Original Research Paper

Volume - 15 | Issue - 10 | October - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

General Medicine

STUDY OF LUNG FUNCTIONS IN CONSTRUCTION WORKERS EXPOSED TO CEMENT DUST: A CROSS-SECTIONAL STUDY

Dr. Maneesh Kumar Yadav*	Junior Resident, Department of Physiology, King George Medical University, Lucknow, India *Corresponding Author
Prof. Pradeep Kumar	Professor, Department of Physiology, King George Medical University, Lucknow, India
Prof. Shraddha Singh	Professor& Head, Department of Physiology, King George Medical University, Lucknow, India
Prof Archna Ghildiyal	Professor, Department of Physiology, King George Medical University, Lucknow, India

ABSTRACT **Background:** The construction industry is a major global job provider and vital to the economy. Cement dust contains various metal oxides and contaminants, yet there is limited research on its immediate health effects. AIM of study is to evaluate the lung functions in construction workers exposed to cement dust. **Materials:** This cross-sectional study conducted at physiology department of KGMU, Lucknow. Total 150 participants divided into three groups each group have 50 participants. Group I exposer duration 5 Years, Group III non-exposer(controlled). Age: 18-60 Years including male & female. Lung function test done by spirometry. Data analyzed using SPSS 24 version software. **Results:** Total population of 150 individuals, evenly split into three groups 50 (33.33%) in each, all were male (100%) across the three study groups This study demonstrates that prolonged exposure to cement dust is significantly associated with a decline in lung function among construction workers. Participants with more than 5 years of exposure (Group 2) exhibited a statistically significant reduction in chest expansion, FEV_1, and FVC compared to those with shorter exposure durations (Group 1) and non-exposed controls (Group 3). **Conclusion:** Our study reveals that long-term exposure to cement dust negatively affects pulmonary function, primarily showing a restrictive pattern. Key influencing factors are age, exposure duration, and chest expansion. Workers with prolonged exposure exhibited decreased FEV1 and FVC values; however, the FEV1/FVC ratio was stable, indicating no obstructive issues. These results highlight the importance of regular spirometry, safety regulations, and health education to reduce respiratory risks for construction workers exposed to cement dust.

KEYWORDS : Chronic Obstructive Pulmonary Disease, FEV1, FVC, FEV1/FVC Ratio

INTRODUCTION

The construction industry is one of the main sources of jobs worldwide and has paramount importance for the global economy. However, it is also one of the most dangerous activities. According to international Labour organization (ILO), about 108,000 workers die every year in construction sits across the world, corresponding to 30% of all fatal work accidents[1,2]. Environmental and pollution has always been a major cause of morbidity and mortality. The incidence of the occupational disease is constantly increasing throughout the world, especially in developing countries due to the lack of proper quality control documentation and the practical approach towards this mammoth problem[3].Cement dust contains various mental oxides including calcium oxide, silicon oxide, aluminium trioxide, ferric oxide, magnesium oxide, sand and other impurities[4]. In various parts of the world , a large number of workers are exposed to silica[5-7]. Respiratory illness with high prevalence and varying degrees of airway obstruction about Portland cement exposure have been reported by earlier investigators[8,9]. The situation of construction workers exposed to cement dust at construction site is about similar to the workers of cement industries. The construction workers are characterized by direct and indirect contact with cement dust and several studies reported significant pulmonary function impairment among construction workers. Among construction workers, the amount and length of exposure to a wide variety of contaminants causes clinical manifestations which might be classified as acute or chronic. Acute manifestations usually include upper airway obstruction, cough, wheezing and dyspnea. The pathophysiology of chronic exposure, in turn, might lead to chronic obstructive pulmonary disease (COPD), pneumonia, lung fibrosis and cancer, among others [10]. Some studies have investigated the changes in the pulmonary function of silica (component of cement dust) exposed workers. For instance, significant reduction in forced expiratory volume in the first second (FEV1), forced vital capacity (FVC) and the mean reduction in forced expiratory volume in the first second/forced vital capacity (FEV1/FVC) has been reported in silica-exposed workers [11-13]. The study evaluates lung function in construction workers exposed to cement dust, highlighting that the severity of effects is determined by the intensity, frequency, and duration of exposure. Progression of the disease can lead to ventilatory disorders. Monitoring pulmonary function parameters is essential for assessing disease prognosis, and implementing occupational exposure limits (OEL) is crucial for worker protection to reduce respiratory disease incidence.

This study investigates the effects of cement dust exposure on lung function in construction workers, specifically focusing on restrictive lung disease. The aims include evaluating spirometric parameters, such as FEV1 and FVC, as well as the FEV1/FVC ratio. The objectives further involve analyzing whether the observed changes in lung function are indicative of restrictive or obstructive lung disease.

Methods

The cross-sectional study conducted at the Department of Physiology, King George's Medical University (KGMU), Lucknow, aimed to assess health hazards associated with cement dust exposure among construction workers. It received ethical clearance from the Institutional Ethics Committee of KGMU (Ref. No. 21th PGTSC-IIA/P10, dated 28.10.2023) and took place over one year. Inclusion criteria encompassed male and female construction workers aged 18 to 60 years exposed to cement dust, while exclusion criteria involved individuals younger than 18 or older than 60, smokers, and those with chronic respiratory illnesses. A total of 150 participants were divided into three groups: 50 exposed to cement dust for less than 5 years, 50 exposed for more than 5 years, and 50 unexposed (control group). Recruitment occurred at construction sites in Lucknow, including cement shops and building construction areas, where discussions about health risks and benefits of lung function tests were conducted. After providing detailed explanations regarding the tests, written consent was obtained from reliable participants, and their medical histories were meticulously recorded following the established criteria. Those participants were allowed for test that full fill the inclusion and exclusion criteria as well as no sign and symptoms of respiratory illness like dyspnea, cough cold and fever. Anthropometric parameter (Weight, Height, BMI) were recorded. Lung function test had been performed by Computerized Spirometry (NDD Medizintechnik AG Easy on PC spirometer CH-8005). Proper instruction and demonstration of method of spirometry was given to all Participants. The spirometer was calibrated according to the manufacturer's instruction every day before starting test. The spirometry was done in standing position. Participants were worn a nose clip. The correct mouthpiece was selected that was fitted

comfortably and formed a tight seal around the participant's mouth. The participants were instructed to take a maximal inspiration, filling their lungs completely. Immediately after maximal inspiration, participants were instructed to exhale forcefully and completely through the mouthpiece. Same test was repeated thrice in similar pattern with a rest period of 05 minutes between each test. Best of the three reading were taken finally.

Statistical Analysis

Data will be entered into Microsoft Excel and analyzed using SPSS version 24.0. Continuous variables, such as lung function parameters (FEV_1, FVC, FEV_1/FVC ratio), will be expressed as mean ± standard deviation, while categorical variables (age groups, smoking status) will be presented as frequencies and percentages. Comparisons between exposed workers and reference populations will be made using independent t-tests or Mann–Whitney U tests for continuous data, and chi-square tests for categorical data. A p-value <0.05 will be considered statistically significant.

RESULTS

Total population of 150 individuals, evenly split into three groups, all were male (100%) across the three study groups, with no female participants included. Group 1 consisted of 50 construction workers who had been exposed to cement dust for under 5 years, representing 33.33% of the total study population. Group 2 included another 50 workers with over 5 years of cement dust exposure, also comprising 33.33% of the participants. The last group, Group 3, functioned as the control group and consisted of 50 individuals with no prior exposure to cement dust, making up the remaining 33.33% of the participants. (Table 1)

The mean ages of the study groups differed significantly, with Group 1 at 34.02 ± 4.08 years, Group 2 at 39.72 ± 6.67 years, and Group 3 at 37.06 ± 7.01 years (F-value = 10.00, $p < 0.001$). Additionally, mean height was significantly different among the groups ($p = 0.014$), with Group 2 being the tallest (166.38 ± 2.10 cm) compared to Group 1 (165.76 ± 2.68 cm) and Group 3 (164.84 ± 2.96 cm). In contrast, weight and BMI did not show statistically significant differences ($p = 0.834$ and $p = 0.260$), indicating they were comparable among all groups and unlikely to confound lung function assessment. (Table 2)

The study revealed that Group 1, with less than 5 years of exposure to cement dust, had a mean chest expansion of 4.43 ± 0.39 cm, comparable to Group 3 (non-exposed), which had a mean of 4.40 ± 0.44 cm. In contrast, Group 2, with more than 5 years of exposure, showed a significantly lower chest expansion of 4.06 ± 0.30 cm. The statistical analysis indicated a significant difference among the groups ($F = 14.56$, $p < 0.001$), suggesting that prolonged exposure to cement dust may lead to decreased chest mobility and potential respiratory issues.(Table 3)

Group comparison analyzed mean FEV_1 and FVC values among participants exposed to cement dust. Group 2 (over 5 years exposure) had the lowest mean FEV_1 (2.58 ± 0.18 L) and FVC (3.32 ± 0.19 L), indicating significant lung function compromise. Group 1 (less than 5 years exposure) showed slightly better values (FEV_1: 2.78 ± 0.10 L; FVC: 3.61 ± 0.17 L), while Group 3 (non-exposed) recorded the highest (FEV_1: 2.85 ± 0.20 L; FVC: 3.69 ± 0.23 L). Significant differences were observed in FEV_1 ($F = 35.57$, $p < 0.001$) and FVC ($F = 46.54$, $p < 0.001$) across groups. The FEV_1/FVC ratio was consistent across groups (Group 1: 0.77 ± 0.04; Group 2: 0.78 ± 0.04; Group 3: 0.77 ± 0.04) with no significant obstructive pattern. Additionally, the FEV_1/FVC percentage was also similar across groups, indicating no significant ventilatory defect (Group 1: 77.38 ± 4.31; Group 2: 77.72 ± 4.13; Group 3: 77.28 ± 3.90). This suggests that the percentage ratio of FEV_1 to FVC remains relatively unchanged regardless of cement dust exposure, further indicating an absence of significant obstructive ventilatory defect in the study population. (Table 4)

The post-hoc analysis of FEV_1 values revealed a significant reduction in Group 2 (over 5 years exposure) compared to Group 1 (under 5 years exposure) and Group 3 (non-exposed), with mean differences of 0.20 L and 0.27 L, respectively ($p < 0.001$). Group 1 and Group 3 showed no significant difference ($p = 0.124$), indicating minimal impact from short-term exposure. For Forced Vital Capacity (FVC), significant differences were noted between Group 1 and Group 2 (mean difference = 0.28 L, $p < 0.001$), and between Group 2 and Group 3 (mean difference = -0.37 L, $p < 0.001$), indicating declines with prolonged exposure to cement dust. Group 1 and Group 3 did not differ significantly ($p = 0.087$). Analysis of the FEV_1/FVC ratio showed no significant variations among groups (p-values ranging from 0.879 to 0.999). Similarly, the FEV_1/FVC percentage showed minimal differences across groups (p-values between 0.857 and 0.993), suggesting that cement dust exposure does not significantly alter this metric or indicate obstructive ventilatory impairment.(Table 5)

DISCUSSION

In our study, the mean age of participants showed a statistically significant difference across the exposure groups. Group 1 (exposed for 5 years exposure) had a mean age of 39.72 ± 6.67 years ($p < 0.001$), and the control group (Group 3) had a mean age of 37.06 ± 7.01 years. This difference is relevant, as age can independently affect pulmonary function due to physiological changes in lung elasticity and compliance over time. The study found no statisticlly significant age difference between the control group and the exposure groups. A similar age distribution was reported in the study by Sumana et al., where the mean age of construction workers was 36 ± 8.6 years and that of controls was 39.4 ± 12.9 years.[12] In the study by Sivakumar et al., most participants were in the age group of 18–30 years, followed by 31– 40 years, indicating that cement work commonly attracts younger individuals.[13] Dewangan et al. reported that participants ≥40 years were more likely to develop pulmonary dysfunction.[14] Our study found that workers who were exposed for a long time had a notable drop in FEV1 (Group 2: 2.58 ± 0.18 L) compared to Group 1 (2.78 ± 0.10 L) and the control group (2.85 ± 0.20 L). The decrease was statistically significant ($p < 0.001$), and this suggests a correlation between exposure duration and compromised pulmonary function. Dewangan et al. and Meo et al. reported similar findings, where FEV1 was markedly reduced in individuals exposed to cement dust, especially after 10 years of exposure.[14,15] Krishna et al. also observed a significant reduction in FEV1 values in exposed warehouse workers.[16] The studies by Sivakumar et al. and Alnawaiseh et al. reaffirmed these results, showing that FEV1 decreased progressively with increased exposure.[13,17] These data confirm the detrimental effect of cement dust on expiratory function, primarily through inflammatory and fibrotic changes in lung tissues.

In the present study, the FVC was lowest in Group 2 (3.32 ± 0.19 L), indicating reduced lung capacity due to long-term cement dust exposure. Group 1 had a mean FVC of 3.61 ± 0.17 L, and the control group had 3.69 ± 0.23 L. The difference was statistically significant ($p < 0.001$). This reduction points to a restrictive type of lung impairment. Supporting this, Krishna et al. and Zeleke et al. found that FVC values were significantly reduced in exposed groups.[10,16] Dewangan et al. also observed that FVC values decreased significantly with more than 10 years of exposure.[14] Shanshal et al. found that restriction was the most common spirometric abnormality in cement-exposed workers.[18] These findings affirm that prolonged cement dust exposure compromises lung volumes, leading to a restrictive ventilatory defect. Our study showed no significant difference in the FEV1/FVC ratio among the groups. Group 1 and Group 3 both had a mean ratio of 0.77 ± 0.04, while Group 2 had 0.78 ± 0.04 ($p = 0.868$). This evidence suggests that although both FEV1 and FVC declined in exposed groups, their proportional relationship remained stable, indicating a restrictive rather than obstructive pattern. Sumana et al. similarly reported no significant difference in the FEV1/FVC ratio among construction workers and controls.[12] Sivakumar et al. noted that this ratio could sometimes be misleading, especially when both FEV1 and FVC decrease simultaneously.[13] Meo et al. and Krishna et al. (2019) observed that the ratios were normal or slightly higher in groups exposed to cement dust, supporting our conclusion that cement dust mainly leads to restrictive lung disease rather than causing significant obstruction.[15,16] In our study, the percentage values of FEV1/FVC in our study—Group 1: 77.38 ± 4.31%, Group 2: 77.72 ± 4.13%, Group 3: 77.28 ± 3.90%—showed no significant variation ($p = 0.857$). This aligns with our finding of preserved FEV1/FVC ratios across groups. The lack of significant change in FEV1/FVC% indicates that the cement dust exposure may not result in an obstructive ventilatory pattern. Sumana et al. similarly reported that while the FEV1/FVC ratio was slightly higher in cases compared to controls, it was not statistically significant.[12] These results show that the main change in lung function from cement dust exposure is restrictive, and the FEV1/FVC% stays the same until the disease gets worse or mixed patterns appear. In our study, the impact of exposure duration was significant, with Group 2 (>5 years) showing markedly worse outcomes than Group 1 (<5 years). This conclusion is consistent with

several previous studies. Alnawaiseh et al. found that each additional year of exposure was significantly associated with decreased FVC and FEV1.[17] Meo et al. showed that workers exposed for over 10 years had significantly reduced lung function.[16] Dewangan et al. demonstrated that more than 10 years of service in dusty sections increased the risk of abnormal PFTs.[14] Krishna et al. also confirmed that individuals with more than 15 years of exposure had a higher risk of restrictive impairment.[16] These studies reinforce the progressive nature of cement dust-induced pulmonary damage and underscore the importance of early diagnosis and preventive interventions. Our study is limited by several factors: it only included male participants, which affects the generalizability to female construction workers; the sample size may not represent variations in lung function across different regions; it relied on spirometry, which does not capture long-term respiratory issues; confounding factors such as smoking history were not deeply analyzed; and its cross-sectional nature restricts causality conclusions regarding cement dust exposure and lung function decline. Recommendations include mandatory lung function testing, provision of PPE, workplace engineering controls for dust exposure, smoking cessation initiatives, and health education on occupational hazards.

CONCLUSION

Our findings confirm that prolonged exposure to cement dust is associated with a significant reduction in pulmonary function parameters, predominantly showing a restrictive pattern. Age, exposure duration, and chest expansion were found to be critical factors influencing lung function. Although FEV1 and FVC were reduced in long-term exposed workers, the FEV1/FVC ratio remained unaffected, indicating the absence of obstructive patterns. These findings emphasize the need for regular spirometry, strict enforcement of occupational safety regulations, and health education among construction workers to mitigate the adverse respiratory effects of cement dust exposure.

Table 1: Distribution of Study Participants Based on Cement Dust Exposure Duration

		n	%
Group 1	Exposure duration less than 5 years	50	33.33
Group 2	Exposure duration more than 5 years	50	33.33
Group 3	Non exposure	50	33.33

Table 2: Comparison of Mean Age, Physical Characteristics among the Study Groups

	Group 1 (n=50)		Group 2 (n=50)		Group 3 (n=50)		F	p-Value
	Mean	±SD	Mean	±SD	Mean	±SD		
Age(year)	34.02	4.08	39.72	6.67	37.06	7.01	10.00	<0.001
Hight(CM)	165.76	2.68	166.38	2.10	164.84	2.96	4.43	0.014
Weight(kg)	61.27	4.26	60.83	3.28	61.05	3.41	0.18	0.834
BMI kg/m2	22.32	1.39	22.05	1.23	22.46	1.12	1.36	0.260

Table 3: Comparison of Chest Expansion Among the Study Groups

	Group 1		Group 2		Group 3		F	p-Value
	Mean	±SD	Mean	±SD	Mean	±SD		
Chest expansion (CM)	4.43	0.39	4.06	0.30	4.40	0.44	14.56	<0.001*

Table 4. Comparison of FEV_1 (Forced Expiratory Volume in 1 Second), FVC (Forced Vital Capacity), FEV1 /FVC and FEV1/FVC % Ratio Among Study Groups

	Group 1		Group 2		Group 3		F	p-Value
	Mean	±SD	Mean	±SD	Mean	±SD		
FEV1(Ltr)	2.78	0.10	2.58	0.18	2.85	0.20	35.57	<0.001*
FVC (Ltr)	3.61	0.17	3.32	0.19	3.69	0.23	46.54	<0.001*
FEV1/FVC	0.77	0.04	0.78	0.04	0.77	0.04	0.14	0.868
FEV1/FVC %	77.38	4.31	77.72	4.13	77.28	3.90	0.15	0.857

Table 5. Post-Hoc Comparison of FEV_1,FVC, FEV_1/FVC and FEV1/FVC % Ratio Between Study Groups

			Mean Difference	p-Value
FEV1(Ltr)	Group 1	Group 2	0.20	<0.001
		Group 3	-0.07	0.124
	Group 2	Group 3	-0.27	<0.001
FVC (Ltr)	Group 1	Group 2	0.28	<0.001
		Group 3	-0.08	0.087
	Group 2	Group 3	-0.37	<0.001
FEV1/FVC	Group 1	Group 2	0.00	0.901
		Group 3	0.00	0.999
	Group 2	Group 3	0.00	0.879
FEV1/FVC %	Group 1	Group 2	-0.34	0.911
		Group 3	0.10	0.993
	Group 2	Group 3	0.44	0.857

REFERENCES

1. da-Silva-Filho PL, Botelho C, Castro HA, Ferreira MJM, Silva AMC. Prevalence and factors associated with respiratory symptoms among civil construction workers: an occupational health surveillance proposal. Rev Bras Med Trab. 2020 Jan 9;17(1):119129.
2. International Labour Organization Standards on occupational safety and health. Geneva: International Labour Organization; 2009. 459 p.
3. Li D, Zhu L, Zhang J, Yang J. Decomposing Differences of Health Service Utilization among Chinese Rural Migrant Workers with New Cooperative Medical Scheme: A Comparative Study. Int J Environ Res Public Health. 2021 Sep 2;18(17):9291.
4. Rahmani AH, Almatroudi A, Babiker AY, Khan AA, Alsahly MA. Effect of Exposure to Cement Dust among the Workers: An Evaluation of Health Related Complications. Open Access Maced J Med Sci. 2018 Jun 13;6(6):1159-1162.
5. Al-Neaimi YI, Gomes J, Lloyd OL. Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. Occup Med. 2001;51:367–73.
6. Thepaksorn P, Pongpanich S, Siriwong W, Chapman RS, Taneepanichskul S. Respiratory symptoms and patterns of pulmonary dysfunction among roofing fiber cement workers in the south of Thailand. J Occup Health. 2013;55:21–28.
7. Erhabor O, Kebbe BI, Isaac IZ, et al. Effect of occupational exposure of cement dust on some hematological parameters of workers in a cement company in Sokoto, Nigeria. Int J Med Sci Health Care. 2013;1(7):21–25.
8. Mirzaee R, Kebriaei A, Hashemi SR, Sadeghi M, Shahrakipour M. Effects of exposure to Portland cement dust on lung function in Portland cement factory workers in Khash, Iran. Iran J Environ Health Sci Eng. 2008;5(3):201–6. 7.
9. Neghab M, Choobineh A. Work related respiratory symptoms and ventilatory disorders among employees of a cement industry in Shiraz, Iran. J Occup Health. 2007;49:273–8.
10. Zeyede K Zeleke, Bente E Moen, Magne Bråtveit. Lung function reduction and chronic respiratory symptoms among workers in the cement industry: a follow up study. BMC Pulmonary Medicine. 2011;11:50.
11. Karkhanis V, Joshi JM. Cement dust exposure-related emphysema in a construction worker. Lung India. 2011;28(4):294–6.
12. Lakshmi Sumana P V, Alice Jemima M, Joya Rani D, Madhuri T. Cement dust exposure and Pulmonary function tests in construction site workers . Asian Pac. J. Health Sci., 2016; 3 (2):43-46
13. U. Sivakumar, Shaik Azmatulla, Kiran Buge, & Bhise R.M. (2021). A Study on Pulmonary Function Test among construction Workers. International Journal of Health and Clinical Research, 2021;4(13): 364–367
14. Dewangan, Pradeep Kumar; Verma, Nirmal; Shrivastava, Neha; Prasad, Manish A. Pulmonary Function Parameters and its Determinants among Cement Factory Workers in Chhattisgarh: A Cross-Sectional Study. Indian Journal of Public Health 65(3):p 226-230, Jul–Sep 2021.
15. Meo, S.A.; Al-Drees, A.M.; Al Masri, A.A.; Al Rouq, F.; Azeem, M.A. Effect of Duration of Exposure to Cement Dust on Respiratory Function of Non-Smoking Cement Mill Workers. Int. J. Environ. Res. Public Health 2013, 10, 390-398.
16. Krishna, L., Pandarikkal, J. R., Sreedharan, R., Sampson, U., Annamala, P. T., & Unni, K. M. Assessment of respiratory morbidity among loading and unloading workers exposed to cement dust. International Journal of Research in Medical Sciences, 2019;7(6): 2422–2427.
17. Alnawaiseh N, El-Gamal F. M. The Effect of Cement Dust Exposure on Lung Function among Cement Factory Workers. Biomed Pharmacol J 2022;15(4).
18. Shanshal SA, Al-Qazaz HK. Consequences of cement dust exposure on pulmonary function in cement factory workers. Am J Ind Med. 2021 Mar;64(3):192-197.