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The Impact of Occupational Cement Dust Exposure on Pulmonary Functions of Construction Laborers: A Cross-Sectional Study

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ABSTRACT

Cement is the most widely used construction material globally, yet prolonged exposure to cement dust, long working hours in dusty environments, and aging can impair pulmonary function. This study aimed to assess the association between cement dust exposure and lung function among construction workers, and to evaluate the prevalence and severity of respiratory symptoms across different exposure categories.

Objectives: The study aimed to determine the impact of cement dust exposure on the pulmonary functions of construction laborers.

Methods: This descriptive cross-sectional study was conducted from August to October 2025 among construction laborers working at SGRRIMHS construction sites, after obtaining informed consent and explaining the procedures. Spirometry was performed using an RMS Helios701 spirometer to measure forced vital capacity (FVC), forced expiratory volume in one second (FEV1), forced expiratory flow (FEF), minute ventilation volume (MVV), and peak expiratory flow rate (PEFR). Data were entered in an MS Excel spreadsheet and analyzed in SPSS version 21.

Results: In the present research, the pulmonary functions were assessed and correlated among construction laborers. This study has shown that pulmonary function parameters, such as Forced Vital Capacity (FVC), Forced Expiratory Volume in the 1st second (FEV1), the FEV1/FVC ratio, Maximum Ventilatory Volume (MVV), and Peak Expiratory Flow Rate (PEFR), were significantly decreased in construction laborers.

Conclusion: Working in dusty environments, along with other risk factors in cement factories, significantly reduces pulmonary function parameters.

Keywords: *Cement dust, Pulmonary and respiratory symptoms, Construction workers.*

INTRODUCTION

Emerging evidence from both developed and developing countries suggests that occupational health hazards and diseases among construction workers pose a significant public health challenge. Although occupational health hazards and conditions in the construction sector are varied, a growing body of research is focusing on respiratory health risks and diseases. However, a significant gap remains in the literature regarding comprehensive summaries of existing evidence. To address this gap, the present study systematically reviewed global evidence on occupational health hazards and associated respiratory conditions among construction workers. India ranks as the world's second-largest cement producer.[1] Cement dust consists of respirable particles with aerodynamic diameters between 0.05 and 5 µm, allowing them to reach and deposit in the alveoli.[3] When exposure exceeds the capacity of the body's homeostatic mechanisms, it may cause a progressive decline in lung function.[4] Occupational exposures can give rise to a spectrum of pulmonary diseases—from airway disorders and interstitial lung conditions to malignancies.[5] These work-related lung diseases

remain widely overlooked worldwide, especially in densely populated, resource-constrained regions such as India.[6] Although studies have reported mixed evidence regarding cement dust's role in respiratory symptom development and pulmonary function decline. [2-6] Most workers remain in the unorganized sector, where regular medical screening is infrequent and both labourers and health-care providers often lack sufficient awareness of occupational lung hazards.[7] The construction industry exemplifies this challenge, with a potentially high but undiagnosed burden of occupational lung diseases. In developing economies like India, the sector has witnessed remarkable growth—expanding at 5.6% annually between 2016 and 2020, compared to 2.9% during 2011–2015—and stands as a major source of employment.[8] Environmental conditions at construction sites—such as dust, fumes, and other respirable irritants—increase workers' vulnerability to respiratory morbidity.[9][10] Prolonged exposure at construction sites to cement dust, inorganic respiratory allergens, welding fumes, and other airborne irritants has been demonstrated to impair pulmonary function.[11][12] Additionally, employment in the construction industry is associated with a modestly increased risk of lung cancer. [13] Construction is one of the stable growing industries in the world, including India. The risks associated with hazards in the construction industry are eight times greater than those in the manufacturing sector [14]. It is one of the labour-intensive works, and construction workers perform high-risk work for meagre wages. Dusty tasks such as abrasive blasting, emptying bags of cement, cutting wood, and masonry expose workers to risk. Construction workers face numerous risks both in their workplaces and in their living environments. They are exposed to physical, chemical, biological, ergonomic hazards, and environmental and psychosocial risk, and the amount of dust is generated from the construction sites, including concrete, silica, asbestos, cement, wood, stone, and sand, which leads to exposure of workers to airborne dust.[15] In India, occupational health was ignored for a long time, which was one of the components included in the National Health Policy 1983. In the National Health Policy 2002 and 2015, it is mentioned that occupational health requires greater emphasis [16]. Currently, there is very limited data on the prevalence of respiratory disorders among construction workers in developing countries like India. From a rehabilitation perspective, it becomes imperative to highlight these impairments for appropriate prevention and intervention. However, the labourers' work is not considered significant, and they are supplied with a lack of amenities.[17] This study aims to investigate the prevalence of respiratory symptoms among construction workers in Dehradun, explore the contributing environmental and occupational factors, and highlight the importance of preventative measures to safeguard the health of this vulnerable group.

MATERIALS AND METHODS

It was a cross-sectional observational study conducted among construction labourers working at different sites at Shri Guru Ram Rai Institute of Medical Sciences, Dehradun, Uttarakhand. The study population comprised construction labourers aged 18–60 years, including masons, cement mixers, plasterers, concrete workers, tile setters/grout workers, and demolition workers, who had worked in cement-dust environments for at least one year and had no history of chronic lung disease or smoking, were included in the study. The study excluded participants who were current or former smokers and those with a known history of asthma, COPD, and tuberculosis. Sample size was calculated by using the 'Single Proportion Sample Size Formula'. Z = 1.96 (Z-score for 95% confidence level), p = 0.5 (assumed prevalence to achieve the maximum required sample size), q = 1 - p = 0.5, d = 0.07 (margin of error or absolute precision), n = (1.96)^2 * 0.5 * 0.5 / (0.07)^2, n = 3.8416 * 0.25 / 0.0049, n = 0.9604 / 0.0049, n ≈ 196,n_adjusted = n / (1 - r), - n = 196, r = 10% = 0.10 and n adjusted = 196 / 0.90 ≈ 217.78. After rounding up, the final adjusted sample size required is 218 participants. Construction workers were recruited from three construction sites in the field practice area of the institution, selected by convenience sampling. Structured questionnaire to collect information regarding respiratory symptoms such as cough, breathlessness, and wheezing. Pulmonary Function Tests (PFTs), including: FVC (Forced Vital Capacity), FEV_1 (Forced Expiratory Volume in 1 second), FEV_1/FVC ratio, PEFR (Peak Expiratory Flow Rate). Spirometry of study participation was done by a pre-calibrated Helios RMS 701 spirometer. Weight in kilograms was measured by a weighing scale, Height in meters was measured by a stadiometer, and BMI was calculated simultaneously. Data was then tabulated and statistically analysed. Data was reported as mean and their corresponding standard deviation (mean±SD). A p-value of <0.05 was considered significant(S), p<0.01 highly significant (HS), and p>0.05 as not significant (NS).

RESULTS

The present study includes 218 construction labourers, who were divided into 4 groups depending on their exposure to cement. In the present study, the mean age(years), height(metres), weight(kilograms) and BMI(kg/m^2) of construction labourers exposed for 1-3 years (n=52) was 32.96±6.4, 169.04±4.37, 69.84±5.84 and 24.45±2.12 respectively. In the present study, the mean age(years), height(metres), weight(kilograms), and BMI(kg/m2) of construction labourers exposed for 4-6 years (n=50) were 34.9±6.66, 169.12+5.43, 70.44±5.1, and 24.66±3.26respectively. In the present study, the mean age(years), height(metres), weight(kilograms) and BMI(kg/m2) of construction labourers exposed for 7-9 years (n=60) was 35.3±6.72, 170.04±4.36, 70.8±8.52 and 24.50±3.01respectively. In the present study, the mean age(years), height(metres), weight(kilograms), and BMI(kg/m2) of construction labourers exposed for >10 years (n=56) were 35.6±5.63, 169.02±6.44, 69.08±8.12, and 24.20±4.12, respectively, as shown in Table I. There is no significant difference in the age, height, weight, and BMI among all 4 groups in our study. In the present study, the pulmonary functions were assessed and correlated among all four 4groups of construction labourers on the basis of their cement dust exposure and correlated with each other. The study has shown that the pulmonary function parameters like the Forced Vital Capacity (FVC), Forced Expiratory Volume in the 1st second (FEV1), the ratio of FEV1/FVC%, Peak Expiratory Flow Rate (PEFR), Maximum Ventilatory

volume (MVV were significantly decreased with increase in the duration of exposure of cement dust in construction labourers except for FEVI/FVC when compared with each other as shown in table2. Long-term exposure to cement dust causes a decline in lung function for construction workers. Workers exposed for over a decade show significant lung impairment, experiencing a decline in key respiratory measures like forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). This also increases the likelihood of developing conditions like chronic bronchitis, a persistent cough, and other breathing problems.

Table 1: Anthropometric parameters of the study group (n=218)				
Parameters	**Study group**			
	Exposed for 1-3Year	**Exposed for 4-6 Years**	**Exposed for 7-9 Years**	**Exposed for >10 Years**
Age (mean±SD)	32.96±6.4	34.9±6.66	35.3±6.72	35.6±5.63
Height(cms)	169.04±4.37	169.12±5.43	170.04±4.36	169.02±6.44
Weight(kgs)	69.84±5.84	70.44±5.1	70.8±8.52	69.08±8.12
BMI	24.45±2.12	24.66±3.26	24.50±3.01	24.20±4.12
No. of workers(n)	52	50	60	56

Table 2: Comparing the effect of duration of exposure on pulmonary function parameters in all groups of construction laborers by ANOVA.						
Parameters	**Study group**				**ANOVAs** f-value	**P-Value**
	Exposed for 1-3Year (n=52)	Exposed for 4-6 Years (n=50)	Exposed for 7-9 Years (n=60)	Exposed for >10 Years (n=56)		
FVC	3.09±0.18	3.01±0.11	2.61±0.21	2.42±0.22	38.5	0.000*
FEV1	2.59±0.29	2.48±0.12	2.19±0.20	2.15±0.25	24.1	0.000*
FEV1/FVC%	85.08±2.55	84.88±1.96	83.75±2.80	82.52±2.35	2.32	0.079**
PEFR	7.84±0.54	8.01±0.21	7.31±0.31	7.20±0.78	16.1	0.00*
MVV	123.1±8.2	120.6±4.19	109.78±5.64	110.9±5.61	27.7	0.00*
Significant reduction in all pulmonary function parameters with the duration of exposure, except FEV1. Note: *p<0.05-Significant,**p>0.05-Not significant						

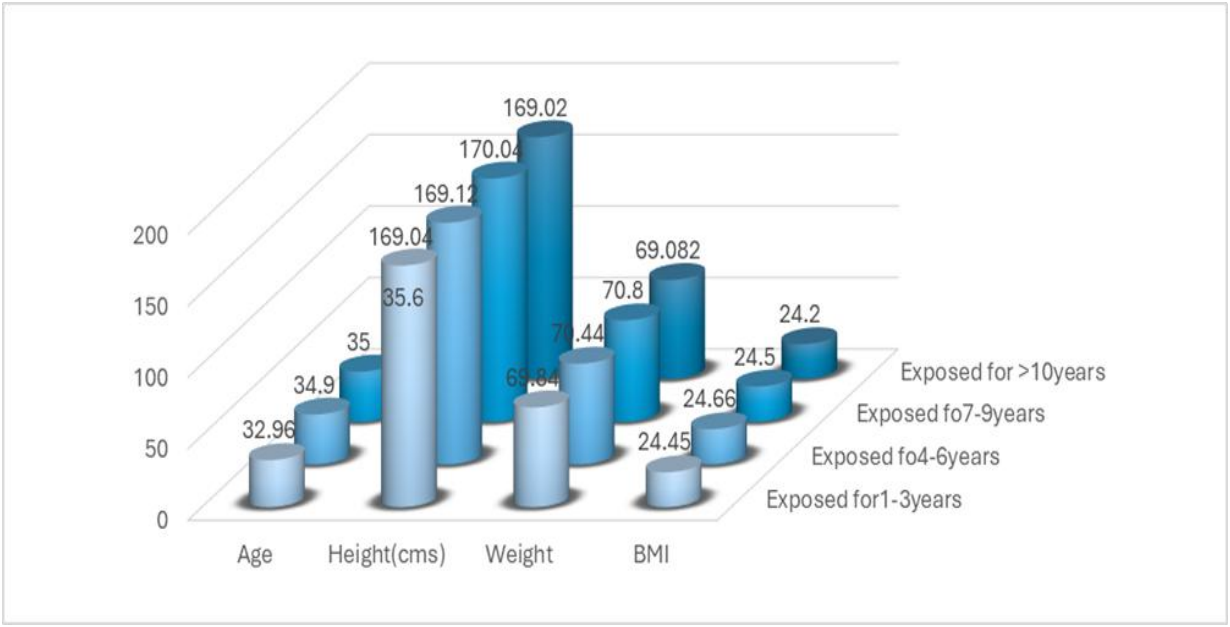

Figure 1: Anthropometric parameters of the study group (n=218)

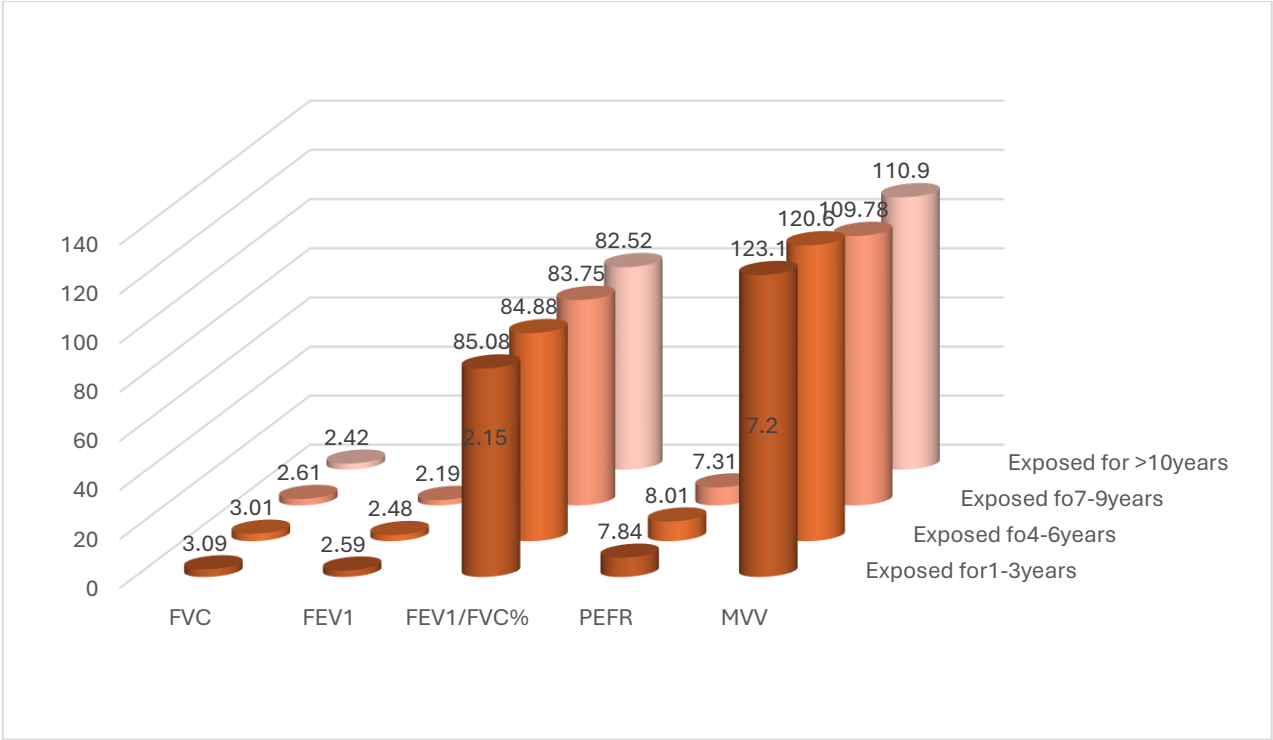

Figure 2: Comparing the effect of duration of exposure on Pulmonary function parameters in all groups of construction laborers by ANOVA.

DISCUSSION

Long-term exposure to cement dust, common in construction work, leads to a significant decline in lung function. This decline is directly related to the duration and level of exposure. The longer a worker is exposed, the more severe their symptoms become, including a persistent cough, breathlessness, and an increased risk of chronic bronchitis and sinusitis. Studies consistently show that workers with over ten years of exposure experience a significant reduction in key respiratory measures like Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and others. The presence of silica in the dust is a major contributor to these negative health effects. Deshmukh et al. [18] in their study found that respiratory symptoms like cough were the most common symptom, which were reported in 2/3rd of construction workers working in a cement dust environment. In another study by Kakooei et al, Chronic exposure to cement dust was significantly associated with the high prevalence of cough, wheezing, and dyspnea among the construction workers [20]. Some studies documented a statistically significant reduction in all Pulmonary Function Test parameters. In contrast, some documented a reduction in selected parameters, and only a few of the studies reported a reduction in none. Tavakol et al. in their study found that exposure to high amounts of silica leads to a significant reduction in pulmonary function [21]. Linch KD in his study finds higher levels of respirable crystalline silica in the ambient air of construction sites.[22] Meijer et al and Rafeemanesh et al. [23 & 24] reported a strong correlation between the duration of exposure to cement dust and pulmonary function decline. Extended exposure to cement dust among construction workers results in a progressive and statistically significant decline in respiratory function, increasing the likelihood of developing both restrictive and obstructive lung diseases, particularly after a decade of employment. To address these risks, it is crucial to implement workplace interventions such as enhanced protective measures, regular job rotation to reduce exposure duration, and routine medical check-ups to monitor workers' health.

Ethical approval: Approved by Shri Guru Ram Rai Institute of Medical & Health Sciences (Reference no. SGRR/IEC/17/25), and Informed consent was taken from all the participants.

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Conflicts of interest: There are no conflicts of interest.

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