

Effects of occupational dust exposure on the health status of portland cement factory workers

Abstract

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Introduction: Chronic exposure to Portland cement dust has been reported to lead to greater prevalence of various clinical conditions (includes both respiratory and non-respiratory). These conditions are consistently associated with the degree and duration of exposure. Regular use of appropriate personal protective equipment if made available at the work site could protect the cement factory workers from adverse health effects. **Objective:** To study the morbidity profile of the cement factory workers. **Type of Study:** Retrospective cohort study. **Material and Methods:** This study was conducted in the Portland Cement Factory in North Karnataka. Data was collected using predesigned questionnaire by personal interview method and clinical examination. A total of 64 male workers are randomly selected who are working in various departments like crushing, raw/cement mill, rotary kiln and packing department. Equal number of unexposed controls was selected from the area atleast 5 kms from the factory and those who are not exposed to cement dust in the past, who are matched for age, Socio economic status and smoking with the exposed population. **Statistical Analysis:** Chisquare test for qualitative data and unpaired t test for quantitative data using Epi info. **Results:** A total of 64 male workers and equal number of matched controls who are not exposed to the cement dust were included in the study. Among exposed maximum of 36% were employed in Crushing department, 25% each in Packing and cement/raw mill. Systolic and Diastolic blood pressure was found to be higher among the exposed, which is statistically highly significant ($p < 0.001$). There is significant increase in weight among exposed ($p < 0.001$). Maximum 29(45.3%) of the workers had stuffy nose and epistaxis when compared to unexposed with Relative risk(RR) of 2.6, followed by Dermatological complaints and lower respiratory complaints with RR of 2.18 and 2.3 respectively. **Conclusion:** Personal protective equipment should be made available at the workplace and educate the personnel to use them. Extensive research is necessary to improve the technical preventive measures that will reduce the risk of occupational health hazards.

Key Words: Portland cement dust, occupational health hazard, COPD.

INTRODUCTION

Chronic exposure to Portland cement dust has been reported to lead to greater prevalence of various clinical conditions which includes both respiratory and non-respiratory systems involvement. These conditions are consistently associated with the degree of exposure. Regular use of appropriate personal protective equipment, if available at the work site could protect the cement factory workers from adverse health effects.^[1]

The pollutants in the cement industry are emitted from the various production processes from the material such as the raw material, crusher, rotary kiln, cranes, mills, storage silos and packing section, etc., Airborne respirable dust levels from less than 5 to more than 40 mg/m³ have been recorded in the work place air of cement factory workers. The aerodynamic diameter of the cement dust ranges from 0.05 to 20 μm, making the whole respiratory tract a target for cement deposition.^[2]

The essential constituents of Portland cement are tricalcium silicate and dicalcium silicate, with varying amount of alumina, tricalcium aluminate and iron oxide and low concentration of hexavalent chromium. Contents of Portland cement includes mixtures of calcium oxide-62-66%, silicon oxide-19-22%, Aluminium tri oxide-4-8%, ferric oxide-2-5%, Magnesium oxide-1-2% and also contains selenium, Thallium, and other impurities.^[3]

Portland cement is also an artificial cement, there are different types of Portland cement such as ordinary, or rapid hardening, sulfate resisting, white colored, low heat, masonry, hydrophobic, water-repellant expanding and non-shrinking, high aluminium, blast furnace and oil wall cement. Portland cement is produced in cement factories under consideration of different substances especially the limestone and clay, which are heated to approximately 1250°C for a period of 90 minutes. The final product is obtained by grinding its contents with 5% gypsum.^[4]

The main route of entry of cement dust particles in the body is the respiratory tract or the gastrointestinal tract or both by inhalation or swallowing. This has been identified as a skin irritant, which causes itching, skin allergy, boils, and burn. In experimental animals those who were fed with cement dust for 42 days found that body weight reduction, osteonecrosis, thinning of cortex, and reduction of epiphyseal cartilage.

Even in the twenty-first century, millions of people are working daily in a dusty environment. They are exposed to different types of health hazards like fumes, gases, and dust which are risk factors in developing occupational lung diseases.

For variety of reasons, like ignorance or the non-availability of personal protective devices, the workers do not adequately protect themselves through personal protective device.^[1]

MATERIALS AND METHODS

This is a retrospective cohort study conducted in the Portland Cement factory in north Karnataka during December 2010 to March 2011.

After obtaining permission from the concerned authorities like factory proprietor, human resource development officer, etc., for conducting the study, workers list was obtained from them. About 150 workers are working regularly in various shifts and about 70 workers were undergoing initial training. Seventy trainees were excluded from the study. We selected 100 workers randomly to participate in the study, who worked in crushing department, raw/cement mill, rotary kiln and packing department for atleast 5 years. Medical records of these workers were scrutinized to determine the health conditions of the workers. The workers who gave history of respiratory and non-respiratory problems like allergy, asthma before the employment during preplacement examination were excluded from the study. But 64 were included in the study who are eligible, readily participated by giving consent and who had

given complete history and examination was done.

Equal number of unexposed people were randomly selected from the area, which is atleast 5 km away from the factory and those who are not exposed to cement dust in the past, these controls were matched for age, socio-economic status, and smoking with

Table 1: Distribution of workers according to the site of employment

Site	No.	%
Crushing department	23	36
Rotary kiln	9	14
Packing department	16	25
Cement/Raw mill	16	25

Table 2: Distribution of study subjects according to physical characteristics

Parameters	Exposed	Unexposed	I	P
Age	44.2±8.6	41.8±7.8	1.66	>0.05
Weight in kg	68±11.3	64±10.8	2.05	<0.05
Height in cm	170.8±7.2	173.2±6.8	1.95	>0.05
Systolic BP	134.16±12.3	128.14±8.3	3.23	<0.001
Diastolic BP	94.4±11.3	86.12±6.32	5.14	<0.001
Cigarette smoking (pack years)	6.1±4.2	5.8±4.8	0.37	>0.05

Values are expressed as mean±SD, P<0.05 is considered as significant, BP=Blood pressure

Table 3: Morbidity patterns among exposed and unexposed

Disease conditions	Exposed		Unexposed		Relative risk
	No.	%	No.	%	
Stuffy nose/epistaxis	29	45.3	2	3.1	2.6
Lower respiratory problems*	24	37.5	2	3.1	2.3
GI problems [†]	14	21.8	2	3.1	1.96
Oral problems [‡]	24	37.5	3	4.6	2.2
Musculoskeletal problems [§]	12	18.8	3	4.6	1.7

*Lower respiratory problems like cough with or without expectoration, rhonchi, crepitations, abnormal respiratory sound on auscultation, [†]Gastrointestinal problems like diarrhea, constipation, dysentery, hematochezia, [‡]Oral problems like aphthous ulcers, tooth caries, plaques, bleeding gums, [§]Musculoskeletal problems like muscle ache, joint pains, myalgia

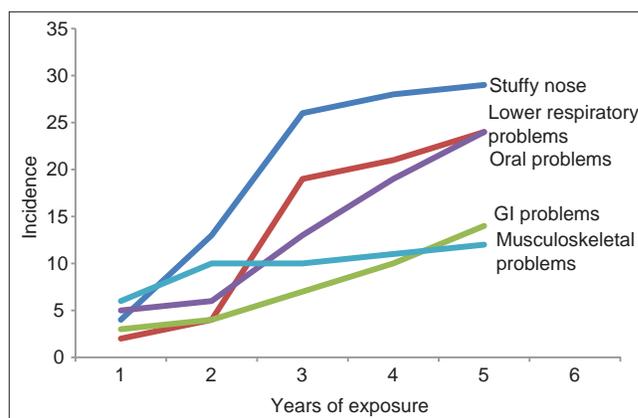


Figure 1: Cumulative incidence of various clinical conditions

the exposed population.

Data was collected regarding general demographic profile, smoking, clinical signs, and symptoms with the help of pre-designed questionnaire by personal interview method and clinical examination. After obtaining height and weight BMI was calculated as weight in kg/height in m². Information was collected regarding the use of personal protection equipment (work coveralls, gloves, dust masks, ear plugs, and safety shoes) while at work, it was found that none of the respondents used any of the above mentioned personal protective devices. Few of the respondents covered their nose and mouth with towel/hand kerchief which itself was dusty and had the stains of black-colored nasal secretions.

Statistical analysis was conducted using EPI-Info software, Chi-square test for proportions, unpaired 't' test for quantitative data. And relative risk was calculated for clinical conditions among exposed and non-exposed.

RESULTS

A total of 64 male workers and equal number of matched controls who are not exposed to the cement dust were included in the study. Among exposed maximum of 36% were employed in Crushing department, 25% each in packing and cement/raw mill [Table 1]. Systolic and diastolic blood pressure was found to be higher among the exposed, which is statistically significant ($P < 0.001$). There is significant increase in weight among exposed ($P < 0.001$) [Table 2]. Maximum 29 (45.3%) of the workers had stuffy nose and epistaxis when compared to unexposed with Relative risk (RR) of 2.6, followed by dermatological complaints and lower respiratory complaints with RR of 2.18 and 2.3, respectively [Table 3].

Table 4: Demographic characteristics of study subjects

Characteristics	No	%
Religion		
Hindu	52	81.2
Muslim	12	18.8
Place of residence		
Urban	43	67.2
Rural	21	32.8
Type of family		
Nuclear	24	37.5
Joint	40	62.5
Educational status		
Primary	1	1.6
Secondary	9	14
Pre-university	24	37.5
Degree	30	46.9
Socioeconomic status		
II	26	40.6
III	37	57.8
IV	1	1.6
Total	64	100

Cumulative incidence of the clinical conditions for the period of 5 years is represented [Figure 1].

DISCUSSION

In the present study it was found the health profiles of the cement factory workers were very poor and the living condition in the working environment was poor. Cement factory workers were exposed to dust at various manufacturing and production process such as quarrying, handling, grinding, shifting, packing, and transportation. These workers were compromised to work in such situation may be due to poor socioeconomic status and low education level [Table 4], similar finding was observed by the Mwaiselage J in their study in Tanzania.^[2]

There was no difference in the occurrence of diseases in the exposed workers who are working in different sections of work through the level of exposure is not same in all the sections. This could be because of workers were reshuffled in different shifts to different sections, hence overall exposure of the workers in our study remained same.

In the physical parameters, it was found that there is significant difference in body weight of exposed compared to unexposed [Table 2], but it was found that no difference by Al-Neami in the study conducted in UAE.^[1] There was significant increase in systolic and diastolic blood pressure among exposed workers when compared to non exposed anyway it was found that there is no difference by Al-Neami.^[1] Intratracheal administration of cement dust in animal studies have shown that it increased fibrosis of heart and also increase in collagen in vessels, may lead to increase in blood pressure.^[3]

In the clinical parameters, among the cement dust-exposed workers 45.3% of them had upper respiratory complaints like stuffy nose, running nose and allergic rhinitis, whereas the non-exposed it was only 3.1% with relative risk of 2.6 [Table 3]. Similarly it was found by many researchers who found stuffy nose was relatively more among exposed workers.^[2] The aerodynamic diameter of cement particles range from 0.05 to 10 μm , and main route of entry of this dust is through inhalation and swallowing. The physical properties that are of importance include particle size, density, shape, penetrability, surface area, electrostatic charge, and hygroscopicity. All particles with an aerodynamic diameter in excess of 10 μm are deposited on the mucous membrane of the nose and trachea. This is an irritant and also causes allergy and various manifestations of upper respiratory tract.^[6,7]

In the present study, the gastrointestinal problems among the exposed group were found to 21.8% whereas among the unexposed it was 3.1% with relative risk of 1.06 for the exposed population. In this study the spectrum of presentation includes diarrhea, constipation, hemorrhoids, etc., other similar studies have found that cement dust caused a stomach cancer.^[7] Hence, this workers need to be subjected to lab investigations to rule out malignancy of GIT.

Substantial number (37.5%) of the exposed workers had oral problems which is very low among unexposed (4.6%). The clinical manifestations include Aphthous ulcer, caries, plaques and unhealthy gums. Since the cement dust can enter through swallowing,^[6,7] A study conducted by Tuominen observed the effect of cement dust on the tooth surface loss was higher.^[8] They also found that workers exposed to dust revealed a high prevalence of dental caries with number of decayed, missing, and filled surfaces along with poor periodontal conditions.

In our study, 18.8% of the exposed group had musculoskeletal problems, whereas 4.6% of the non-exposed had this problem with relative risk of 1.7. Similar studies have shown that 7.04% had musculoskeletal problems among exposed though not significant when compared to non-exposed.^[9] Studies conducted in experimental animals have shown that bioaccumulation of industrial cement dust components which is inhaled, accumulated in bones.^[10] In another study the weanling pig fed with cement dust for 42 days found that body weight gain was suppressed, observed lesions of the humerus bone along with osteonecrosis, thinning of cortex and reduction of epiphyseal cartilage.^[11]

In the present study, 37.5% of the exposed population had lower respiratory signs and symptoms like cough, with or without expectoration, wheeze, crepitations, etc., which were only 3.1% among unexposed population. The dust particles ranges from 3 to 10 μm in diameter can be deposited throughout the tracheobronchial tree. Particles between 0.1 and 3 μm in diameter are deposited in alveoli resulting in the range of clinical presentation. The pathogenesis is most probably due to its irritating, sensitizing and pneumocytic properties.^[3,12] Al-Neaimi YI conducted a study in UAE, found that around 30% of the exposed had cough, 25.4% had phlegm, 7.5% had wheeze and 20.9% had dyspnea.^[1] Whereas Neghab M in their study observed that 28.4% had wheezing, 17% with breathlessness, 31% had cough.^[13] In another study by Abrons HL found that the exposed population had respiratory complaints in a range of 8-15%.^[14] Al-Neaimi YI also studied respiratory function test to know the type of respiratory illness (obstructive/restrictive), but this was not done in our study as a limitation of the study. Many studies have found that exposed workers had restrictive lung diseases after exposure to the cement dust for a particular time period^[1,6,7] with decreased FVC, FEV₁ and an increase in FEV₁/FVC ratio. Few studies have found that cement mill workers suffered from chronic bronchitis,^[15-17] which was also noticed in our study. In a study conducted in Tanzania detected lower respiratory complaints in (41.2-43.1%) among exposed compared to low exposed (6.0-9.1%).^[2] In Malaysia lower respiratory complaints was 25% and chest tightness in 19.4%.^[18] These symptoms and signs were exaggerated among those exposed group who are smokers and exposure to domestic smoke. Respiratory tract disorders, the most important group of occupational diseases in the cement industry are the result of inhalation of airborne dust. Chronic bronchitis often associated with emphysema has been reported as the most frequent respiratory disease.^[19] Additionally silicosis followed by

mixed dust pneumoconiosis have been claimed greatest risk for cement factory workers.^[20]

Cement industries in the developed countries are more efficient in dust control measures using methods such as enclosure of dust, emitting machinery, conveyor belts and its transfer points, improved general mechanical ventilation in the work areas: Local exhaust ventilation from the crusher and packing machinery: Replacement of pneumatic packing machine with automatic impellar driven packing machine; wet dust suppression during cleaning activities; greater diligence in maintenance of machinery to prevent dust release; regular use of high quality personal protective respiratory equipment and influencing workers behavior by training and education.^[21]

CONCLUSIONS

In the present study, the workers were suffering from varied health problems, which was relatively more than the general population. It also suggests the cement factory workers were exposed to the dust in the environment, with minimum or no protective equipments. Hence, there is an urgent need to look into the matters by the concerned authority to improve the living conditions. Health education was given regarding the personal protection measures, but needs reinforcement in the form of regular such education programs and legislative laws. Keeping in view the hazards of cement dust it is advisable, therefore the cement factory management, their workers and health officials should work together to adopt technical preventive measures such as well-ventilated work areas and workers should wear appropriate apparel, mask, safety goggles, gloves, ear plugs and gum boot is also important that cement mill workers must undergo pre-employment and periodic medical surveillance test. These measures would help to identify susceptible workers in due time and improve the technical preventive measures that will decrease the risk of occupational hazards in the cement industry workers.

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