.3*(-0.6~-0.1)	30,885	49,260
Middle SDI	2.94(2.36–3.66)	2.48(2.01–2.96)	-15.65	-0.7*(-1.0~-0.4)	39,793	68,908
Low-middle SDI	0.91(0.75-1.08)	0.83(0.69-1.00)	-8.79	-0.4*(-0.5~-0.2)	6903	12,986
Low SDI	0.20(0.16–0.25)	0.17(0.14–0.22)	-15.00	-0.5*(-0.6~-0.4)	520	970

Note: ASIR: Age-standardized incidence rate; AAPCs: Average Annual Percentage Change; SDI: Socio-Demographic Index. The data in parentheses are 95% uncertainty intervals. *$P < 0.05$

(Source: Global incidence, prevalence and disease burden of Silicosis...[10])

Table 3. Global Trends on Prevalence of Silicosis 1990 to 2019

Location	ASPR, 1990 (×1/10^5)	ASPR, 2019 (×1/10^5)	Percentage changes, 1990–2019 (%)	AAPCs, 1990–2019 (%)	Prevalent cases, 1990	Prevalent cases, 2019
Global	33.13(26.71–42.19)	31.60(26.06–37.87)	-4.62	-0.2(-0.5~0.0)	1,383,913	2,648,973
High SDI	7.76(5.98–10.46)	5.82(4.93–6.93)	-24.91	-1.0*(-1.6~-0.5)	80,954	103,106
High-middle SDI	46.94(37.74–58.93)	45.75(37.80-55.27)	-2.52	-0.1(-0.4~0.2)	514,816	934,452
Middle SDI	58.75(46.76–75.94)	52.14(42.61–63.10)	-11.25	-0.4*(-0.9~-0.0)	675,240	1,376,876
Low-middle SDI	16.02(13.15–19.17)	15.47(12.89–18.35)	-3.45	-0.2*(-0.3~-0.0)	106,822	222,347
Low SDI	2.55(2.06–3.14)	2.40(1.93–2.99)	-5.78	-0.2*(-0.4~-0.1)	6016	12,114

Note: ASPR: Age-standardized prevalence rate; AAPCs: Average Annual Percentage Change; SDI: Socio-Demographic Index. The data in parentheses are 95% uncertainty intervals. *$P<0.05$

(Source: Global incidence, prevalence and disease burden of Silicosis...[10])

Table 4. Global Trends on DALY of Silicosis 1990 to 2019

Location	ASDR, 1990 (×1/10^5)	ASDR, 2019 (×1/10^5)	Percentage changes, 1990–2019 (%)	AAPCs, 1990–2019 (%)	DALY, 1990	DALY, 2019
Global	13.88(10.81-17.00)	7.87(6.25–9.96)	-43.30	-2.0*(-2.2~-1.8)	577,390	655,763
High SDI	5.48(4.88–6.33)	1.98(1.61–2.82)	-63.87	-3.5*(-3.8~-3.2)	57,818	37,443
High-middle SDI	16.91(13.65–20.37)	9.48(7.13–12.40)	-43.94	-2.1*(-2.3~-1.8)	185,018	192,032
Middle SDI	22.11(16.01–28.27)	12.50(9.70-16.09)	-43.46	-2.0*(-2.3~-1.7)	255,802	328,415
Low-middle SDI	10.59(5.91–14.19)	5.95(4.47–7.49)	-43.81	-2.0*(-2.2~-1.9)	68,609	84,548
Low SDI	4.16(0.99–7.71)	2.54(0.96–3.98)	-38.94	-1.7*(-1.9~-1.5)	10,079	13,283

Note: ASDR: Age-standardized DALY rate; AAPCs: Average Annual Percentage Change; SDI: Socio-Demographic Index. The data in parentheses are 95% uncertainty intervals. *$P<0.05$

(Source: Global incidence, prevalence and disease burden of Silicosis...[10])

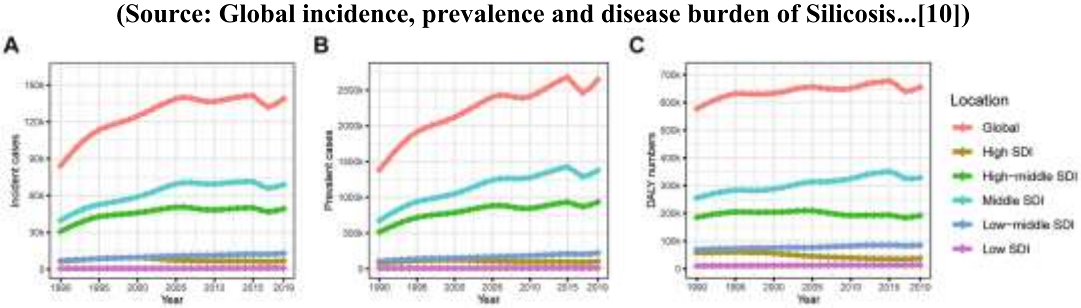

Figure 10. The changes in Incident, Prevalent cases, and DALY number of Silicosis 1990 to 2019 (A) Incident Cases (B) Prevalent Cases (C) DALY Numbers
(Source: Global incidence, prevalence and disease burden of Silicosis...[10])

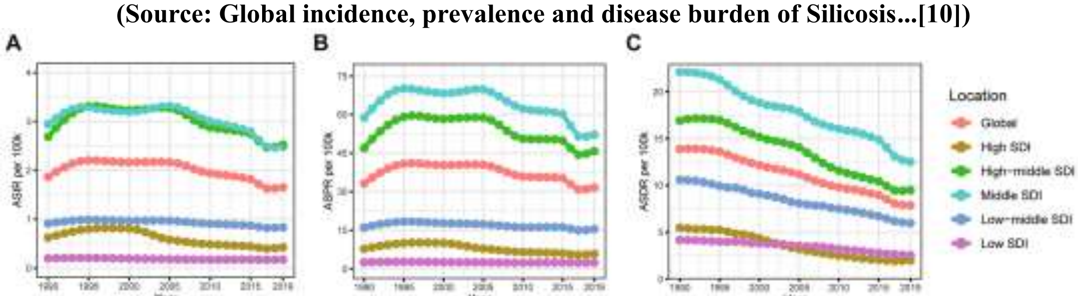

Figure 11. The ASRs of Silicosis from 1990 to 2019 (A) ASIR (B) ASPR (C) ASDR
(Source: Global incidence, prevalence and disease burden of Silicosis...[10])

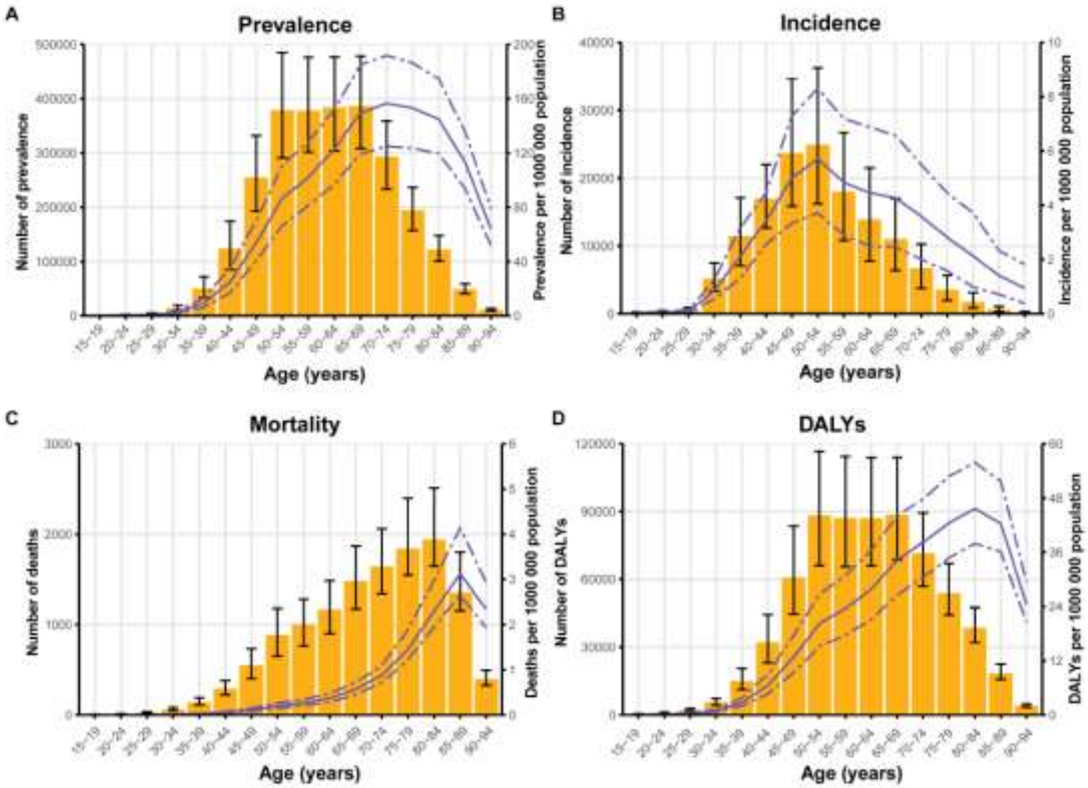

Figure 12. The ASRs of Silicosis by Age Group for prevalence (A), Incidence (B), Mortality (C) and DALYs (D) per 100,000 population in 2019
(Source: Current status, trends, and predictions in the burden of silicosis...[25])

The numbers and ASRs of silicosis by age group for prevalence (**A**), incidence (**B**), mortality (**C**), and DALYs (**D**) per 100,000 population in 2019. The yellow columns represent the numbers, while the purple lines reflect the ASRs. The error bar and dash-to-dash gap present the 95% UIs. ASRs, age-standardized rates; DALYs, disability-adjusted life years; UIs, uncertainty intervals.

Yi et al. [25], in the regional analysis for 2019, found the three regions with the highest prevalence of silicosis were all located in Asia. Ranked by ASRs, East Asia topped (110.240, 95% UI: 90.448 to 133.420), followed by Central Asia (31.600, 95% UI: 26.065 to 37.872), and South Asia (12.389, 95%UI: 9.473 to 16.498). East Asia also recorded the highest ASRs for incidence (5.780, 95% UI: 4.751 to 6.908), mortality (0.406, 95% UI: 0.317 to 0.556), and DALYs (24.610, 95% UI: 18.65 to 31.852) of silicosis. Notably, the 95% lower UIs for prevalence, incidence, mortality, and DALYs in East Asia surpassed the 95% upper UIs for these measures in all other regions. The finding of the study underscored a significantly elevated burden of silicosis in East Asia relative to other geographical regions.

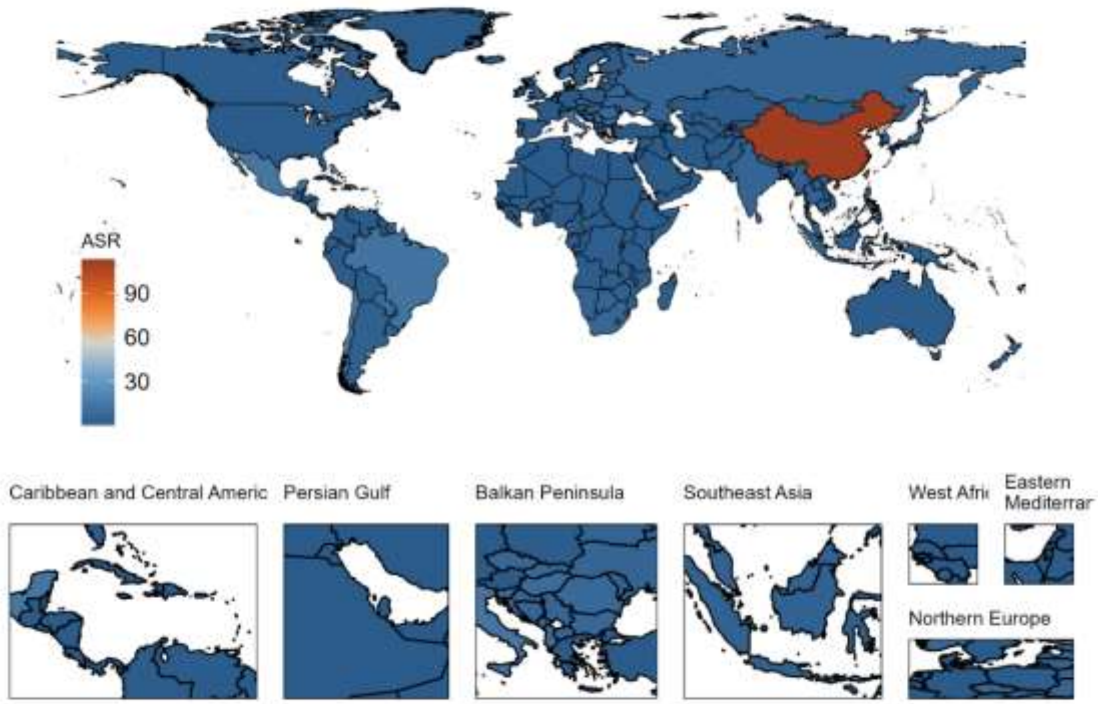

Figure 13. The ASRs of Prevalence of Silicosis per 100,000 population in 2019
(Source: Current status, trends, and predictions in the burden of silicosis...[25])

In India, silicosis is prevalent among construction and mining workers in Gujarat, Rajasthan, Pondicherry, Haryana, Uttar Pradesh, Bihar, Chhattisgarh, Jharkhand, Orissa, and West Bengal. Rajasthan has the highest prevalence rate [20][24].

The incidence rate of occupational diseases in the UAE is generally low. This is due to the country's policy of modernizing public health facilities and implementing stricter workplace control. However, recently, doctors have raised concerns about the rise of COPD, and they are associating it with the increasing smoking habit. While health agencies, government organizations, and public health specialists are campaigning against smoking, it becomes essential to pay more attention to other environmental and occupational factors like silica exposure since smoking, together with silica exposure, may lead to accelerated complications.[26]

TREATMENT, PREVENTION, AND CONTROL

There is no specific treatment for silicosis. Removing the source of silica exposure is important to prevent the disease from getting worse. Supportive treatment includes cough medicine, bronchodilators, and oxygen if needed. Antibiotics are prescribed for respiratory infections as needed. In most critical cases, lung transplantation may be prescribed.

A study by Haibing Yang [27] indicated that the survival times of silicosis stage I, II, and III, from the year of diagnosis to death, were 21.5, 15.8, and 6.8 years, respectively. 25 % of the silicosis patients had a survival time beyond 33 years. The mean death age of all silicosis cases was 56.0 years. The most common form of silicosis, chronic silicosis, takes at least ten years from first exposure to develop, and death does not typically occur until many years after that. The study also showed that in 52.2% of cases, silicosis was diagnosed approximately 9.1 ±5.7 years after the dust exposure had ceased. The progression rates of silicosis from stage I to II and from stage II to III were 48.2 % and 18.5 %, and the duration was 4.1 +/- 0.2 and 6.8 +/- 0.2 y, respectively.

Preventing Silicosis is extremely critical and can be achieved only by controlling the exposure to Respirable Crystalline Silica (RCS). OSHA standard 1910.1053 sets the Permissible exposure limit (PEL) at 50 $\mu g/m^3$, calculated as an 8-hour TWA. The employer must ensure that no employee is exposed to an airborne concentration of respirable crystalline silica in excess of the limit in all industries. It requires the employers to assess the exposure, set out control areas, demarcate the control areas, and regularly monitor the exposure condition in the control areas. The employees working in exposure conditions need to be provided with respiratory protection equipment. Regular medical examination has to be conducted. A baseline needs to be established for all employees working in exposure conditions before joining, and health monitoring needs to be carried out against the baseline.[29]

Further, OSHA standard 1926.1153 addresses respirable crystalline silica exposure in the Construction industry by setting the upper limit at 25 micrograms per cubic meter of air (25 µg/m3) as an 8-hour time-weighted average (TWA) under any foreseeable conditions. It requires employers to limit worker exposure to silica and enact protective measures when exposure is unavoidable. Supervisors must follow OSHA control methods or independently design dust control measures. All workplaces with crystalline silica must adhere to the permissible exposure limit (PEL).

Table 1 in OSHA's respirable silica standard outlines various construction processes and the accompanying dust control methods. Employers should use the table to guide their exposure protection decisions. [30]

OSHA's standard also requires all construction employees to:

- Write an exposure control plan: Employers must establish a plan listing all tasks that expose workers to respirable silica. Then, it needs to list all the protective measures in place on the construction site.
- Assign a competent person: The competent person must be present on the site and is responsible for reinforcing the exposure control plan.
- Offer medical exams: The standard requires employers to provide employee medical exams, including X-rays and lung function tests. Employees using respirators more than 30 days each year need to be tested every three years.
- Train workers about health hazards: Employers are also responsible for educating workers on the health hazards of silica. They should thoroughly explain the importance of protective measures and how employees can stay safe while working.
- Keep records of silica exposure: OSHA requires employers to keep records of silica exposure and medical exams.

Mine Safety and Health Administration (MSHA) continues to enforce the 2.0 mg/m^3 or lower standard for respirable coal mine dust. Samples are analyzed for silica content to determine if the respirable dust standard should be reduced to control the miner's exposure to silica.[31]

Silicosis is a notified disease in India under the Mines Act (1952) and the Factories Act (1948). The Factory Act of India (1948) mandates a well-ventilated working environment, provisions for protection from dust, reduction of overcrowding, and provision of basic occupational health care. The Department of Social Justice and Empowerment also hosts a 'silicosis portal.' A system of worker self-registration, diagnosis through district-level pneumoconiosis boards, and compensation from the District Mineral Foundation Trust (DMFT) funds to which mine owners contribute. The code makes it mandatory for all employers to provide annual health checks free of cost as prescribed by the appropriate Government.

DISCUSSION AND CONCLUSION

In India, Tuberculosis is an active disease. The government is running special schemes to treat and cure tuberculosis. Because the primary symptoms of Silicosis are similar to those of tuberculosis, silicosis is often diagnosed as tuberculosis in the beginning. Notifications do not happen in the early stages.

To date, India has not implemented a national policy for pneumoconiosis. Rajasthan is the first state to implement a policy on pneumoconiosis, including silicosis detection, prevention, control, and rehabilitation. However, the policy focuses more on rehabilitation/compensation than prevention.

The law requires employers to facilitate medical check-ups for employees. As can be seen from the list, the tests for early detection are pretty costly. Since there is no specific mention in the law, employers usually do not arrange silicosis detection tests for all employees. They are arranged only when the employee starts suffering extreme symptoms.

A number of times, poor employees prefer hiding the symptoms since they know that if they are certified as suffering silicosis, they will be stopped from going to the same job, and they might not find another safer job due to their lack of skills.

Silicosis may develop even after ceasing exposure to dust, so dust exposure must be monitored. However, collecting samples from the workplace might not be sufficient enough to indicate the actual exposure of a particular worker or a workgroup. Workers most vulnerable to silica exposure must be provided with personal sampling cyclones [32] and pumps attached to their dress, and the sample collected must be analyzed properly at the end of the shift.

Such effort will be able to cover up the issue associated with long working hours as well as the continuously varying dust level for the workers working in small crushers for road work and other infrastructure work in the open field.

There are so many different types of respiratory masks available in the market. Due to a lack of knowledge, employers tend to choose masks that are not suitable for the particular type of work. On the other hand, due to a lack of training, the employees feel uncomfortable working with masks and tend not to use the mask even though it is provided.

In UAE, though suspended particle monitoring in the workplace is advised, proper coverage of all activities is not being possible since a personal monitoring siphon has not yet been made mandatory as a part of PPE.

Though saw cutters, grinders, and polishers equipped with dust suction technology have been marketed, the use of such technologies has not been made mandatory and has been left to the developers/Employers.

All the above reemphasizes the requirement of implementing a clearly defined national policy in line with the ILO/WHO program. In a country like India, the Government should consider subsidizing PPEs, including respiratory protection and high-end construction equipment with dust control mechanisms. Research on alternative materials needs further promotion to ensure sustainable development.

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