Section: Research Paper

Effects of Cement Production on Respiratory Functions of Workers at Cement Factory of Rajasthan

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Abstract : Dust can be produced by almost all production processes in Portland cement factory. Dust exposure potentially can affect respiratory function.In this study we assessed effect of cement dust exposure on respiratory function in a cement production factory in Chittorgarh Rajasthan. A respiratory symptoms questionnaire was completed and pulmonary function tests were carried out on 55 exposed and 24 non exposed workers at a cement factory. Additionally, respirable dust level was determined by the gravimetric method. X-ray fluorescence (XRF) technique was performed to determine the silica phases and the SiO_2 contents of the bulk samples. The arithmetic means of personal respirable dust were 24.22 mg/m^3 in the crushing, 21 mg/m^3 in the packing, 4.3 mg/m^3 in the cement mill, 4.2 mg/m^3 in the kiln and 4.9 mg/m^3 in the maintenance that were higher than threshold limit value of the American Conference of Governmental Industrial Hygienists which is 4 mg/m3. This value in the unexposed group was 0.81 mg/m^3. In this study cough, sputum, wheezing and dyspnea were more prevalent among exposed subjects. Exposed workers compared to the unexposed group showed significant reduction in Forced Expiratory Volume in one second ,Forced Vital Capacity , and Forced Expiratory Flow between 20% and 80 % of the Forced Vital Capacity ($P<0.05$). It can be concluded that in our study there was close and direct association between cement dust exposure and functional impairment among the cement factory workers.

Keywords : Ordinary Portland Cement, Pollution , Respiratory System , Dust Effects , India .

1 INTRODUCTION

Ordinary Portland cement production is a dusty process. Portland cement is manufactured from a clay and limestone mixture that is calcined in kiln. Portland cement silicate is a class of hydraulic cements containing tri and dicalcium silicate in addition to aluminum, tricalcium aluminate and iron oxide. The final product usually contains 60 to 70% calcium oxide, 19% to 24% silicon dioxide (including about 5% free), 4 to 7% aluminum trioxide, 2 to 6% ferric oxide and less than 5% magnesium oxide . The volume of cement production in Rajasthan is high ,About 5000 workers are working in cement production factories . Occupational exposure to cement dust is likely to vary in different production operations and process . Several clinical

and epidemiological studies have shown an increased incidence of respiratory impairment and high frequency of respiratory symptoms among cement production workers.

2 MATERIALS & METHODS

The current investigation was carried out in the years 2021 and 2022 at cement manufacturing facility in Chittoergrah, Rajasthan. Crushing, raw milling, calcination in a rotary kiln, cement milling, packing, and maintenance make up the basic production process. Before entering the raw mill, the raw materials limestone (60 percent) and red soil (40 percent) are crushed. It has been ground into little pieces. The ground materials are placed in the rotating kiln, which has calcining, transition, and burning zones. Clinker is created during this burning process at a temperature of 1300–1450 degree Celsius. Gypsum (4-5%) is added to the clinker mixture before being processed in the clinker mill to create Portland cement. The finished product is kept in silos until being shipped in bulk or packaged.

In this study, a group based technique was used to select 55 male workers as exposed and 24 male workers as unexposed. The study's questionnaire was slightly modified from the American Thoracic Society's Questionnaire on Respiratory Symptoms. Using a portable, calibrated Vitalogrph spirometer, a pulmonary function test was conducted on the worker while they were standing. This exam included measuring their FEV1, FVC, PEF, and FEF indices. Under the direction of an experienced occupational health specialist, lung function tests were carried out. Samples were prepared for both production and administrative office locations. On a cellulose acetate filter with a pore size of 0.8 m that was placed in a 37 mm cyclone and coupled to a sampling pump with a flow rate of 0.2 l/min and calibrated by a digital automatic calibrator, respirable dust was collected. The samples were underwent quantitative analysis at AIIMS Jodhpur using a microbalance with a detection limit of 0.01 mg. The bulk sample's silica phases and SiO_2 content were identified and estimated using the X-ray fluorescence method. The Statistical Package (SPSS version 25). was used to establish a database and perform all statistical analyses

3 RESULTS & DISCUSIONS

The demographic characteristics of the exposed and unexposed groups are summarized in Table 1. Between two groups, there was no clinically or statistically significant difference. Crushing and packaging employees were exposed to more respirable dust than cement mill, kiln, maintenance, and administration employees. The XRF technique was employed to estimate the silica phases and the SiO_2 content. The frequency of atypical respiratory symptoms in exposed and unexposed participants is shown in Table 3 .Compared to the control group, exposed workers exhibited higher dyspnea, sputum, wheezing, and coughing. But these variations lacked statistical significance. The measures of pulmonary function are assessed in both exposed and unexposed patients. The findings showed that the exposed worker ventilatory indices were considerably lower than those of the unexposed individuals. Between exposed and unexposed people in our investigation, there were no discernible variations in the three main confounding factors of age, smoking, and length of employment. The highest AM concentrations of respirable

cement dust are exposed to workers who are involved in the crushing and packing processes. Data analysis revealed that the exposed group's mean respirable dust concentration was higher than the ACGIH TLV of 5.4 mg/m^3. In line with earlier studies, the exposed workers in our study had more wheezing, coughing, dyspnea, and chronic phlegm than the control group did, but these differences were not statistically significant. This might be as a result of our study's small sample size.

Table 1. Compression of demographic variables between exposed and unexposed groups.

Variables	**Exposed**			**Unexposed**			
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**	**P-Values**
Height (meters)	1.71	1.54	1.91	1.72	1.52	1.92	0.67
Age (years)	42	23	65	40	24	62	0.38
Weight (Kg)	76	52	110	73	50	112	0.32
Working Duration (year)	14	2	23	15	3	26	0.41
Smoking (pack year)	4	0	15	5	0	16	0.55

Table 2. Respirable dust (mg/m^3) and SiO2% content of bulk materials in the cement factory.

	No. of Samples	**Means**
Respirable dust		
Ore crushing	14	28
Kiln	22	5.4
Packing	8	24
Cement mill	11	5.1
Maintenance	32	4.6
Administration	55	0.5
SiO_2% content		
Lime stone	3	6
Bauxite	3	24
Kiln feed	3	12
Clinker	3	25

Table 3. Frequency of respiratory symptoms among exposed and unexposed subjects

Variables	**Exposed**		**Unexposed**		
	No.	**%**	**No.**	**%**	**P-Values**
Cough	35	72	15	39	0.1

Wheezing	25	40	8	20	0.15
Sputum	22	43	8	21	0.25
Dyspenia	27	45	9	33	0.22

Table 4. Pulmonary function indices and abnormal pulmonary function parameters frequency in exposed and unexposed workers

Variables	**Exposed**		**Unexposed**		
	Measured	**Predicted**	**Measured**	**Predicted**	**P-Values**
FVC	3.5	4.12	4.55	4.9	0.005
FEV1	2.5	3.34	3.37	3.6	0.001
FEV1/FVC	0.75	0.70	0.8	0.85	0.004
FEF	3.12	4.1	2.9	3.7	0.001

4 CONCLUSIONS

The main finding of this study is that exposed workers had considerably worse lung function metrics (FVC, FEV1, and FEF) than the control group. However, there was no statistically significant difference in the frequency of aberrant FEV1/FVC ratio between the exposed workers and the control group. This aspect may be reflected in the likelihood that restrictive rather than obstructive ventilatory dysfunction will result from occupational inhalation exposure to cement dust. The study's data and information may be helpful for national health surveillance and retrospective exposure assessment programmes. In our investigation, there was a lot of exposure to airborne, respirable cement dust. This may be partially ascribed to the fact that the machinery and process flow are frequently outdated and installed without efficient dust control tools like electrostatic precipitators. Additionally, it can be inferred that cumulative cement dust exposure is linked to a persistent deterioration of ventilatory function. National cement dust exposure assessment and health surveillance systems are strongly advised due to the high levels of dust exposure in our study.

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