ORIGINAL ARTICLE

Qualitative method to re-evaluate cases of acute and accelerated silicosis from West Bengal

Pinaki Sensarma[1], Soumya Sarkar[2], Ujjwala Gupta[3], Jitumoni Rajkonwar[4], Sabrina Khan[5]

[1,5]Department of Public Health. MSHM Knowledge Campus, Kolkata

[2]Program Lead. Department of Immunization Technical Support Unit, MOHFW New Delhi

[3]Assistant Professor, Department of Public Health, Yenopia University, Mangalore

[4]Ph' D Scholar, Department of Public Health, SRM University, Gantok Sikkim

CORRESPONDING AUTHOR

Dr. Pinaki Sensarma, Associate Professor, Department of Public Health, NSHM Knowledge Campus, Kolkata Institution, West Bengal

Email: pinaki.sarma@nshm.com

CITATION

Sensarma P, Sarkar S, Gupta U, Rajkonwar J, Khan S. Qualitative method to re-evaluate cases of acute and accelerated silicosis from West Bengal. Journal of the Epidemiology Foundation of India. 2026;4(1):111-121. DOI: https://doi.org/10.56450/JEFI.2026.v4i01.014

ARTICLE CYCLE

Received: 11/01/2026; Accepted: 05/03/2026; Published: 31/03/2026

COPYRIGHT

© The Author(s), [2026]. Published by the Journal of the Epidemiology Foundation of India (JEFI) under a Creative Commons Attribution 4.0 International License (CC BY 4.0).

ABSTRACT

Background: A marginal farmer's income is inadequate to sustain a decent living. Hence, they work in brick fields or similar jobs during the lean season, which generates respirable dust containing silica. Lungs are sensitised. Lung already sensitised to crystalline silica, and the lack of use of personal protection equipment during this work worsen the symptoms. **Objectives:** Evaluate the actual cumulative period of exposure in brick fields and ramming mass industry. Combine the Direct Acyclic Graph and Bradford Hill Graph to identify the causal pathway. To find out the epidemiological pathway, follow a characteristic pathway. **Results:** Twenty-five workers are affected by Silicosis; two medical officers of the local hospital and one interviewee have been interviewed in depth. Thematic content analysis using open, axial, and selective has been used for coding. Interviews have been coded as explained, and reached saturation. Objectives has been achieved by eight interviews. Data Triangulated with ILO/WHO radiographic grade (mostly 1/2/3), health camp data, and DAG modelling of confounders such as chronic malnutrition. Worked in the brickfield for some years, not recorded, the only record is of the brickfield lung already affected by respirable crystalline silica only worsens even for a short time. . ILO ratings indicated moderate to severe profusion; all Bradford Hill requirements were satisfied, affirming cumulative RCS as the causative factor inside migratory chains from farms to kilns through intermediaries. **Conclusion:** Gradual improvement in the social and economic context and advocacy for active community nutrition, promotion of personal protective equipment and screening may prevent silicosis.

KEYWORDS

Ramming Mass, Chest X-ray, Severe Silicosis

INTRODUCTION

Income from agriculture is inadequate for marginal farmers for a decent living in rural areas as per recent economic analysis. Marginal farmers are defined as farmers who own very small plots of agricultural land,

typically less than one hectare (about 2.5 acres)(1).

Evidence shows that the number of such farmers is staggering in North 24 Parganas, where the case studies have been done. Marginal farmers in North 24 Parganas often turn to seasonal brickfield labor to supplement low agricultural incomes, enduring physically demanding work like brick moulding, carrying, and loading under hazardous conditions(2,3).

These farmers, are typically from rural marginalized communities, face land scarcity and economic instability, pushing them into informal brick kiln jobs during off-seasons. Brickfields provide quick cash but trap workers in cycles of poverty due to minimal wages and debt bondage. Women and children frequently join, performing unorganised work force amid long hours from dawn to dusk(4).

Labor involves back-breaking tasks such as mixing clay, shaping bricks, and stacking in extreme heat or dust, leading to health risks like respiratory issues from silica exposure. No social security, poor housing, or access to healthcare exacerbates vulnerabilities, with enforcement of labor laws remaining weak. Migrants dominate, relocating seasonally within West Bengal for survival(5).

In the absence of a good, sustainable income, they are lured into working in ramming mass from neighboring areas. The job, though it involves long hours of work, they are provided accommodation and food. These marginal farmers lack skills and education to pursue other vocations and forced to work in the ramming massindustry. There is higher prevalence of acquiring sexually transmitted infection, HIV and Tuberculosis, soil transmitted helminthiasis.

Severity can be assessed by the complete clinical picture and radiological grading as per ILO.WHO grading criteria.

Minakhan, Basirhat health district, North 24 Parganas is an agricultural area. People from this area tend to migrate to other jobs as agricultural income for small farmers and agricultural laborers cannot fulfil the financial requirements of their families. The interviewed patients said that this is the reason for their migration to work in West Bardhaman stone quarries and crushing units that produce raw materials for ramming mas(2,3). They are also forced to live in the factory areas, increasing the duration and quantity of exposure manifold as they inhale the dust continuously. When Inhaled as a respiratory particulate matter, this dust, containing crystalline silica, causes progressive respiratory health problems. This problem may develop in less than 10 years. After developing acute symptoms, which forced them to abandon work in the stone quarry and crushing units to back to their home. At their home they attended health camps where they were diagnosed with silicosis. These cases were classified as acute and accelerated silicosis in a previous cases study by same researchers and already published earlier.

This was reported as a case study. In the current research authors are doing the analysis of pathways of disease development in the different socio economic and nutritional context.

“Ramming mass” is an specialised industrial material for many industries.

Workers involved in mixing, crushing, or handling of ramming mass are exposed to high level of silica dust inhalation risk, especially without proper protective measures. These granules constitute respirable crystalline fragments or respirable crystalline silica (RCF/RCS)

Respirable crystalline fragment particles which leads to lung fibrosis and severe respiratory impairment.

Once the clinical symptoms start deteriorating, they return to their villages. Diagnosis is delayed due to a lack of specialised healthcare, which worsens their condition(7,8).

West Bengal government has published a notification on “Silicosis Relief Rehabilitation and Treatment Policy – West Bengal(10).

Silicosis is widely prevalent in India. Silicosis was first reported in India in 1934 when a detailed investigation carried out in Kollar gold mines between 1940 and 1946 showed this as a serious problem(11). it has also been reported in various other mines like gold, uranium, mica, lead, zinc, sandstone, mineral processing, slate and a host of other minerals. A study in Rajasthan has shown a high prevalence of silicosis among the workers in

marble quarries. The prevalence had a range of 38.4% to as high as 78.5% in Karuali. Many silicosis cases were misdiagnosed as tuberculosis by clinicians as a result of a lack of awareness(12). Subsequent research and representation to various states governments by affected workers, Ngo's working on occupational health, and various others lead to the development of various acts and regulations which lead to the development of nationwide regulation of making silicosis a notifiable as well as compensable disease- Rajasthan model of detection, relief and rehabilitation model for silicosis victims. Silicosis is also a notifiable disease under Mines Act (1952), the Factories Act (1948), and the Building Act (1996) and can also be compensable under various state governments' laws through the chief inspector of factories(13).

Silicosis can be classified as acute, accelerated, or chronic.

1. Acute silicosis occurs with high-intensity, short-duration exposure. Patients present within weeks to 5 years of the initial insult. it resembles chronic silicosis
2. Chronic silicosis occurs after 10 years, or more often, at a low to moderate level of exposure.
3. Accelerated silicosis develops within 3 to 10 years of exposure to silica dust. It is associated with a higher level of exposure and a greater risk of progressive massive fibrosis. The diagnosis is based on a history of high levels of exposure within the preceding years and chest x-ray features of both acute and chronic silicosis.

The severity of silicosis is assessed by comparing serial X-ray, HRCT, and spirometry measurements. Spirometry measurements at the initial stages may show a restrictive pattern, progressing to an obstructive pattern, and finally to both.

For the present epidemiological research purpose, data obtained from the health camp was supplemented with in-depth probing of their history. Reasons for their migration, associated health and nutritional factors and poor access to healthcare to subsequent development of silicosis has been framed as per grounded theory hypothesis.

Objectives

1. To reevaluate the duration of exposure to silica dust in ramming mass industries or brick making industry, where both may be a source of silica dust exposure of variable intensity.
2. Validation of causal pathway through - Direct Acyclic Graph and matching Bradford Hill criteria
3. To compare the clinical and epidemiological findings of these cases with the pattern from other similar Indian studies to see any emerging pattern

Material & Methods

This study employed a qualitative research design to explore the occupational health trajectories and lived experiences of workers in the ramming mass industry.

All the diagnosed cases of silicosis who attended the health campinterviews have been eligible for in-depth interviews.

This approach was selected to understand the complex interplay between prior occupational history (specifically, brick kiln work) and other occupations where there is an exposure risk of RCF. Analysing the duration of work in the brick-in-brick field and ramming mass.

All the twenty five workers were interviewed in depth, Analysis of the 8 workers were analyzed after interviewing 8 worker, 2 medical officers and 1 recruiter (bhaya)

Researchers analysed 11 in-depth interviews. Among them, 8 have ramming mass workers, 2 are medical officers working in the hospitals, and 1 is arecruiter.

During the analysis of 8 workers in depth interview, a specific pattern has been emerging researchers decided not to proceed further with more analysis. (15, 16)

Eight workers have been interviewed in depth. As per the grounded theory hypothesis, when the researchers felt no additional previous occupational history could be obtained (on their lived in experiences) it was decided not to proceed further (During the interview process,

it was felt that theoretical saturation had been obtained or no new observation was likely to be recorded, so it was decided to end the interview and analyze the data.)

• **Labor Recruiter (n=1)** : A contractor involved in sourcing labor for the ramming mass industry.

3. Data Collection

In-Depth Interviews (IDIs) have been prepared to investigate the following

- Occupational history
- Migration patterns
- Daily work activities
- Use of personal protective equipment (PPE)
- Health-seeking behaviour
- Clinical observations (from medical officers)
- Recruitment patterns (from the contractor)

Doctor's Interviews: Focused on clinical diagnosis, severity of respiratory distress, and prognosis of the clinical conditions.

Recruiter Interview : Explored recruitment strategies, target demographics, and the rationale for sourcing labor from specific prior industries (e.g., brick kilns).

Data Analysis

All interviews were transcribed and subjected to Thematic Content Analysis. The analysis followed a three-stage coding process:

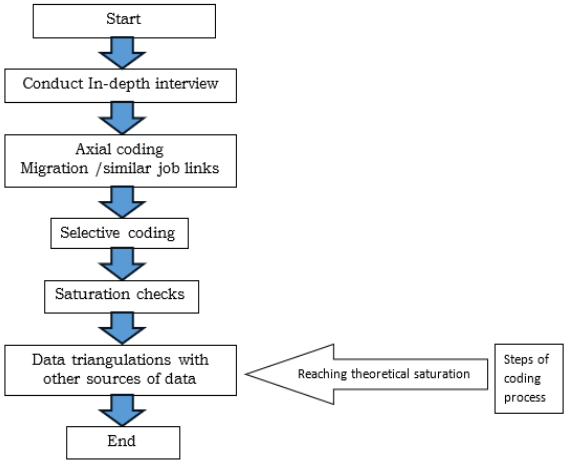
Open Coding : Identifying initial concepts (e.g., "dust exposure," "breathing trouble," "previous job").

Axial Coding : Connecting categories to reveal relationships (e.g., "Brick Kiln History" linked to "Recruitment Preference").

Selective Coding : Developing the core narrative of the study.

Triangulation was used to validate findings by cross-referencing worker narratives with medical reports and recruiter testimony to ensure reliability.

Iterative qualitative analysis until saturation



RESULTS

Social demographic profile and characteristics, ILO/WHO grading of the workers are given below. Results are reproduced from the earlier studies, which have already been referenced.

Table 1 : Recording of observation of the health camp

Duration of work in stone quarry / Ramming Mass Unit as recorded by Minakha Hospital	Please specify the duration you have worked there in stone crushingindustry there	Actual duration of work as stated during in-depth interview	ILO Rating
3 years		12 months	1/2 , p/p
5 years and 6 months		24 months	2/1 , p/q
7 months		18 months	3/2 , p/q
3 years and 6 months		12 months	2/2 , q/p
2 years		6 months	2/2 , p/q
6 years		18 months	2/3 , q/t
10 years	7-8 months	24 months	2/2 , r/r
2 years		4 months	1/1 , p/q
3 years		9 months	1/1 , p/p
3 years and 6 months		12 months	1/2 , q/r
8 years	?	13 months	
6 years	?		
3 years		7 months	1/1 , p/p
5 years		24 months	3/2 , r/r

2 months	12 months	1/1 , p/p
3 years	24 months	2/1 , q/q
8 years	15 months	1/1 , q/r
6 years	10 months	1/1 , p/q
4 years	15 months	1/2 , p/q
3 years	36 months	1/1 , p/p
6 years		3/2 , r/q
4 years	36 months	3/3 , q/r
3 years	13 months	?
8 months	20 months	Pneumothorax with colapsed lung Cnt be rated
3 years and 6 months	24 months	1/2 , p/q

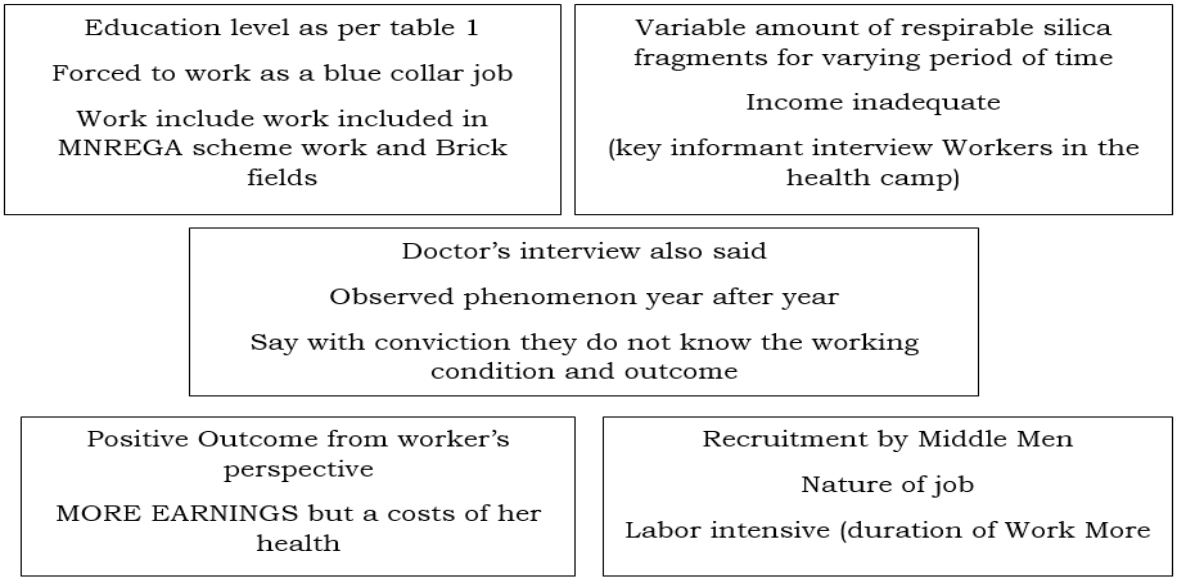
Analysis of the report from the health camp, as reported in the case series report(6).

Social and Economic Profile of the Patients 7 respondents belonged to the lower/lower income category, and 18 to the upper lower income category, as per the Kuppuswamy scale 16.

All respondents worked in the ramming mass in the West Bardhhaman district, which is a silicosis incidence district.

Analyse the in-depth interview

Image 1; Analysis of in-depth interview



In addition to their working hours, all the study subjects used to live in the factory premises.

One worker who is now a patient stated that "Sir, when the mills operate it is white powder all around, we cannot recognize each other"

Interviews of doctors corroborated the statement of the workers

All the workers were recruited by an agent from their village home in Minakhan block, North 24 Parganas and migrated to the mills in West Bardhaman.

They were aware of the hazards of their occupation as they knew others who has succumbed early to the disease. "We know that many people have gone to work, and many have died within a short time" – another patient told.

Both the medical officer, when interviewed, supports the statement of the workers

So even if they work for a short duration exposure is hugely cumulative- unrecorded duration of work in ramming mass, brick field other duration exposure –

Hypothesis : Events/sequencing fitting into Bradford Hill Cteria(17).

The development of silicosis among undereducated workers in the ramming mass industry can be systematically analyzed using

the Bradford Hill criteria. These criteria are a set of principles developed by Sir Austin Bradford Hill to evaluate causal relationships in epidemiological studies and are highly applicable in occupational health research. Here, I will provide a comprehensive analysis by applying each of the nine Bradford Hill criteria to the development of silicosis in this specific context:---

Strength of Association: Epidemiological studies have consistently shown a strong association between occupational exposure to respirable crystalline silica (RCFS) and silicosis. Workers exposed to high levels of silica dust, such as those in the ramming mass industry (a material often used for furnace linings with high silica content), experience significantly elevated risks of developing silicosis compared to unexposed individuals. For instance, a cross-sectional study of workers in silica-related industries demonstrated silicosis prevalence rates ranging from 11% to 26% depending on exposure duration and intensity (20,21,22).

Consistency: Numerous studies across various industries globally, including mining, stone cutting, ceramic production, and engineered stone fabrication, have demonstrated similar findings regarding the link between silica dust exposure and silicosis. The uniformity of these findings across different populations and settings strengthens the case for causality. For example, workers in artificial stone industries, where materials like ramming mass are common, have shown accelerated and acute silicosis even with relatively short-term, high-concentration exposures(18,19,20,21)

Specificity: Silicosis is uniquely caused by inhalation of crystalline silica particles, making this a highly specific association. While silica exposure may also contribute to other diseases (e.g., lung cancer, chronic obstructive pulmonary disease (COPD), and tuberculosis), silicosis itself is directly attributable to the fibrogenic effects of silica dust on the lungs, which cause progressive and irreversible scarring(23)

Temporality: The Bradford Hill criterion of temporality requires that the cause precede the effect. In silicosis, this criterion is satisfied because workers exposed to silica dust typically develop disease symptoms only after prolonged exposure durations or latency periods. Acute or accelerated silicosis, which has been observed in cases of high-level exposure in industries like the ramming mass sector, underscores how cumulative exposure over time directly correlates with disease onset(24,25)

Biological Gradient: The risk of silicosis shows a clear dose-response relationship with silica exposure levels. Higher cumulative exposure to silica dust results in increased disease prevalence and severity. For example, occupational studies have found that individuals with higher levels of silica dust exposure (measured in milligrams per cubic meter-year) had greater radiographic evidence of lung damage compared to their less-exposed peers(26).

Plausibility: Scientific evidence supports the biological plausibility of silica exposure leading to silicosis. When respirable silica particles are inhaled, they bypass the respiratory tract's natural defences and settle in the alveoli. These particles trigger persistent inflammation and fibroblast activation, culminating in fibrosis and scarring of lung tissue. This mechanism has been validated in both experimental animal studies and epidemiological observations.

The cause-effect relationship between silica dust exposure and silicosis is coherent with existing knowledge in occupational health and pathophysiology. It aligns with experimental data, clinical observations, and the natural history of the disease. Reports of silicosis outbreaks in industries like stone fabrication and ramming mass production provide further coherence, illustrating the predictable outcomes of high silica exposure without adequate protective measures

An experimental situation which can serve as an animal. Repeated inhalation of respirable crystalline silica can cause silicosis in mice; histological examination is proof of this. Also in experimental animals. Anti-diabetic drugs like metformin which is widely used can prevent silicosis. Pathway is Activating Autophagy via the AMPK-mTOR Signaling Pathway. This is beyond the scope in this research. But dust ex definite proof of dust exposure is en evident in pathway of Bradford Hill Criteria

Cause effect relationship: Marginal farmers enter adulthood with poor physiological reserves vulnerable to various silica dust exposure for it is ubiquitous presence. High RCF exposure ensures highly susceptible to high RCF in Ramming, Mass. Duration of exposure is additional problem(27,28)

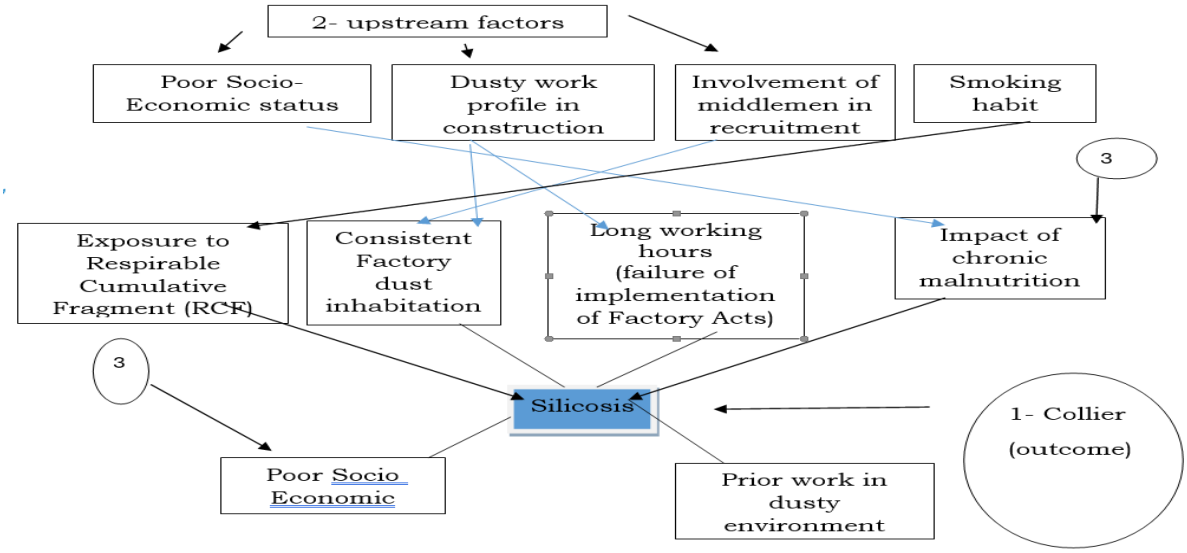
The workers are from low socioeconomic backgrounds. Body Mass Index lack sensitivity but is specific for chronic malnutrition in specific situation. Economic deprivation per se may may cause low body mass index. Again malnutrition is not linked to silicosis. Continuous exposure to low respirable crystalline silica primes the terminal respiratory tract to silicosis which is an additive effect. Therefore a pathway is a proposal for "Direct Acyclic Graph" with cofounder and collider (27,28,29)

Analyzing the confounder and collider: These elements: low socioeconomic status, prior dusty work (brick kilns, MNREGA-type manual work), recruitment by middlemen, smoking and other lifestyle factors (like smoking), chronic malnutrition, and cumulative respirable crystalline silica (RCS/RCF) exposure leading to silicosis. In the bulleted causal chain at the end, "cumulative RCF exposure" is influenced by several upstream determinants (e.g., recruitment, nature of job/duration, low SES factors), and "development of silicosis" is the outcome(30).

If in the DAG both "cumulative RCF exposure" and "likely from chronic malnutrition" (and/or other low-SES lifestyle factors) point into "development of silicosis" (or into a common intermediate such as "physiological vulnerability"), then that node is a collider on the paths connecting those upstream factors. Conditioning on that node (for example, restricting to silicosis cases only, or adjusting for "vulnerability" in a regression) will open non-causal paths between its parents and can induce spurious associations between them (classic collider bias).

Silicosis is a serious public health problem in unorganized sector. Work in dusty environment. Work in the unorganised sector means it is outside regulatory control. There is a delay in diagnosis 29. - It is to be noted that when the workers are unable to work, they are terminated and sent back home.(31)

Figure - Pathway of Direct Acyclic Graph for the Development of Silicosis among Ramming Mass Workers



Direct Acyclic Graph) – insert image here: Coding occupational histories from in-depth interviews with silicosis cases involves structured qualitative analysis to identify patterns in migration, work trajectories, and exposure risks. Grounded theory, as used in your prior ramming mass worker studies, provides a fitting iterative approach.History+1

Preparation Steps: Transcribe audio recordings verbatim, anonymizing participant

details like names or locations. Familiarise yourself with transcripts through multiple readings, noting recurring motifs such as marginal farming backgrounds or recruiter influences. Used software like QDA Minor Lite for efficiency, especially with 8 interviews reaching theoretical saturation

Open Coding Phase: Perform line-by-line coding to generate initial descriptive codes directly from the data. Examples tailored to your workers' histories:

- "Marginal farmer origins"
- "Migration to brick kilns for labor"
- "Recruiter-mediated placement"
- "Ramming mass tasks (ramming, dust exposure)"
- "Duration/intensity in each job"
- "Health symptoms onset".History+1

This phase yields 50-100 granular codes per transcript, capturing raw occupational narratives without preconceptions.

Axial Coding Phase: Group open codes into categories, exploring causal conditions, contexts, and consequences. Key categories from similar migrant silica studies:

Category	Sub-codes	Link to Silicosis
Migration	Farmer to kiln ; recruiter	Cumulative prior dust
Pathway	role; economic push	exposurepmc.ncbi.nlm.nih+1
Job	Brick kiln labor; ramming	Intensity ramps RCS
Sequence	mass shift; factory living	inhalation[pubmed.ncbi.nlm.nih]
Exposure	Dust levels; no PPE; short-	Accelerated disease
Factors	term high-intensity	onset[sciencedirect]
Confounders	Malnutrition/low BMI; low SES	Amplifies fibrosis risk[perplexity]

Connect categories (e.g., migration enables unmonitored exposure).pmc.ncbi.nlm.nih+1

Selective Coding Phase: Integrate categories into a core narrative, such as "Cumulative Silica Pathways via Migrant Labor Chains." Validate with constant comparison across your 8 cases and triangulation (e.g., medical records), refining until no new insights emerge. This builds theory on rapid silicosis in informal sectors, informing interventions.

Export codebooks as tables for your mixed-methods proposal, ensuring inter-coder reliability if collaborating.

Open coding

1. Marginal famers
2. Lack of employment and job opportunities
3. Lack of knowledge regarding occupational risk
4. Axial Coding

In this DAG, the main collider is silicosis, the main confounder (for the effect of silica exposure on silicosis) is chronic malnutrition from low SES, and the green boxes at the top are the key upstream factors. (image generated)

Collider in this graph

A collider is a node that has two or more arrows pointing into it.

Here, silicosis (red box) is a collider because it has incoming arrows from several blue boxes: cumulative RCF exposure, living in factory premises, long work hours, and chronic malnutrition.

Confounder in this graph

A confounder is a common cause of both the exposure and the outcome (a “parent” of each on a backdoor path).

If the exposure of interest is cumulative RCF exposure and the outcome is silicosis, then chronic malnutrition (from low SES) operates as a confounder: it is caused by low SES and also directly affects silicosis, while low SES also increases silica exposure, opening a backdoor path from exposure to outcome through SES and malnutrition.

Upstream factors

Upstream (distal) determinants are higher-level causes that influence more proximal, work-related risk factors.

In this figure, the upstream factors are the green boxes at the top:

Low socioeconomic status (Low SES)

Prior dusty work (MNREGA/brick kilns)

Recruitment by middlemen

Smoking

These upstream factors lead to the more proximal blue occupational conditions, which then influence silicosis 31.

Discussion

The case study of silicosis in the ramming mass industry highlights a cumulative exposure trajectory beginning in brick kilns and intensifying in ramming mass units. Workers with compromised lung function from prior low-grade exposures encountered exceptionally high levels of RCF in ramming mass units, leading to acute or accelerated silicosis. There is possibly no data that the socio-economically marginalised backgrounds, poverty, malnutrition, school dropout, and early labor force entry reduced physiological reserves and increased susceptibility. Recruiters exploited this vulnerability by offering slightly higher wages and free accommodation. Back and forth migration between Bricklin and other high risk jobs like ramming mass cannot be said with certainty but strong evidences exists other wise

Exploitation by middlemen or 'bahya" called among the workers due to poor awareness, inaccessible healthcare, and employer neglect, diagnosis occurred only after catastrophic lung damage had already occurred. Workers were routinely dismissed once they are not able towork..

Finally, the pattern of the problem of Silicosis in Eastern India

The study indicates a systemic, recurring pattern rather than isolated cases. West Bardhhaman and adjoining districts have small-scale, unregulated ramming mass units with extremely high RCS levels, attracting vulnerable migrants from agricultural areas.

The study demonstrates that severe respiratory morbidity among ramming mass workers is the predictable outcome of a cumulative exposure pathway. Pathways has already described earlier, 32,9. Occupational Health Hazards faced by workforce in the unorganized is well replicated here.

Where

Addressing Ethical Issues- Administrative permission has been obtained from State Institute of Health and Family Welfare, the competent authority to do provide administrative approval.

Institute Ethics Committee clearance has been provided by Jawahar Lal Medical College and Memorial Hospital, Kalyani nearest medical college where the stidy was conducted

Now Online softwareturboscribe and Notebook LLM have been used for transcribing the interview transcription and translation has been done using Notebook LLM, translation from Bengali to English. Throughout all stages of the research, the researchers have ensured that anonymity. During the process of coding has remained anonymous. As per nrms all the data will be kept in safe custody and destroyed after 5 years.

Conclusion

This is not an isolated one-off factory event but can be generalized event among labourers of the unorganised sector where back and forth movements have seen to be observed

Recommendation

Targeted surveillance: Include ramming mass units, stone crushing sites, and brick kilns in West Bengal's PPCS activities for mandatory registration, regular dust monitoring, and annual health screening of all workers using standardized ILO X-ray classification.

Engineering controls: Enforce source elimination of respirable crystalline silica through wet processing, local exhaust ventilation, and strict prohibition of worker housing within production premises in all small-scale silica-handling units.

Labour protection: Regulate middlemen recruitment with mandatory written contracts specifying silica hazards, exposure duration limits, and entitlements to free PPE, health monitoring, and compensation under state silicosis policies.

Social security integration: Extend disability pensions, rehabilitation benefits, and family cash transfers to migrant silicosis patients dismissed from informal work, linking them to MNREGA re-entry and skill development programs.

Research agenda: Conduct longitudinal cohort studies across Eastern India to quantify cumulative silica exposure pathways

(agriculture → brick kilns → ramming mass) and validate the proposed DAG through exposure measurement and clinical correlation.

Limitation of the Study

Work history, of only 8 ramming mass work history has been two medical officers and 1 recruiter has been analysed. . phenomenological sample limits statistical generalizability to all ramming mass or silica-exposed workers in India.

Relevance of the Study

The study shows how marginal farmers from North 24 Parganas move into brick kilns and then ramming mass units, accumulating silica exposures across multiple informal jobs before presenting with acute or accelerated silicosis. This shifts the frame from "isolated factory outbreak" to a broader, life-course exposure trajectory in the unorganized sector.

Authors Contribution

All authors have contributed equally.

Financial Support and Sponsorship

Nil

Conflict of Interest

There are no conflicts of interest.

Acknowledgement

We acknowledge the contribution of Mr Samit Kr Carr of OSHAJ, Jamshedpur. Dr. Mihir Ruapni Director, ICMR, Dr Kamalesh Sarar, former director UCMR, and Dr Anup Dutta, Sharamajeevi Hospital. Srirampur for their suggestion and active guidance

Declaration Of Generative AI And AI Assisted Technologies In The Writing Process

Notebook LM for Analysis of Interview and Perplexity AI for geerating the outline of Direct Acyclic Graph

References

1. Gulati A, Saini S, Roy R. Going beyond agricultural GDP to farmers' incomes. In: Gulati A, Roy R, Saini S, editors. Revitalizing Indian agriculture and boosting farmer incomes. Singapore: Springer; 2021. p. 281-318. doi: 10.1007/978-981-15-9335-2_10.
2. Mandal A. Comparative study of marginal farms in India vis-à-vis West Bengal; evidences from last decade [Internet]. Economic Affairs. 2016 Dec Available from: https://doi.org/10.5958/0976-4666.2016.00073.5
3. Lundgren-Kownacki K, Kjellberg SM, Gooch P, et al. Climate change-induced heat risks for migrant populations working at brick kilns in India: a transdisciplinary approach. Int J Biometeorol. 2018;62(3):347-358. doi:10.1007/s00484-017-1476-0
4. Chattopadhyay AK, Kundu RK. Transition from agriculture to non-agriculture occupations in West Bengal, India: causes and way forward [Internet]. Asian J Agric Dev Available from: https://doi.org/10.37801/ajad2023.20.2.4.
5. Nicolaou L, Sylvies F, Veloso I, Lord K, Chandyo RK, Sharma AK, Shrestha LP, Parker DL, Thygerson SM, DeCarlo PF, Ramachandran G, Checkley W. Brick kiln pollution and its impact on health: a systematic review and meta-analysis. Environ Res. 2024;257:119220. doi: 10.1016/j.envres.2024.119220. Epub 2024 May 246. SS
6. Sarkar S, Sensarma P, Khan SJ, Rajkonwar J, Carr S. Case series of acute and accelerated silicosis among ramming mass workers from West Bengal. Int J Community Med Public Health. 2025 Jul;12(8):3781-3788. doi: 10.18203/2394-6040.ijcmph20252494
7. Tavakol E, Azari M, Zendehdel R, Salehpour S, Khodakrim S, Nikoo S, Saranjam B. Risk evaluation of construction workers' exposure to silica dust and the possible lung function impairments. Tanaffos. 2017;16(4):295-303
8. Omidianidost A, Ghasemkhani M, Azari MR, Golbabaei F. Assessment of occupational exposure to dust and crystalline silica in foundries. Tanaffos. 2015;14(3):208-212.
9. Carr SK. Ramming mass industry is fatal for workers. Down To Earth. 2025 Apr 18. Available from: https://www.downtoearth.org.in/health/ramming-mass-industry-is-fatal-for-workers.
10. Government of West Bengal, Health & Family Welfare Department. National Health Mission. Activities and Programme for Prevention and Control of Silicosis [PP&CS] [www.wbhealth.gov.in DO dated 10/08/2022.
11. Rao SS. Silicosis in India. Br Med J. 1934;1(3832):1094. doi:10.1136/bmj.1.3832.1094
12. Mlika M, Adigun R, Bhutta BS. Silica-Induced Pneumoconiosis [Archived]. 2023 Aug 17. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 30726026.
13. Sharma N, Kundu D, Dhaked S, Das A. Silicosis and silicotuberculosis in India. Bull World Health Organ. 2016;94(10):777-8. doi: 10.2471/BLT.15.16355
14. Baum L, Arnold TC. Silicosis. [Updated 2023 Aug 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK594245/

15. Chun Tie, Y., Birks, M., & Francis, K. (2019). Grounded theory research: A design framework for novice researchers. SAGE open medicine, 7, 2050312118822927. https://doi.org/10.1177/2050312118822927
16. McLeod S. Grounded Theory In Qualitative Research: A Practical Guide.(URL; https://www.simplypsychology.org/wp-content/uploads/simplypsychology.org-Grounded-Theory-In-Qualitative-Research-A-Practical-Guide.pdf
17. Hossain SR. Modified Kuppuswamy scale updated for the year 2025 [Letter to the Editor]. Int J Community Med Public Health. 2025;12(5):2423-5. doi: 10.18203/2394-6040.ijcmph20251411.
18. Shimonovich, M., Pearce, A., Thomson, H., Keyes, K., &Katikireddi, S. V. (2021). Assessing causality in epidemiology: revisiting Bradford Hill to incorporate developments in causal thinking. European journal of epidemiology, 36(9), 873–887.
19. Shimonovich, M., Pearce, A., Thomson, H., Keyes, K., &Katikireddi, S. V. (2021). Assessing causality in epidemiology: revisiting Bradford Hill to incorporate developments in causal thinking. European journal of epidemiology, 36(9), 873–887. https://doi.org/10.1007/s10654-020-00703-7
20. Aghilinejad, M., Naserbakht, A., Naserbakht, M., & Attari, G. (2012). Silicosis among Stone- Cutter Workers: A Cross-Sectional Study. Tanaffos, 11(2), 38–41.
21. Banks DE, Morring KL, Boehlecke BA, Althouse RB, Merchant JA. Silicosis in silica flour workers [Internet]. Am Rev Respir Dis. 1981;124(4):445-50. Available from: https://doi.org/10.1164/arrd.1981.124.4.445
22. Requena-Mullor M, Alarcón-Rodríguez R, Parrón-Carreño T, Martínez-López JJ, Lozano-Paniagua D, Hernández AF. Association between Crystalline Silica Dust Exposure and Silicosis Development in Artificial Stone Workers. Int J Environ Res Public Health. 2021 May 25;18(11):5625. doi: 10.3390/ijerph18115625. PMID: 34070293; PMCID: PMC8197517.
23. Jeebhay MF, Cavalin C, Chen W, Cohen RA, Fireman E, et al. Current global perspectives on silicosis—Convergence of old and newly emergent hazards. Respirology. 2022;27(6):387-398. doi: 10.1111/resp.14242. Accessed December 9, 2025.Hoy RF
24. Nowak-Pasternak, J., Lipińska-Ojrzanowska, A., &Świątkowska, B. (2022). Epidemiology of silicosis reported to the central register of occupational diseases over last 20 years in Poland. International journal of occupational medicine and environmental health, 35(5), 561–570. https://doi.org/10.13075/ijomeh.1896.0195024
25. Howlett P, Gan J, Lesosky M, Feary J. Relationship between cumulative silica exposure and silicosis: a systematic review and dose-response meta-analysis. Thorax. 2024;79(10):934-942. doi:10.1136/thorax-2024-221447
26. Mundt KA, Thompson WJ, Dhawan G, Checkoway H, Boffetta P. Systematic review of the epidemiological evidence of associations between quantified occupational exposure to respirable crystalline silica and the risk of silicosis and lung cancer. Front Public Health. 2025;13:1554006.
27. Howlett, P., Gan, J., Lesosky, M., & Feary, J. (2024). Relationship between cumulative silica exposure and silicosis: a systematic review and dose-response meta-analysis. Thorax, 79(10), 934–942.
28. Yang B, Lu X, Peng C, Meng X. ilicosis: from pathogenesis to therapeutics. Front. Pharmacol., 29 January 2025 .Front. Pharmacol., 29 January 2025 https://doi.org/10.3389/fphar.2025.1516200
29. Zaidi SH, Kw KL. Effect of general dietary deficiency and protein malnutrition on the fibrogenesis caused by silica dust in rats 30changesz. Archives of environmental health, 23(5), 365–372.
30. Rupani MP. Challenges and opportunities for silicosis prevention and control: need for a national health program on silicosis in India. J Occup Med Toxicol. 2023;18(1):11.
31. Kuncová M, Havránková J, Holusa R, Palecek F. Experimental silicosis of the rat: correlation of functional, biochemical and morphological changes. Arch Environ Health. 1971;23(5):365-372. doi:10.1080/00039896.1971.10666022
32. Howlett P, Mousa H, Said B, Mbuya A, Kon OM, Mpagama S, Feary J. Silicosis, tuberculosis and silica exposure among artisanal and small-scale miners: a systematic review and modelling paper. PLOS Glob Public Health. 2023;3(9):e0002085. doi: 10.1371/journal.pgph.0002085
33. Khetan M, Babu BV. Silicosis prevalence and related issues in India: a scoping review. J Occup Med Toxicol. 2025;20(1):3. doi:10.1186/s12995-024-00445-2.
34. Fluck B, Mahdjoubi L, Fluck D, et al. Disparity in the risk of exposure to respirable crystalline silica dust among non-manual and manual employees in the construction industry. Saf Extreme Environ. 2021;3(2):125-132. doi:10.1007/s42797-021-00037-x
35. Jindal SK. Silicosis in India: past and present. Curr OpinPulm Med. 2013;19(2):163–168. doi:10.1097/MCP.0b013e32835bb19e
36. Singh D, Carr SK, Sarkar B, Ali SI, Sarkar K. A cluster onset of acute and accelerated silicosis cases in workers of ramming mass industries in Jharkhand, Eastern India. J Family Med Prim Care. 2023;12(8):1654-1658. doi:10.4103/jfmpc.jfmpc_2518_22.
37. National Commission of Labour Available https://prsindia.org/files/bills_acts/bills_parliament/2007/bill150_20071205150_National_Commission_on_Labour_2_Chapter_7_unorganised_sector_Part_A_1.pdf
38. S. Srinivasan, N Tyagi. Respiratory diseases affected by informal workers. In: Shah IA, Sial QS, Fateh S, editors. Generative AI techniques for sustainability in healthcare security. Hershey (PA): IGI Global; 2025. p. 95-124. doi: 10.4018/979-8-3693-6577-9.ch006.