International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2025: 7.089

Study of Repeated Susceptibility to Cement Dust Exposure and Its Persistent Consequences on Haemostatic Markers among Male Cement Handlers at Dalmia Bharat Cement Plant

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Abstract: ***Background**: According to the current study, cement male handlers at Dalmia Bharat Cement Plant were evaluated for persistent effects of cement dust exposure on certain haemostatic parameters. This study found that repeated and protracted exposures, depending on sensitivity and duration, have led to detrimental health conditions and deteriorating health, in-addition selected haemostatic markers. **Materials and Methods**: The study involved a total of 120 participants from the Dalmia Bharat Cement Plant located in Kalyanpur, Banjari - 821303, Bihar. Among participants, 60 were workers directly exposed to cement dust, referred to as cement handlers (CH), due to their job responsibilities over the past eight years. The remaining 60 participants, who had no exposure to cement dust, served as controls and were classified as non-cement handlers (NCH), consisting of office staff within the same factory. The average age of the workers were 36 years (±1.51 years), and their mean (BMI) body mass index were 21.60 (±2.56 kg/m²). The participants had been employed in the cement industry for an average of 94.15 months (±3.85 months), which is approximately 7.85 years. Cement handlers were susceptible to cement dust for about 8 hours each day, weekly 6 days. Blood of CH and NCH was collected venipuncture technique and 5 ml of blood was collected for the laboratory analysis of prothrombin time (PT) and International normalized ratio (INR), activated partial thromboplastin time (APTT), D-Dimer, Von Willebrand factor (VWF) and fibrinogen. **Results**: Results of current study unveiled risk for haemostasis had been significantly associated with increase in PT and INR, APTT, VWF, D-Dimer and fibrinogen levels in the cement handlers. **Conclusion**: The present study finds positive association of cement dust exposures with haemostasis- an aggregate mechanism specialized in salvaging blood loss; among cement handlers (CH) when compared with Non-cement handlers (NCH) as persons control of Dalmia Bharat Cement Plant.*

Keywords: Cement dust, Environmental pollution, Haemostatic markers, Dalmia Bharat cement plant, Factory workers

1. Introduction

An intolerable number of health problems, associated with haemostasis too, have always been caused by environmental pollution. According to this perspective, the cement sector is important and is growing quickly both globally and in India. Due to persistently high levels of construction development activity, the emerging market has seen an increase in demand for cement manufacturing [1–3]. The cement industry significantly contributes to pollution in the environment [4]. The many stages of cement manufacturing such as clinker cooling, raw material grinding, rotating kilns, packaging facilities, and storage units produce dust and other airborne particles [5–6]. Lime, silica, alumina, and iron oxides make up the majority of the basic ingredients required to make cement [7]. Silica exposure can cause haematological disease and other detrimental effects on many bodily organs; it has been a significant health concern [8]. The pathologic processes of cement dust-induced toxicities have been identified as lipid peroxidation, oxidative damage, and immunologic pathways [9]. Oxidants originate from iron that can be detached from methemoglobin (MetHb). When free iron is involved, Haberweiss reaction occurs which can be influenced by the existence of ferritin of red blood cells (RBCs). This particular ferritin looks for free iron. [10]. Chromium particularly Cr (VI) is a powerful oxidizing agent found in large amount in cement dust. The penetration of Cr (VI) to vital organs like respiratory system (the lungs), liver, kidney, muscles, hairs and bone brings about deleterious effects through the reactive oxygen species (free radicals) production as well as serious inflammatory response [11–12]. Additionally numerous studies reveal that cement dust because of its penetrating ability reach the systemic circulation therefore affecting spleen, heart, liver, muscles, bone, and hairs, eventually changing their microstructure and physiological function. Cement dust enters our bodies by eating, inhalation, and epidermal exposures, to a lesser degree [13]. Haemostasis is an aggregate mechanism: a well linked procedure specialized in salvaging blood loss, thus restoring the damaged tissue rectitude [14]. Haemostasis is therefore influenced by procedures that activate the exercise in order to cease the loss of blood hence inhibiting the production of thrombus. There is primary and secondary haemostasis. The primary haemostasis is responsible for the development of a plug at a damaged exposed cell area with platelets during an injury while the secondary haemostasis forms a common pathway that sprouts from the binding of two coagulation pathways, the intrinsic and the extrinsic pathways. These common pathways stimulate fibrinogen to fibrin through a process to effect platelet plug [15]. The haemostatic paramaters being evaluated in this study among NCH and CH includes; prothrombin, Von Willebrand factor, D-dimer, fibrinogen.

2. Material and Methods

The study involved a total of 120 participants from the Dalmia Bharat Cement Plant located in Kalyanpur, Banjari - 821303, Bihar, India. Among participants, 60 were workers directly exposed to cement dust, referred to as cement handlers (CH), due to their job responsibilities over the past eight years. The remaining 60 participants, who had no exposure to cement dust, served as controls and were classified as non-cement handlers (NCH), consisting of office staff within the same factory. The average age of the workers were 36 years (±1.51 years), and their mean (BMI) body mass index were 21.60 (± 2.56 kg/m²). The participants had been employed in the cement industry for an average of 94.15 months (±3.85 months), which is approximately 7.85 years. Cement handlers were susceptible to cement dust for about 8 hours each day, weekly 6 days. Blood specimens were collected after clotting by paramedical staff at the plant. Total of 5 ml of blood was drawn from each participant during fasting state, between 7:00 and 9:00 AM, using the vein-puncture technique. These blood samples were transferred to a trisodium citrate and plain vacutainer, mixed well and quickly sent to a clinical laboratory for analysis, where cardiovascular biomarkers were assessed. Haemostatic markers that includes in PT and INR, APTT, VWF, D-Dimer and fibrinogen levels analyzed using a using a fully automated coagulation analyzer BCS XP system II make of Siemens, Germany and VIDAS compact automated immunoassay analyzer make of BioMerieux, France.

Exclusion criteria: Workers with a history of blood transfusions, alcohol use, cigarette and shisha smoking, anemia, asthma, cardiovascular illness, or cancer were not allowed to work. Participants in this study were also excluded if they had ever worked in any other business that emits dust or fumes.

Ethical clearance: The Department of Research and Development's Ethical Committee and Review Board of Dr. A.P.J Abdul Kalam University, Indore, India fully authorized the protocol. Researched performed compliance with the ethical criteria that are comparable to the "1964 Declaration of Helsinki" and its later revisions [16]. In Kalyanpur, Banjari, Bihar, the Dalmia Cement Factory's management authority obtained prior consent. Every participant was informed of the goal of the study. Every participant completed an informed consent form and willingly participated in the study. Researchers assured them of the confidentiality of their personal information, and coding was completed thereafter.

Statistical analysis: Full filled using ANOVA or the Student's paired t-test to compare two groups based on paired data at different significance levels. The data of determinations were expressed using mean ± S.E. A probability value that was statistically significant ($p < 0.05$) was taken into consideration.

Data collection: This is case-referent study; information was obtained from employees through in-person interviews that were conducted in both their native tongue and English. Employees who met the inclusion criteria were informed about the research objectives, and then they then submitted necessary data to full fill survey [17]. Workers participating in tasks such as bagging, loading, grinding, and crushing were exposed to the greatest quantities of cement dust in their immediate area.

3. Results

The anthropometric index (Weight, Height, BMI & WHR) and mean Age of the cement dust exposed cement handlers (CH) assigned as test groups and non-cement handlers (NCH) assigned as control groups were shown in Table1.

Table 1: The socio-demographic profiles of 120 individuals, consisting of Cement Handlers (CH) and Non-Cement Handlers (NCH) at Dalmia Bharat Cement Plant, were examined.

Subjects	Parameters				
	Age (Year)	Weight (Kg.)	Height (Cm)	BMI (meter/Kilogram^2)	Ratio of Waist to Hip (inches)
NCH (n=60) (Range)	33.78 ± 0.98	61.75 ± 4.20	163.2 ± 7.21	23.20 ± 2.11	0.85 ± 0.04
CH (n=60) (Range)	(20.0 - 45.0) 39.24 ± 1.32	(50.0 – 71.0) 61.08 ± 5.50	(145 – 180) 168.1 ±5.78	(19.5 – 25.5) 21.60 ± 2.56	(< 0.90) 0.93 ± 0.02
	(25.0 – 48.0)	(52.0 – 70.0)	(149 – 177)	(19.0 – 25.2)	(< 0.95)
P- Value	<0.05*	>0.05	<0.05*	<0.05*	<0.05*

Note: Data are shown as Mean ± S.E., with * indicating significance at $p < 0.05$, ** at $p < 0.01$. Abbreviations: NCH - Non-Cement Handlers, CH – Cement Handlers, PT - prothrombin time, APTT- activated partial thromboplastin time, INR- International normalized ratio and VWF - VonWillebrand factor.

An analysis of anthropometric measurements in cement handlers (CH) Significant differences ($P < 0.05$) were seen in BMI and waist-to-hip ratio (WHR) between cement handlers and non-cement handlers. Blood samples from both cement dust-exposed and non-exposed personnel were analyzed to assess the effect of prolonged cement dust susceptibility on haemostatic markers. Analysis measured Results demonstrated significant increase ($P < 0.05$) in in PT and INR, APTT, VWF ($P < 0.001$), D-Dimer ($P < 0.01$) and fibrinogen levels ($P < 0.001$) in the cement dust exposed cement handlers compared to non-cement handlers (controls). The data is presented in Table 2.

Table 2: Susceptibility to dust on PT, APTT, VWF, D-Dimer and fibrinogen levels among Non-Cement Handlers (NCH) and Cement Handlers (CH) with varying susceptibility durations at Dalmia Bharat Cement Plant.

Subjects			Parameters			
	PT (sec)	APTT (sec)	INR	VWF (ng/mL)	D-DIMER (pg/mL)	FIBRINOGEN (mg/mL)
Control (n=60)	13.71±1.67	27.19±2.36	1.10±0.20	54.93±1.22	267.49±11.41	1.71±0.11
Exposed (n=60)	16.09±1.45	33.32±2.05	1.31±0.23	66.52±1.34	588.87±15.65	5.30±0.13
P value	<0.05*	<0.05*	<0.05*	<0.01**	<0.01**	<0.01**

Note: Data shown as Mean ± S.E., with * indicating significance at $p < 0.05$, ** at $p < 0.01$
Abbreviations: PT - Prothrombin Time, APTT- Activated Partial Thromboplastin Time, INR- International Normalized Ratio and VWF – Von Willebrand Factor.

Blood samples taken from CH exposed to cement dust and those were not, analyzed to evaluate the impact of durations of exposure on PT, INR, APTT, VWF and D-Dimer. Additionally, the fibrinogen levels were also evaluated. A comparative analysis based on varying periods of cement dust exposure revealed that mean values of PT and INR ($P < 0.05$) as well as APTT, VWF, D-Dimer and fibrinogen levels were significantly higher ($P < 0.01$) in cement handlers exposed to longer durations of dust exposure.

4. Discussion

As best to knowledge, this solitary conducted in Bihar state in India, that investigates pollution of air and environmental health maladies among Dalmia Bharat cement Plant workers, focusing on linking prolonged workplace exposure dust susceptibility with occurrence of haemostatis. The present study found a positive correlation, suggesting that increasing environmental pollution emerging as significant role in affecting haemostatis in exposed cement handlers. A key strength of this research is its novel approach in assessing the long-term and detrimental cement dust exposure on haemostatic markers, an area that has not been sufficiently explored. Earlier research confirmed that inhaling cement dust causes respiratory issues, as long-term accumulation can damage the airway epithelium and provoke inflammation. Although cement dust is linked to numerous diseases, limited research has measured inflammatory markers in factory workers to assess its impact on inflammation. [18]. Present study exhibits cement dust exposure was associated with increased haemostatic markers in workers, supporting a link between inflammation and hemostasis. In cement dust-exposed individuals, dust susceptibility triggers pulmonary macrophages, mesothelial cells, and fibroblasts to generate free radicals, ultimately increasing inflammatory cytokines like TNF-α and NF-κB [19]. Von Willebrand factor is a glycoprotein that aids clotting by binding platelets, connective tissue, and factor VIII, which it helps stabilize [20]. The elevated levels of VWF, fibrinogen observed in cement workers may stem from underlying inflammation, aligning with findings from prior research [21] which linked inflammation to increased levels of VWF and fibrinogen. In this study, cement-exposed workers showed markedly higher D-dimer levels than non-exposed controls, indicating increased fibrin degradation driven by inflammation. [22]. Fibrinogen is a protein that is produced in the liver and enters the circulation. It is cleaved by thrombin and then undergoes polymerization to form clot [23]. Our research study observed elevated fibrinogen levels in subjects exposed to cement dust compared to the control group, suggesting a heightened risk of deep venous thrombosis or pulmonary embolism. This aligns with a previous study which associated elevated plasma fibrinogen with a higher risk of venous thromboembolism, including deep venous thrombosis (DVT) and pulmonary embolism (PE) [24]. Additionally, this finding aligns with earlier studies reporting elevated fibrinogen levels in subjects exposed to both high and low levels of inhalable dust. [25]. Research in the pulp and paper industry demonstrated a significant fibrinogen response alongside several other markers following dust exposure. Additionally, numerous studies have documented elevated fibrinogen levels associated with exposure to high concentrations of cement dust [26].

5. Conclusion

The present study finds demonstrates significant association between cement dust exposure and haemostasis—an aggregate mechanism specialized in salvaging blood loss; among cement handlers (CH) when compared with non-cement handlers (NCH) as persons control of Dalmia Bharat Cement Plant. Exposure to cement dust disrupts hemostatic regulation, leading to the upregulation of studied hemostatic markers.

6. Recommendation

Cement handlers should not only be educated on proper PPE use, but wearing adequate PPE should also be mandatory for all personnel. Additionally, regular medical evaluations should be encouraged for workers exposed to cement dust.

Conflict of interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be constructed as a potential conflict of interest.

Ethical Consideration

The manuscript is original, and it has not been published elsewhere. All authors reviewed the original content of the manuscript. No AI tool was used during the study and writing the manuscript.

Acknowledgment

We would like to thank the following people for their assistance in this study, workers of Dalmia Bharat Cement Plant at Kalyanpur, Banjari, District Rohtas, Bihar who volunteer to be used for the present study, phlebotomist and laboratory technician of clinical biochemistry department, Famous Diagnostic Centre, Sasaram-821115, Rohtas, Bihar, India.

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