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Evaluation of Some Haematologic Parameters among Cement Loaders in Port-Harcourt

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cement remains a very useful discovery in the modern world and has served many purposes in the circle of construction, the dusts generated in the manufacturing, packaging, transporting, and also usage has impacted negatively on those exposed to the dusts at various levels. This study focuses on assessing the health impact of cement dust on haematologic parameters among cement loaders in Port Harcourt. A cross sectional study design was employed for this study. A total 200 male subjects; 100 healthy cement exposed workers and 100 apparently healthy non exposed male subjects. Subjects were selected randomly based on set inclusion and exclusion criteria. Venous blood samples were collected using venipuncture technique into EDTA bottle for the assay of Erythrocyte Sedimentation Rate (ESR) and Full Blood Count (FBC). ESR was estimated using Westergreen method while FBC was assayed using Haematology analyzer. There was a significant decrease in WBC count, RBC count, haemoglobin (Hb) level and monocyte in cement workers (*p*-value<0.05) but there was a significant increase in ESR level in cement workers (*p*-value<0.05). This study has shown that there cement dust exposure results in inflammation and can as well interfere with red blood cell production process.

Keywords: Cement; haematological parameters; exposure.

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1. INTRODUCTION

Cement is a very fine substance with adhesive and cohesive qualities that acts as glue for the individual elements. There are over ten different varieties of cement used in construction, each with a different composition and made for particular purposes [1]. These include rapid-hardening cement (RHC), quick-setting cement (QSC), low-heat cement (LHC), sulphate-resistant cement (SRC), blastfurnace slag cement (BFSC), high-alumina cement (HAC), white cement (WC), coloured cement (CC), pozzolanic cement (PzC), air-entraining cement (AEC), and hydrophobic cement (HPC). Cements are generally useful in the production of concrete materials, bridges, houses, culverts, and as well as in construction works (Joel and Mbapuun, 2016). Molecules of principal value in cement essentially include 60-67% calcium oxide, 17-25 silicon oxide (SiO2), 3-5% aluminium (Al) oxide, with some amount of iron oxide, chromium (Cr), potassium, sodium, sulphur and magnesium oxide [2,3]. Portland cement is the most used type of cement, and it has a large amount of lime when it comes to rapid-hardening cement [1]. The composition of cement includes; Lime (CaO), Silica (SiO2), Alumina (Al_2O_3), Calcium Sulphate ($CaSO_4$), Iron Oxide (Fe_2O_3), Magnesia (MgO), Sulphur (S), and Alkalies. The most extensively used cement for constructions and builing is the Ordinary Portland Cement (OPC). It is made through a procedure known as hydration by crushing, grinding, and combining particular proportions of lime or calcium Oxide (CaO: from limestone, chalk, shells, shale or calcareous rock), iron (Fe_2O_3: from clay, iron ore, scrap iron and fly ash), silica (SiO_2: from sand, old bottles, clay or argillaceous rock), alumina (Al_2O_3: from bauxite, recycled aluminum, clay), and Gypsum, $CaSO_4.2H_20$: found together with limestone [4]. The chemical interactions between the cement and the water give Portland cement its strength. This is a complicated process that is best understood by first learning about cement's chemical makeup [4]. Molecules of principal value in cement essentially include 60-67% calcium oxide, 17-25 silicon oxide (SiO2), 3-5% aluminium (Al) oxide, with some amount of iron oxide, chromium (Cr), potassium, sodium, sulphur and magnesium oxide [2,3]. Portland cement, which is one of the mostly used cements, comprises a mixture of calcium oxide (60–67%), silicon dioxide (17–25%), aluminium trioxide (3–8%) and ferric oxide (0–5%) [5]. Some of these elements exists freely and abundantly in nature. An example is Aluminium which it has no recognized critical role in biological systems, but has been shown to pose a threat to the health of both humans and animals. Other elements found in cement: iron, chromium, calcium, and silica have all been shown to pose a health hazard to those exposed to them. Different types of cells exist in the human blood, and these cells serve various activities [6]. These blood cells are produced in the haemopoietic tissue [7]. The most significant cells in the formation of blood cells are stem cells. Gordon [7] found that soluble factors regulate haemopoiesis, which follows a hierarchical structure in which multipotent stem cells give rise to progenator cells, which then divide to produce adult blood cells [7].

Exposure to dust causes alteration in blood cell counts. This can be due to allergic reactions and inflammation which in turn evoked by dust entering the lungs. This has been observed even from dust generated from Rice mill [8]. A study showed that neurtrophil, eosinophil and lymphocyte count among haematological indices were significantly increased in exposed individuals compared with control group. Patil et al., [8] thus posit that high level of dust exposure has deleterious effects on blood. Discoveries based on a research by Rahman, [9] finalized that the exposure to cement components as well as inhalation leads to problems. The haematogical indices that have been implicated in cement exposure are ESR, WBC, RBC, Hb levels. These parameters are raised due to exposure to cement particles thereby suggesting, increased activation of allergic response [10]. Also, reports have shown the protective role of haematopoietic products in prevention of oxidative stress related diseases [11,12]. Specifically, Gawad et al. [12] demonstrated the protective role of erythropoietin against apoptosis induced oxygen radicals. Furthermore, cement dust exposures has been reported to result in significant occupational health problems and long term complications and symptoms. Another study reported that occupational exposure to cement dust may have a negative impact on the haemopoietic function with emphasis on the provision and use of appropriate personal protective equipment.

2. MATERIALS AND METHODS

2.1 Study Design

A cross sectional study design was employed for this study. A convenient sampling size of 200 subjects was used. This research work was carried out on 200 male subjects; of which 100 were cement exposed healthy subjects working in one cement depot and eight loading sites and 100 were apparently healthy non exposed male subjects. The exposed subjects were selected randomly. The medical history as well as the bio-data, socio demographics, environmental and lifestyle of the study subjects were obtained with the use of a well-structured questionnaire.

2.2 Study Area

The study was carried out in Port Harcourt metropolis, Rivers State, Nigeria. Port Harcourt is the capital and biggest city of Rivers State, Nigeria with its geographic coordinates as latitude: 4°46′38″ N, longitude: 7°00′48″ E and elevation above sea level: 16 m = 52 ft. It lies along the Bonny Stream and is situated in the Niger Delta. The Port Harcourt urban Harcourt territory has an expected populace of 1,865,000 occupants, up from 1,382,592 starting at 2006 [13]. Despite the change of weather and climate being the influential factors that impact cement consumption, cement still remains a construction raw material, regularly distributed across various parts of Port Harcourt city [14]. Cement regardless of the economic situation, imparts on the country’s gross local product [15]. The study sites for this research were Dangote cement depot Trans-Amadi and Cement loading points/shops across Port Harcourt Metropolis ranging from Borokiri (latitude: 4.7463, longitude: 7.0364), Choba (latitude 6.50’ 00’’E; longtitude: 007.00’ 00E, Eleme junction (latitude: 4°51'21.6"N, longitude: 7°04'00.4"E), Eneka (latitude: 4°53'59.0"N (4.8997100°) and latitude: 7°01'59.9"E (7.0333100°)), Mile 3 Diobu (latitude: 4° 47' 57" North, longitude: 7° 0' 34), Rukpokwu (latitude: 4.902909, latitude: 7.001263), Rumuokoro (latitude: 4° 52' 3" North, longitude: 6° 59' 53" East), and Woji (longitude: 4° 47' 18" North, longitude: 7° 0' 3" East) all in Port Harcourt, Rivers State, Nigeria [16]. Dangote cement depot is situated at RIVOC, Trans -Amadi in Port Harcourt, Rivers State.

2.3 Study Population

This study involved 100 cement loaders who worked in cement depots and shops, and another 100 control subjects who were not involved in the use of cement occupationally. The biodata of the subjects were obtained using questionnaire. Individuals involved in any occupation that involves the use of cement, were not recruited as control subjects. Informed consent was also obtained from the subjects. All subjects were apparently healthy.

2.4 Eligibility

2.4.1 Inclusion criteria

The cement loaders involved in the study were those that had been exposed to cement dust for a minimum period of three months without any history of smoking, who gave their consent to participate in this study and are adults between the ages of 20 to 60 years of age.

The unexposed control subjects were apparently healthy male subjects who reside outside the vicinity of the cement exposed areas. Subjects with no history or signs suggestive of respiratory, haematologic, bone or liver diseases were considered eligible and selected into both the exposed and unexposed groups.

2.4.2 Exclusion criteria

Subjects with previous exposure to any occupational agents other than cement silica etc. were excluded from the study. Also, those with history or diagnosed case of asthma or any respiratory diseases or other diseases like diabetes mellitus, pulmonary tuberculosis, having history of acute or chronic infection or recent case of hospitalization, and those with these chronic illnesses were exempted from the study. Those who had worked for less than three months as well as those who did not consent were excluded from this study.

With the help of questionnaire and interview, all participating cement loaders were interviewed by trained interviewers. All participants went through medical assessment to rule out the presence of diseases like asthma, diabetes, hypertension, anemia, cancer, infections or those who have recently had blood transfusion, thyroid and heart problems. Participants with diseases, drug therapy and alcohol, antioxidants, exposure to deadly substances or radiation therapy were not included in the study.

2.5 Sample Collection, Transportation, Processing and Preservation

After seeking consent and giving explanations, venous blood samples were drawn from the antecubital fossa of this study subjects using vacutainer sample containers. This is in accordance to the description given by Cheesbrough, [17].

Venous blood sample of 3ml size was drawn into a vacutainer blood sample container of 0.5 ml of 1.2 mg/ml ethylene diamine tetra-acetic acid (EDTA) and properly mixed for the assessment of ESR, full blood count to ascertain haemoglobin count, white blood cell count and white cell indices, platelet count, platelet indices.

Within 24 hours, every venous blood sample drawn into dipotassium ethylene diamine tetra-acetic was completely assayed, to obtain complete blood count.

To the point of analysis, all drawn samples were conveyed via cold chain (ice packs/ crushed ice in air tight and sealed thermo-container) and temperature maintain with 2-8^{o}C.

2.6 Sampling Technique

Simple random sampling technique was used for recruitment to give everyone an equal chances of been selected into the study so as to rule out bias.

2.7 Sample Analyses

2.7.1 Determination of Erythrocyte Sedimentation Rate (ESR)

The blood sample for erythrocyte sedimendation rate was estimated using westergreen manual method.

Procedure: 0.4 ml (400 ul) of Trisodium citrate solution was added into a westergren bucket, add 1.6 ml (1,600 ul) of blood was also added to the Zero “0” mark. It was stood vertically undisturbed and free from vibrations for 1 hour in the Westergren stand after which the levels of the red cell was read and results were recorded in mm/hr.

2.7.2 Measurement of full blood count

The study samples for complete blood count were all assayed with the use of haematology automated analyzer.

Procedure: Here, the blood sample to be assayed was mixed up with a vortex mixer then the lid of the sample bottle was turned open and the sample inserted into the Mythic auto-analyser through the machine probe. The results of the analysis were displayed on the machine screen and were printed out.

3. RESULTS

3.1 Demographic Characteristics of Subjects

A total of one hundred (100) apparently healthy cement dust exposed male participants within the age of 20–60 years and one hundred (100) apparently healthy non cement dust exposed male control participants of age between 20 and 60 years were recruited for the study.

In Table 1, the age mean levels of Control and Exposed subjects are 38.69±8.21years and 38.78±1.04years respectively. Marital status was categorized as “married” and “single”. In the Control group, 56subjects were married and 44subjects were single while in the Exposed group, 60 subjects were married and 40subjects were single.

3.2 Comparison of Haematological Parameters of Control and Exposed Subjects

Table 2 showed the results of haematological parameters among cement loaders (exposed group) and control group (non-exposed group). The findings showed that there was a significant increase in ESR level in the exposed group ($p<0.05$) while there was a significant decrease in WBC, RBC, Hb and monocyte levels in the exposed group ($p<0.05$). Other assayed parameters did not show any significant difference between both group ($p>0.05$).

Table 1. Demographic characteristics of subjects

Characteristics	Control subjects (n=100)	Exposed subjects (n=100)
Age(Yrs)	38.69 ± 8.21	38.78 ± 1.04
Marital Status		
Married	56 (28.00%)	60 (30.00%)
Single	44 (22.00%)	40 (20.00%)

Table 2. Comparison of haematological parameters of control and exposed subjects

Subjects	Parameters													
	ESR (mm/hr)	**WBC ($x10^9$/L)**	**RBC ($x10^{12}$/L)**	**Hb (g/dL)**	**MCV (fl)**	**MCH (pg)**	**MCHC (g/dL)**	**PLT ($x10^9$/L**	**MPV (fl)**	**NEUT (%)**	**LYMP (%)**	**EOS (%)**	**BASO (%)**	**MONO (%)**
Control (n=100)	10.46 ±8.74	5.97 ±2.32	5.47 ±0.94	15.03 ±1.32	83.14 ±5.03	28.71 ±2.71	38.17 ±32.22	214.20 ±70.54	11.13 ±2.64	43.51 ±11.85	45.90 ±12.82	3.53 ±2.30	0.10 ±0.09	6.14 ±3.14
Exposed (n=100)	20.56 ±13.68	4.44 ±3.81	5.08 ±0.76	14.24 ±1.28	83.59 ±6.38	28.59 ±2.79	34.18 ±4.68	218.00 ±86.45	10.61 ±1.05	39.32 ±18.51	60.97 ±7.58	3.07 ±2.29	1.11 ±0.12	3.44 ±3.08
T value	6.151	3.401	3.227	4.324	0.5480	0.3077	1.226	0.3448	1.823	1.897	1.951	1.402	0.7288	6.127
P value	<0.0001	0.0008	0.001	<0.001	0.5843	0.7586	0.2218	0.7306	0.0699	0.0592	0.0525	0.1625	0.4670	<0.0001
Remark	S	S	S	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	S

Key: ESR- erythrocyte sedimentation rate, WBC- white blood cells, RBC- red blood cells, Hb- haemoglobin, MCV- mean corpuscular volume, MCHC—mean corpuscular haemoglobin concentration, MCH- mean corpuscular haemoglobin, PLT- platelets, MPV-mean platelet volume, LYMP-lymphocytes, EOS- eosinophils, BASO- basophils, MONO-monocytes, S-significant at p<0.05 and NS-not significant at p>0.05

4. DISCUSSION

This study evaluated some haematological among individuals exposed to cement dust. In this study, 100 subjects between the ages of 20 and 60 years were selected from the population of interest (cement loaders) and 100 subjects were recruited from non-cement loaders population to form the control group.

The results from this study showed that the exposed subjects had significantly, higher ESR but significantly lower and monocyte count compared to the control subjects. The increase in ESR may be due to inflammation that resulted from the cement dust. According to Bray et al. [18], ESR was reported to be associated with infections or tissue inflammation. In agreement with this finding, Pollard, [19] said constituents of cement such as silica-alumina have been reported to cause inflammatory reactions. This finding agrees with the work of Erabhor et al., [20] and Westerberg et al. [21] reported a notable increase in erythrocyte sedimentation rate in the cement dust exposed subjects compared to the control subjects which is in total consonance with this present study.

This study observed a significantly lower WBC and monocyte count in the exposed subjects, compared to the control subject. The lower WBC level may be due to disruption of white blood cell by the cement dust. According to Emmanuel et al. [22], cement dust increase the changes of disruption of white blood cell parameters in the body. Farheen et al. [23] also reported similarly that components in cement dust have effects on haematopioetic system. This finding agrees with the work of Okonkwo et al. [24] who reported decrease in white blood cell count in cement workers. A contrary finding was reported by Erhabor et al. [20]. A study conducted by Farheen, [23]; John and Olubayo, [10] reported significant changes in haematological parameters such that there was significant increase in total white blood cell count (WBC count) which is in contrast to the reduced WBC levels of cement dust exposed subjects compared to the control subjects as recorded in this particular study. The elevated monocyte count among cement exposed subjects in their study is not in consonance with this very study which recorded reduced monocyte counts. According to Patil et al. 18], generally, exposure to dust causes alteration in blood cell counts. This can be due to allergic reactions and inflammation which in turn is evoked by dust entering the lungs. This has been observed even from dust generated from other dusty materials

The data from this study showed that the exposed subjects had significantly lower Hb and RBC compared to the control subjects. This may be that components of cement dust interfered with haemopioetic process. Report by Emeka et al. [25] suggested that alteration in haematologic parameters could be due to the effect of cement dust components such as aluminum, calcium and silicon on the cellular blood component formation system. This finding agrees with the work of Ahmad and Akhter, [26]. Many ailments have been linked to cement dust exposure and according to them there was significant reduction in the values of haematocrit and haemoglobin level. This study is in consonance with the study carried out by Nwafor et al. [27], which illustrated some haematological parameters with significant decrease as seen in the values of red blood cell counts and haemoglobin levels due to exposure to cement dust. Long- term cement dust subjection can lead to the damage of the haemopoietic structure. A study done in Bangladesh, by Ahmad Rahnuma and Akhter Qazi Shamima in [26] on cement dust related to total count of red blood cell, suggested that cement dust exposure leads to haemoglobin concentration damage and reduction of red blood cell count. This is in agreement with this study. In addition, a study carried out by Jacob et al. [28] on cement workers showed that Hb was decreased in value also.

5. CONCLUSION

This study has shown that exposure to cement dust could significantly cause changes in some haematological parameters, especially on anaemia indicators and some indicators or markers of inflammation such as white blood cells and ESR.

6. RECOMMENDATIONS

The cement loaders should be educated on the importance of using adequate PPE and the need for regular medical checkup for the cement workers.

ETHICAL CLEARANCE AND INFORMED CONSENT

Ethical approval for this research was obtained from the Rivers State Health Research Ethics Committee. Permission was also taken from the authorities of cement loading sites/shops and Dangote cement depot, RIVOC, Trans-Amadi, Port Harcourt. Written consent was obtained from participants before recruitment into the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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