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Investigation into Workplace Health and Hygiene Associated to Cement Exposure and the Health Status of Construction Workers using Lung Function Parameters and a Hygiene Study

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Abstract: *Workers in the construction industry are frequently exposed to various hazardous substances on the job. Long-term exposure to cement has been associated with a range of health issues and progressive complications. Recent research indicates that occupational contact with cement dust can negatively impact the lungs, liver, and epithelial tissues. This study includes 633 participants, comprising masons, helpers, concrete mixers, tile workers, and those involved in loading and unloading. Among them, 74% have been exposed to cement for over 10 years, with 16% having more than 20 years of exposure. The occupational breakdown is as follows: 43% are masons, 15% helpers, 9% concrete mixers, 6% tile workers, and 27% are engaged in loading and unloading tasks. Skin-related problems are more commonly observed among masons and tile workers. Helpers and concrete mixers frequently report both pulmonary and dermatological issues. Loading and unloading workers experience all these symptoms at a higher rate.*
The construction industry is one of the fastest-growing sectors globally. Workers in this field are routinely exposed to a variety of hazardous substances. Portland cement, the most commonly used type of cement, contains several toxic components. Prolonged exposure to these substances can result in a range of health issues and long-term complications. This study examines 508 cases involving laborers from the construction sector. Participants were categorized into three groups based on their duration of exposure: less than 10 years, 10–20 years, and over 20 years. Among them, 60% were masons, 21% helpers, 12% concrete mixers, and 7% tile workers. Skin-related issues were reported by 90% of masons. Helpers commonly experienced both skin problems and respiratory conditions. Overall, 42% of the workers suffered from skin rashes or inflammations. Among concrete mixers, 72% reported skin burns and 23% experienced impaired lung function. Seventy percent of tile workers reported skin-related issues.

Keywords: Cement dust exposure; Construction workers; Occupational health hazards; Respiratory symptoms; Skin irritation; Lung function; Masons; Loading workers; Hygiene study; Personal protective equipment (PPE); Health risk assessment; Occupational safety; Preventive measures; Cement industry etc

I. INTRODUCTION

The construction industry is recognized as one of the leading global sectors and plays a vital role in national development. Workers in this field make up the second-largest labor force within the unorganized sector. Cement is a fundamental component in construction, with Portland cement being the most widely used type. It is a fine, odorless, grey powder composed of silica, lime, alumina, and iron oxide. Additionally, it contains heavy metals such as nickel, chromium, and lead, along with trace elements like magnesium, sodium, potassium, selenium, thallium, and other impurities. Exposure to Portland cement can occur via inhalation, ingestion, or contact with the eyes and skin. The substance is known to cause eye irritation, and prolonged or repeated skin contact with cement dust may result in dermatitis (Hathaway et al., 1991). Chronic inhalation of cement dust can lead to respiratory issues such as coughing, sputum production, wheezing, dyspnea,

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and chronic bronchitis, as well as negatively impact pulmonary function. Extended skin exposure may lead to inflammation or, in some cases, chemical burns. Continuous contact with wet cement can cause skin damage, chemical burns, rashes, and inflammation. Various additives, including alkaline hardeners used to produce specialty cements, may further elevate health risks. Cement dust can irritate the skin, nasal mucosa, and respiratory tract. When deposited in the respiratory tract, it triggers a basic reaction, raising pH levels and irritating exposed mucous membranes (Zeleke et al., 2010). Recent epidemiological studies suggest that 2–8% of all cancer cases are linked to workplace exposure to carcinogens, with some evidence pointing to components in cement and concrete as contributing factors.

India has recently undertaken significant infrastructure development efforts to meet the demands of globalization, and Kerala has emerged as a key contributor in this process. In Pali district Rajasthan, construction activities have seen rapid, exponential growth. The promise of high wages has drawn a substantial number of both skilled and unskilled workers to the construction sector. Construction workers make up the second-largest labor force within the country's unorganized sector. Individuals working in this field are exposed to various hazardous substances. Portland cement, a primary material in the construction industry, contains numerous toxic elements. Exposure to cement has been associated with a range of occupational health issues and complications. Cement primarily consists of calcium oxide, silicon dioxide, aluminum trioxide, ferric oxide, magnesium oxide, selenium, thallium, and other trace impurities. It also contains heavy metals such as nickel, lead, cobalt, and chromium (Baby et al., 2008). Prolonged exposure to cement dust can lead to clinical symptoms and inflammatory conditions, including chronic cough, phlegm production, reduced lung function, skin irritation, conjunctivitis, and in some cases, cancers of the lung, stomach, and colon (Abou Taleb et al.). Contact dermatitis is a frequent health complaint among construction workers (Shah and Tiwari, 2010). Workers typically encounter cement through skin contact and inhalation, with ingestion being a less common route. The detrimental effects of cement dust on biological systems stem from the irritant and sensitizing nature of its constituents. Long-term exposure can result in skin inflammation or chemical burns. Occupational contact with silica, a major component of cement, has also been linked to an increased risk of autoimmune diseases. Elements like chromium and silica can provoke inflammatory responses due to workplace exposure, potentially leading to damage in specific organs and affecting the immune system (Fell et al., 2003; Omini and Akpogomeh, 2007; Mojimoniyi et al., 2007; Ogunbileje et al., 2010). The current epidemiological study aims to assess the health risks associated with wet cement exposure among construction workers in the pali of rajasthan.

II. LITERATURE REVIEW

Constituents in the cement have crucial role in pathogenicity. Chromium and aluminium are the chief toxic constituents present in cement. Chromium present in its hexavalent state cause more damage to our skin. So, chronic exposure to these pollutants could increase peroxidation of membrane lipids in different tissues resulting in neurotoxicity, renal failure and anaemia (Guo et al., 2004 ; Gupta et al., 2005; Ranjbar et al., 2008) .

A review by Bock et al., 2003 found that actual prevalence of chromate allergy was much higher in workers exposed to cement. Hand dermatitis generally predominates in construction workers. Hand dermatitis predominated with the involvement of more than 73.7% of workers in contrast to 11.6% with facial dermatitis and 6.9% with leg dermatitis in Northern Bavaria from 1990-1993. Hand dermatitis involves both palm and dorsum in some cases. After the forearm, the second most affected area is the dorsal surfaces of hands. In these workers least affected area is the palmar surface due to their pattern of work.

Apart from chromium, cobalt and nickel present in the cement also act as allergen. The presence of these substances have already been confirmed in Asian cements (Goh, et al.,1986). But allergy to cobalt and nickel is less severe than chromate. This is because they are in insoluble form and has low sensitization potential (Fregert et al., 1978). Thus allergy to these metals is considered as a secondary agent for damaging skin.

Epoxy resin is another important constituent present in cement. It has a very high sensitization potential. Occupational contact dermatitis is a frequent form of dermatitis in construction workers. Due to its volatile nature, epoxy resin can also cause contact dermatitis in the areas away from hand such as face and neck (Dickel et al., 2002).environments. In many cases, cost-cutting measures compromise the installation of safety systems.

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During cement processing, dust is a hazardous substance; however, high ambient temperature, radiant heat and high noise levels are also common hazards. The health risks posed by inhaled dust particles are influenced by duration of exposure and biological responses exerted by particles (Meo et al., 2004). In the short term, exposure to high levels of cement dust irritates the nose and throat and causes difficulty in breathing. Broncho-constriction occurs during the work shift for the cement workers who are exposed to relatively high dust concentrations producing changes in pulmonary function.

Occupational exposure to cement dust is known to be an important factor in the causation of the chronic respiratory health effects (Merenu et al., 2007).Occupational atmosphere plays a chief role in the health status of an individual. Park, (2007) reported that inhalation of dusts during their working hours lead to the risk of adverse respiratory effects. Deposition of dusts in our breathing zone leads to manifestation of pathological conditions. Concentration and size of airborne dust in breathing zone, nature of dusts, and period of exposure are crucial factors in relation with occupational lung diseases (Mengesha et al., 1998).

III. PROBLEM IDENTIFICATION

Problem	Cause	Effect
Silicosis	Inhalation of reparable crystalline silica present in cement dust	Lung scarring, difficulty in breathing, chronic cough, and permanent lung damage
Chronic Obstructive Pulmonary Disease (COPD)	Long-term exposure to cement and silica dust	Chronic bronchitis, emphysema, airflow limitation
Asthma	Exposure to alkaline dust particles and allergens in cement	Coughing, wheezing, chest tightness, shortness of breath
Bronchitis (Acute/Chronic)	Inhalation of cement dust, often without proper PPE	Persistent cough with mucus, throat irritation, chest congestion
Hypersensitivity Pneumonitis	Reaction to airborne organic/inorganic materials including cement particles	Inflammation of alveoli, flu-like symptoms, shortness of breath
Allergic Reactions/Skin Issues	Contact with cement ingredients (chromates, lime, etc.)	Dermatitis, eczema, rashes, eye irritation
Pulmonary Fibrosis	Long-term cement dust exposure leading to scarring of lung tissue	Stiffening of lungs, fatigue, chronic cough, reduced oxygen intake
Lung Cancer (in extreme cases)	Prolonged exposure to silica dust and other toxic compounds without protection	Severe lung damage and malignancy

IV. MATERIAL AND METHODOLOGY

The present study was carried out in the state of Rajasthan. The study population includes masons, helpers, loading and unloading workers, tile workers, and concrete mixers. The loading and unloading workers operate at the cement goods shed located at a railway station and its nearby depot, while the remaining participants work at their respective construction sites. A structured questionnaire was developed, focusing on potential health hazards to which the participants were likely exposed. Each individual in the study group was approached personally, and data were collected on a one-to-one basis. The study consists of 633 participants and categorizes them into three groups based on the duration of their employment in cement-related work: less than 10 years, 10–20 years, and over 20 years. The health issues investigated include persistent cough, breathlessness, wheezing, sneezing, skin burns and rashes, irritation of the skin, eyes, and throat, as well as headaches, hair loss, and changes in hair color. These symptoms are considered indicative of respiratory (pulmonary) and skin-related (cutaneous) health problems.

The current study was conducted in the state of Rajasthan and focused on workers exposed to wet cement. The participants included masons, helpers, tile setters, and concrete mixers, all of whom were employed at their respective job sites. A

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questionnaire was designed to address potential health hazards to which these workers may be exposed. Each participant was interviewed individually, and data were collected through personal visits A total of 508 cases were documented in the study. Based on their duration of employment in cement-related work, the laborers were classified into three groups: those with less than 10 years of experience, 10–20 years, and over 20 years. The primary respiratory and skin-related health issues investigated included persistent cough, breathlessness, wheezing, sneezing, skin burns and rashes, irritation of the skin, eyes, and throat, as well as hair loss and changes in body coloration.

V. RESULT

1-The study includes a total of 633 cases (refer to Table 1). Among the helpers, 33 participants were female; however, their data were not analyzed separately. Seventy percent of the participants had more than 10 years of exposure to cement-related work, while 16% had over 20 years of exposure. Of the 633 individuals interviewed, 43% were masons, 15% helpers, 9% concrete mixers, 27% loading and unloading workers, and 6% tile workers. Each occupational group was further subdivided into three categories based on the duration of their exposure to cement: less than 10 years, 10–20 years, and more than 20 years.

Table 1: Category and duration wise distribution of the study group

Category	Duration as cement workers			Total
	<10 years	10-20 tears	>20 years	
Masons	53	175	47	275
Helpers	37	49	11	97
Concrete Mixers	19	25	10	54
Tile workers	20	11	4	35
Loading & unloading Workers	45	97	30	172
Total	174	357	102	633

Health hazards of construction workers such as masons, helpers, concrete mixers and tile workers and transporters like loading & unloading workers are focused in this study. Frequency of lung function impairment and cutaneous problems are more observed in these workers. Persistent cough, breathlessness and wheezing are taken to be indicators of lung function impairment. Frequency of cement workers with lung function impairment is shown in table -2

Table 2: Frequency of lung function impairment in different classes of workers

symptoms	*Masons*	*helper*	*Concrete Mixers*	*Tile workers*	*Loading & unloading Workers*
Persistent cough	32	27	26	7	56
Breathlessness	28	34	30	8	68
Wheezing	10	18	12	4	35
sneezing	12	15	5	12	30

Workers who were exposed to wet cement have more cutaneous problems than dry cement workers. Cutaneous effects include burning effect, skin rashes/ inflammations and irritation to skin. Frequency of cutaneous symptoms are shown in table -3.

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Table 3: Frequency of Cutaneous symptoms in different classes of workers

Symptoms	Masons	Helper	Concrete mixers	Tile workers	Loading & unloading worker
Burning effect	66	60	70	70	30
Skin rashes/inflammation ion	26	40	30	38	12
Irritation to skin	36	46	32	25	16
Hair loss and colour change on body	80	75	65	85	78

Masons have reported more cutaneous symptoms. Altogether 90% have skin related symptoms. Sixty six percentage have skin burns, 26 % have skin irritation and 36 % have skin rashes and 80% have hair loss or change in hair colour on body. Persistent cough is reported by 32% and breathlessness is reported by 28% of masons. Cutaneous problems are more frequent in helper category compared to lung function parameters. Above 80 % have cutaneous problems in this group. Forty percentage have skin rashes and skin irritation is also reported in 46 % of helpers. Thirty four percentage of helper group also complained by breathlessness. Tile workers and concrete mixers also have skin related problems. Out of 54 concrete mixers, 70 % have skin burning, 30 % have skin rashes and 65 % of workers have reported hair loss & colour change on body. Twenty six percentages of workers have persistent cough and breathlessness is also reported in 30% of workers. Seventy percentages of tile workers have cutaneous problems. Sneezing is also reported by 12 % of these workers. All the symptoms under study are more prevalent among loading and unloading workers. Of all symptoms considered respiratory tract and skin diseases are the highest. Fifty six percentages have persistent cough, 68% have breathlessness and 30% have skin burns. Hair loss and change in hair colour on body are reported by 78% of loading and unloading workers.

2-The study comprises 508 cases (Table-1). Of these only 48 cases were females under helper category and not separately analyzed. Seventy two percent cases have more than 10 years of exposure in cement work and 17 % over 20 years. Out of 508 individuals interviewed during the study 60 % individuals belonged to the category of masons, 21 % helpers, 12% concrete mixers and 7% tile workers. Individuals under each category (based on nature of work) were further divided in to three based on their duration of exposure to cement.

Table 1. Category and duration wise distribution of the study group

Category	Duration as cement workers			Total
	<10 years	10-20 tears	>20 years	
Masons	60	186	58	304
Helpers	39	54	13	106
Concrete Mixers	20	29	11	60
Tile setter	21	12	5	38
Total	140	281	87	508

Impairment and cutaneous effects is shown in table -2. Cutaneous problems have been reported in 90 % of masons. Sixty four percent have skin burns, 38 % have skin irritation, 33 % have skin rashes and 79 % have hair loss or change in hair colour on body. Persistent cough is reported by 30%, breathlessness is reported by 19 % of masons. Wheezing and sneezing is also complained by 9% and 8% of workers respectively. Helper category reported skin related problem as well as pulmonary ailments. Forty two percentages of workers were affected by skin rashes/ inflammations. Altogether ninety percentages of workers have shown skin related problems. This includes burning, irritation to skin, Skin rashes/ inflammations and hair loss/ hair change on body. Twenty eight percentages of workers have breathlessness and 33% have reported persistent cough.

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Table: 2 Frequency of lung function impairment & cutaneous effects in different categories of workers.

Symptoms	Masons	Helpers	Concrete mixers	Tile workers
Lung function impairment				
Persistent cough	30	28	23	8
Breathlessness	19	33	29	9
Wheezing	9	19	9	3
Sneezing	8	10	11	15
Cutaneous effects				
Burning effect	64	53	72	69
Skin rashes/inflammation	33	42	28	40
Irritation of skin	38	44	31	23
Hair loss and colour change on body	79	72	66	86

VI. DISCUSSION

1-Construction workers are more exposed to cement than other labours. Wet cement preparations are more handled by construction workers. Construction workers reported more symptoms related with skin than respiratory tract. Actually they are handling with cement preparations of different combinations rather than in dust form. Hence the chances of inhaling are less in comparison to loading and unloading workers. When the cement dust comes in contact with water, hydroxides are formed that impair natural water alkalinity, living tissue leads to burning, skin rashes and inflammation. However, pulmonary problems were also observed in the study group of masons. They have more than fifteen years of exposure. This shows that there is a correlation between and symptoms years of exposure. Burning and skin rashes are important symptoms seen in workers exposed to wet cement. Moist cement burns occur on lower leg, ankle and dorsal regions of hand. In some workers it will leads to scaling of skin, oozing and itching. Exposure to wet cement can also cause inflammation called Irritant Contact Dermatitis due to the presence of hexavalent chromate in cement. This hexavalent form penetrates the skin easily than other forms (Korrallus U et al 1984). Loading and unloading workers showed maximum frequency of symptoms like persistent cough, breathlessness, wheezing etc. This is caused by the exposure to dry dust particles which is in definite correlation with their nature of work. Portland cement contains some insoluble residues. A fraction of the insoluble residue may be free respirable silicates, which can cause silicosis, fibrosis of lungs and possibly cancer. Hence Portland cement can be considered as potential cause of occupational lung disease. Inhaling high levels of dust may occur during emptying cement bags. Short term exposure to cement dust irritates the nose and throat and causes choking and difficulty in breathing.

2-Health problems of construction workers are highlighted in this study. Construction worker perform a large variety of duties concerned with building, repairing and wrecking building and so on. Their work may include mixing, pouring and spreading concrete, gravel and other materials. Workers are exposed to cement and its potential toxicological effect during pouring and cleaning processes. Cutaneous problems are more prevalent than pulmonary problem among masons, helpers, concrete mixers and tile workers. They handle wet cement preparations of different combinations rather than in dust form. Cement is the common cause of dermatitis among construction workers. Skin diseases are more frequent

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among cement users than manufacturing workers. Because the presence of hexavalent chromate in cement. The hexavalent form penetrates the skin easily than other forms (Korrallus U *et al* 1984). Chromium dermatitis affects the dorsal region of hands and distal forearms. Other impurities such as nickel and cobalt also lead to more complications. When the cement dust comes in contact with water, hydroxides are formed that impair natural water alkalinity, living tissue leads to burning, skin rashes and inflammation Even though cutaneous problems are more reported by workers in the construction field, respiratory problems are also reported by helpers and concrete mixers. This is due to the pattern of their work. They are also exposed to dry cement during their work. Hence inhalation of dry cement is more in these two groups compared to masons. Cement dust has been implicated as a cause of mucous hyper secretion and obstruction of small airways

VII. CONLCUSION

1-Construction sector is world's largest industrial employer with 7% of total world employment and 31% of industrial employment. Cement can cause ill health by skin and eye contact or inhalation. Risk of injury depends on duration and level of exposure and individual sensitivity. There are many reports on the health hazards of cement factory workers. But the reports on construction workers are very less. They have to handle cement in different combinations at different time interval. Masons, concrete mixers, tile setters, helpers, loading and unloading workers form the working force in construction industry. Of this masons, concrete mixers, tile setters and helpers were exposed to wet cement and loading workers to the dry cement in the form of dust. The prime aim of the study is to understand the occupational hazards of cement and health status of cement workers in construction industry. It has also attempted to suggest remedial measures to reduce work related hazards.

Health hygiene and lung function parameters in construction workers were studied. There were 876 samples for Health hygiene study and lung function parameters of 150 masons, 150 loading workers and 150 controls were studied.

In the Health hygiene study, most of the workers were in the 25-35 age groups. Major share (79%) of workers were below 20 years of exposure. When the personal habits were considered, 64.27 % were found alcoholics and 39.4% were smokers. Betel, nut, lime and tobacco chewing was not popular among the study group. Instead 24.9% of masons were using pan-parag. In the present study, persistent cough, breathlessness and wheezing were the symptoms of lung function impairment. Respiratory tract symptoms were more observed among loading workers. In this study, 87% of loading workers were using face masks of cotton cloths, bath towels and hand-kerchiefs. There was statically significant association with the use of protective devices and symptoms were reported. The face mask used currently is not enough to prevent the entry of 0.05 µm sized cement particles.

Occupational cutaneous symptoms like irritation on skin, burning, skin rashes etc were reported in higher percentage in all categories of workers. Burning was more (70%) reported by concrete mixers. They were using finger-caps, gloves and boots etc as personal protective devices. On analysing the present data using 'z' test, statistically significant benefit was found in these device users.

2-In lung function study reduced but not significant mean and S. D values of FVC % predicted was observed in both cases than controls. The mean and S D values of FEV1/FVC % predicted were higher in both cases than control. The present observations are contradictory to other reports. These may be due to the difference in occupational style of our study group. Other experimental groups are working in cement factories so their labouring hours and patterns are different from the present study group. Lowered percentage of MMEF reflects the amount of dust accumulated in the alveoli. In the present study both cases showed non-significant reduced mean value of MMEF. Of this, lowest mean value was shown by loading workers. It reflects that the pattern of their work generates more dust during their labour. This is the first study report examining this parameter among cement exposed group.

Normal spirometer was expressed by 38.7% of loading workers and 42.7 % of their controls. While comparing normal spirometer in different age groups, it gradually decreases but last two groups (IV and V) showed variation which may be due to difference in the sample size. Eventually the impairment (mixed pattern) showed increasing pattern from first group to fifth group. It shows direct correlation with duration of exposure.

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On comparing the two study groups loading workers showed lower normal spirometry and higher impairment. It showed they are having the highest lung function impairment. Deposition of cement dust in different sites of respiratory tract results in accelerated symptoms and decline in lung function capacity. Even though loading workers take some preventive measures and duties on alternate days, they were constantly exposed to cement for longer duration. Clearing the wagon, loading the trucks and other vehicles waiting for the purpose are done by them without taking proper security measure and rest between labours. Hence they are the real victims of the cement exposure.

The present study unveil the working conditions, occupational hazards, protective measures taken and the health status of one of the most vibrant work force in district. Immigrant workers and women helpers are not included in the present study. This provided homogeneity to the data. Workers exposed to wet cement have reported the symptoms like irritation on skin, burning, skin rashes. Irritation on eye, hair loss and change in hair colour are also reported. Loading workers who are exposed to dry cement (dust) have lower normal spirometry and higher lung function impairment. The present study showed that exposure of humans to cement dust is capable of inducing marked hazardous alterations in some enzymatic activities, liver functions and some biochemical parameters. The present day practice of face masks, finger caps, gloves boots etc. are not enough to protect them

VIII. RECOMMENDATIONS

1. Cement Workers should be adequately informed about the specific hazards associated with their job and the specific safety measures they should follow to protect themselves.
2. Workers must be provided with health education on occupational hazards and preventive measures.
3. Workers should regularly use high quality protective devices in their work places.
4. Loading workers should use industrial masks.
5. Awareness campaign should be conducted about the occupational health hazards and regular use of high quality personal protective equipment's to contractors, builders and other stake holders.
6. Workers should undergo regular medical checkup which might help to detect the occupational related abnormal parameters in early stage.
7. Campaign among workers to avoid alcohol and the new generation chewing items.
8. Cement workers should avoid smoking as it reduces the lung's ability to clear dust.
9. Legislation to reduce health hazards of the construction workers.
10. Development of recommendations and requirements of engineering and environmental appropriate to safeguard this industry from health hazards.
11. Regulatory agencies should be committed to monitor this industry also.
12. The observation that cement exposure in construction workers cause small airway disease should further be tested in a follow-up study

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