Original Research Article

DURATIONAL EFFECT OF CEMENT DUST EXPOSURE ON HAEMATOLOGICAL PROFILE OF ALBINO RAT

Abstract

This research work studied the durational effects of cement dust inhalation on the haematological parameters of exposed Albino rats. In this study, a glass house animal exposure chamber was fabricated using a plexi-glass and two blowing fans of adjustable revolution. Twenty five Albino rats were divided into five groups. Group A served as the control, while group B, C, D and E served as the test, and were exposed for 15, 30, 45 and 60 days interval respectively, for one hour daily to cement dust (200g), at a revolution of 3000rpm of the fans. At the end of the exposure, the animals were sacrificed, blood collected in EDTA bottle and was analysed for some haematological variables. The result showed that there were significant durational increase ($p < 0.05$) in the levels of Packed Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC), Lymphocyte, Monocytes and Eosinophils of the test group compared to control group but there was no significant difference in the Wbc, Basophils, Platelets and Neutrophils levels among the groups ($p >0.05$). In conclusion, there is a durational exposure haematotoxic effect of cement dust inhalation on rat exposed to cement dust.

***Keywords**: Cement, exposure, haematological, rats*

Introduction

Cement consists essentially of compounds of lime (calcium oxide, CaO) mixed with silica (silicon dioxide, SiO_2) and alumina (aluminum oxide, Al_2O_3). The lime is obtained from a calcareous (lime-containing) raw material, and the other oxides are derived from an argillaceous (clayey) material. Additional raw materials such as silica sand, iron oxide (Fe_2O_3), and bauxite—containing hydrated aluminum, $Al(OH)_3$—may be used in smaller quantities to get the desired composition [1].

In Nigeria, The Federal Ministry of Commerce and Industry estimates that the effective demand is around 20 million tons. According to Ian Furnivall and Tunde Abidoye, acute infrastructure deficit and significant demand for housing has driven domestic production volumes up to 25 % over the last four years [2]. However the Federal government in her effort to improve the availability of the commodity in 2010 banned the importation of cement into the country in order to encourage local production and existing companies are increasing their capacities. Dangote

Cement Company formerly Benue Cement Company in Benue State for instance, increased its capacity from 0.45 million to 2 million per annum in 2008 and now 2.9 to 3 million. In 2010 UNICEM added 2.5 million tons of its capacity to local capacity while Lafarge WAPCO added 2.2 million tons in 2011. With these improved capacities the quantity of cement in the market has improved.

Exposure to cement dust has been implicated as the major cause of silicosis and lung cancer. Individual involved either directly or indirectly in activities such as shearing, crushing, breaking or drilling of silica-based materials including concrete, tile, and stone in addition to building and construction workers are major culprits in this regard [3-5]. Majority of factory workers in Nigeria and in other developing countries are ignorant of the need for certain precautionary measures required to safeguard their health due to ignorance and illiteracy. Most often than not they are hired without necessary prerequisite training and mobilized to work site with or without personal protective equipment [6].Thus, knowledge and awareness about occupational hazards among factory workers in Nigeria is grossly inadequate. Thus, how working in highly dusty environments affects health and safety is a serious concern [7].

This increasing health concern on cement production proliferation and exposure to humans necessitated the need to study the effect of durational exposure of cement dust in a well-controlled animal model.

Materials and Methods

Study area

The study was carried out in the Animal House of the Faculty of Basic Medical Sciences in PAMO University of medical science, Port Harcourt, Nigeria.

Ethical Clearance

Ethical clearance for this study was obtained from The Ethics Committee of Pamo University of Medical Sciences, Port Harcourt, Nigeria.

Study Design

Twenty five (25) albino rats were used in this study and they were divided into five groups of four animals each based on duration of exposure to cement dust.

Group A was used as control (rats in this group was not exposed to cement dust).

Group B was exposed to cement dust for 15 days

Group C was exposed to cement dust for 30 days

Group D was exposed to cement dust for 45 days

Group E was exposed to cement dust for 60 days

All groups except Group A were exposed to 200g of cement dust for one hour daily for the period of the group exposure duration in a glass house animal exposure chamber fabricated using a plexi-glass and two blowing fans of adjusted for 3000rpm. At the end of the exposure, the animals anesthetized in chlorofoam, sacrificed, blood collected in EDTA bottles and were analysed for full blood count [8].

Sample Collection Method

Exactly 3mls of blood was collected through cardiac puncture as described by the method of [9] in an anticoagulant bottle (EDTA) was used for the hematological assay.

Laboratory Analysis

The study samples were all assayed with the use of automated machine as described by Nyebuchi [10]. The Haematological Parameters which were analysed are: PCV, Hb, Rbc, Wbc, Platelet, Lymphocyte, Monocytes, Basophils, Neutrophils and Eosinophils.

Statistical Analysis

Data generated from the study were analyzed descriptively and inferentially using SPSS 24.0. Descriptively, mean and standard deviation were calculated and inferentially, One Way ANOVA and Post hoc analysis were carried out. Significance of the test was set at P-value<0.05.

Results

Table 1 shows the comparison of haematological parameters among the five groups (A, B, C, D and E). The results show that there were significant decrease (P-value<0.05) in the levels of PCV, Hb, RBC count among the groups. Lymphocytes, Monocytes and Eosinophils had significantly increasing values (P-value<0.05) with increasing exposure time meanwhile, there were no significant change in the levels of WBC, PLT, neutrophil and basophils among the groups.

Table 1: Comparison of Haematological Parameters amongst the Studied Groups.

Groups	PCV %	Hb g/dl	WBC $x10^9$/l	RBC $x10^{12}$/l	Platelet $x10^9$/l	Neutrophil %	Lymphocyte %	Monocytes %	Eosinophil %	Basophil %
A (control)	55.3±9.6	18.3±3.2	15.7±3.3	5.9±0.9	436.3±87.7	21.5±4.4	60.8±5.6	8.75±4.5	9.0±1.8	0.0±0.0
B	38.0±5.5	13.0±1.7	7.9±3.1	4.1±0.6	545.0±312.3	29.8±7.8	49.3±13.4	14.3±6.8	4.0±2.7	0.0±0.0
C	44.8±2.9	14.9±0.9	6.7±1.9	4.7±0.2	254.0±63.0	19.8±6.9	74.0±9.7	3.8±2.1	2.3±2.2	0.3±0.5
D	44.8±1.3	14.9±0.4	15.8±4.9	4.9±0.1	436.3±19.3	15.8±7.8	73.8±6.9	5.0±2.8	4.3±2.6	0.0±0.0
E	57.3±7.9	19.1±2.6	16.1±10.1	5.9±0.9	332.5±57.8	21.3±3.6	61.8±5.4	11.5±1.9	6.3±1.9	0.0±0.0
F-value	6.6	6.2	2.9	6.2	2.2	2.6	5.6	4.7	5.1	1.0
P-value	0.003	0.004	0.060	0.004	0.119	0.08	0.01	0.01	0.01	0.44
Remark	SS	SS	NS	SS	NS	NS	SS	SS	SS	NS
Post hoc										
A VS B	NS (0.13)	NS (0.15)	NS (0.07)	NS (0.11)	NS (0.95)	NS (0.45)	NS (0.57)	NS (0.68)	NS (0.12)	NS (0.84)
A VS C	NS (0.38)	NS (0.39)	SS (0.03)	NS (0.30)	NS (0.08)	NS (0.99)	NS (0.23)	NS (0.39)	**SS (0.02)**	NS (0.84)
A VS D	NS (0.38)	NS (0.38)	NS (1.00)	NS (0.39)	NS (1.00)	NS (0.71)	NS (0.13)	NS (0.65)	NS (0.13)	NS (0.84)
A VS E	NS (0.99)	NS (0.99)	NS (1.00)	NS (1.00)	NS (0.39)	NS (1.00)	**SS (0.04)**	NS (0.79)	NS (0.33)	NS (0.84)
B VS C	NS (0.33)	NS (0.41)	NS (0.95)	NS (0.43)	NS (0.48)	NS (0.40)	NS (0.13)	NS (0.18)	NS (0.85)	NS (0.84)
B VS D	NS (0.30)	NS (0.36)	NS (0.19)	NS (0.28)	NS (0.95)	NS (0.20)	NS (0.12)	NS (0.25)	NS (1.00)	NS (0.84)
B VS E	**SS (0.04)**	**SS (0.04)**	NS (0.61)	**SS (0.03)**	NS (0.69)	NS (0.41)	NS (0.51)	NS (0.92)	NS (0.67)	NS (0.84)
C VS D	NS (1.00)	NS (1.00)	NS (0.12)	NS (0.77)	NS (0.07)	NS (0.93)	NS (1.00)	NS (0.95)	NS (0.77)	NS (0.84)
C VS E	NS (0.17)	NS (0.17)	NS (0.49)	NS (0.22)	NS (0.43)	NS (0.99)	NS (0.31)	**SS (0.01)**	NS (0.16)	NS (0.84)
D VS E	NS (0.18)	NS (0.18)	NS (1.00)	NS (0.29)	NS (0.13)	NS (0.71)	NS (0.16)	NS (0.06)	NS (0.74)	NS (0.84)

Data was analyzed using one-way ANOVA followed by Games-Howell and values were considered significant at $p<0.05$.

KEY;
SS = statistically significant
NS = not statistically significant

Discussion

In this research study, Wistar rats were exposed to cement dusts via a fabricated exposure chamber, to determine the histomorphological, haematological and liver function parameters of the exposed Wistar rats.

In this study, the Packed cell volume (PCV), Hemoglobin concentration, Erythrocytes, Lymphocytes, Monocytes and Basophils of the test group were significantly lower ($p<0.05$), and the white blood cell and platelet counts were significantly higher ($p>0.05$) than that of the control group. This result in this finding is in agreement with the earlier findings of Mojiminyi *et al.*, in 2008 who reported that the hemoglobin concentration and packed cell volume of exposed workers were significantly lower [11]. This finding was also supported by a study Nyebuchi et al. (2022) who reported increase in anaemia tendencies in cement workers in Port Harcourt [10]. The decreasing packed cell volume, reduced hemoglobin concentration and red blood cell count may not be due to nutritional deficiency as all the groups of animal were properly fed, but may be due to increasing cement dust exposure toxicity as anemia has been documented over time as an index of toxicity [12]. The alteration in the anaemia indicators is a suggestive that cement dust affects the haemopoietic line of red blood cell production because decrease in red blood cell production leads to decrease in PCV and Hb levels in blood [10].

It was also reported in this study that there were increase in the levels of lymphocytes, monocytes and eosinophils. The rise in these white blood cells may be due to inflammation. A study by Nyebuchi et al. (2022) revealed that cement dust could trigger inflammation due to rise in inflammatory markers in cement workers in Port Harcourt [10].

There was no significant effect of cement dust durational exposure on total WBC, neutrophils and basophils. This implies that cement did not affect the functionality of WBC, neutrophils and basophils in rats exposed to different duration of cement dust. This is also in agreement with the study conducted by Nyebuchi and her colleagues in 2022 who mentioned that duration of study does not have any effect on some haematological parameters [10].

Conclusion

This study has revealed that durational exposure may affect the erythropoietic process and may as well trigger inflammatory response in rats.

References

1. Ahmed, R., Qazi, R.A. & Mainul, H. (2021). Cement dust revelation and inflammatory response: Global health component with special consideration towards Bangladesh. *Advances in Human Biology*, 11(3), 281-284.
2. Ian, F. & Abidoye, T. (2009). Nigerian cement industry set period of major growth; Ultimate guide to business, trade and investment in Nigeria. *International Journal of Advanced Academic Research*, 6(3), 11-20
3. Falode, J. A., Akinmoladun, A. C. & Olaleye, M. T. (2019). Ameliorative property of Kigelia africana crude and flavonoid leaf extracts on aluminum-induced hepatotoxicity in albino rats. *Comparative Clinical Pathology*, 28(5), 1495-1506.
4. Xiang .P., He, R. W., Liu .R. Y., Li .K., Gao .P., Cui .X. Y. & Mal. Q. (2018). Cellular responses of normal (HL-7702) and cancerous (HepG2) hepatic cells to dust extract exposure. Chemosphere, 193, 1189-1197.
5. Asghari, F. B., Jaafari, J., Yousefi, M., Mohammadi, A. A. & Dehghanzadeh, R. (2018). Evaluation of water corrosion, scaling extent and heterotrophic plate count bacteria in asbestos and polyethylene pipes in drinking water distribution system. *Human and ecological risk assessment: an international journal*, 24(4), 1138-1149.
6. Choudhry, R. M. (2014). Behavior-based safety on construction sites: A case study. Accident analysis & prevention, 70, 14-23.
7. Ngombe, L. K., Nlandu, R. N., Ngombe, D. K. S., Ilunga, B. K., Okitotsho, S. W., Sakatolo, J. B. K. & Danuser, B. (2019). Respiratory health of dust-exposed cement carriers in Haut-Katanga province, DR Congo. *Environnement, Risques & Santé*, 18(6), 500-507.
8. Okolonkwo, B. N., Amadi, C. F., Chikwubike, U. O. & Nyenke, C. U. (2022). The comparative effects of vitamin E + C on the chronic toxicity of paraquat in albino rats (Rattus norvegicus). *European Journal of Medicinal Plants*, 33(6), 7-13
9. Parasuraman, S., Raveendran, R., & Kesavan, R. (2010). Blood sample collection in small laboratory animals. *Journal of pharmacology & pharmacotherapeutics*, 1(2), 87.
10. Nyebuchi, J., Eze, E. M., Bartimaeus, E-A. S., & Ken-Ezihwo, S. U. (2022). Evaluation of some haematologic parameters among cement loaders in Port Harcourt. *Asian Haematology Research Journal*, 6(3), 1-8

11. Mojiminiyi, F. B. O., Merenu, I. A., Ibrahim, M. T. O., & Njoku, C. H. (2008). The effect of cement dust exposure on haematological and liver function parameters of cement factory workers in Sokoto, Nigeria. *Nigerian journal of physiological sciences*, 23(1-2).
12. Nwafor, P. C., Odukanmi, O. A., Salami, A. T., Owonikoko, M.., & Olaleye, S. B. (2019). Evaluation of a cement dust generation and exposure chamber for rodents: blood heavy metal status, haematological variables and gastrointestinal motility in rats. *African Journal of Biomedical Research*, 22(1), 79-87.