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Haematological and Body Weight Changes in Wistar Rats Following Exposure to Cement Dust

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Author for Correspondence*: mabel.ghi-omosun@uniben.edu/+234-704-994-8914.
<https://dx.doi.org/10.4314/sokjmls.v9i2.17>**Abstract**

Cement dust is an atmospheric pollutant which poses a significant threat to the environment and humans (Akinola *et al.*, 2018). This study investigated the haematological and body weight changes in Wistar rats following exposure to cement dust. Twenty-four (24) Wistar rats weighing between 250 g and 280 g were divided into 4 groups of 6 rats per group. Group A rats were placed in a cement dust free chamber while Group B - D rats were exposed to various concentrations of cement dust dispersed from 5 g, 10 g and 20 g of cement, respectively. The weights of the animals in each group were taken and recorded weekly and the difference between them and previous weights were noted. At the end of 30th day of exposure, the animals were weighed and euthanized under chloroform anaesthesia. Blood samples were collected through cardiac puncture into EDTA anticoagulated tube for haematological analysis. Findings of the study for body weight showed that cement dust caused significant decrease in body weights of the exposed rats across all the groups. Cement dust also decreased some haematological parameters such as lymphocytes and basophils, haemoglobin and haematocrit, red blood cells and other red cell indices with associated reticulocytosis. These deranged haematological parameters may lead to anaemia and increased susceptibility to infections. The decreased haematological parameters are consistent with usual haematological findings in anaemia. It was concluded that exposure to cement dust caused body weight loss and haematological derangements in rats which are

capable of compromising haematological function and could ultimately lead to mortality.

Keywords: Cement dust; haematological parameters; blood cells; anaemia

Introduction

Cement dust is an atmospheric pollutant (Alakija *et al.*, 2015). It is emitted during the manufacturing and processing of cement, transportation, bag dumping and emptying, storage, usage and concrete cutting (Alakija *et al.*, 2015). Cement dust contains toxic substances such as aluminium, silicon, calcium, manganese, iron and zinc which can trigger inflammatory changes in the blood forming organs and may lead to pathogenesis of various haematological diseases including anaemia (Akpan *et al.*, 2014).

Exposure to cement dust may cause several health complications and pathogenesis because cement dust contains many types of chemicals. The most reported occupational hazards for cement workers are allergy and other respiratory illnesses (Iyawe and Ebomoyi, 2017). Some authors have reported that exposure to cement dust may result in some metabolic disorders, cardiovascular diseases and severe inflammation. Not much has been reported on cement dust exposure on body weight and parameters of haematological functions. It will be of public interest to know the effects of cement dust exposure on body weight and haematological parameters. The haematological parameters such as white blood cells, lymphocytes, monocytes, neutrophils, eosinophils, basophils, platelets,

haemoglobin, haematocrit, reticulocytes, red blood cells and other red cell indices are commonly examined to assess the toxic stress induced by cement dust (Nwafor *et al.*, 2019).

Anaemia is a condition in which the number of red blood cells or the haemoglobin concentration within them is lower than normal (Mark *et al.*, 2016). It occurs when the blood doesn't have enough haemoglobin or red blood cells or if bleeding causes loss of red blood cells and haemoglobin faster than they can be replaced (Harrison, 2014).

Blood cells are cells produced through haematopoiesis and found mainly in the blood. Due to the fact that cement dust contains many hazardous chemicals, prolonged or repeated exposure to it may cause destruction and inflammation of the blood forming-organs which then results in failure of blood cells production which could ultimately lead to anaemia (Iyawe *et al.*, 2012; Harrison, 2014). If the anaemia is not treated quickly enough, it can lead to respiratory failure and death (Mark *et al.*, 2016; Ross and Wilson, 2018). Besides cement dust, other irritating substances such as asbestos, secondhand smoke and coal dust have been linked to anaemia (Moore and Dalley, 2014; Mark *et al.*, 2016).

Signs and symptoms of cement dust related anaemia include fatigue, wheezing, dyspnoea, cyanosis, dizziness, multiple-organ failure and death if left untreated (Harrison, 2014; Drake *et al.*, 2015; Cheesbrough, 2016). Hence, the objective of this paper was to investigate the effects of cement dust on the haematological parameters and body weight of *Wistar rats*.

Objectives of the Study:

The objectives were to;

1. Investigate the effects of cement dust exposure on the weight of *Wistar rats*.
2. Determine haematological parameters in rats exposed to cement dust.

Materials and Methods

Experimental Animals: Twenty-four (24) adult *Wistar rats*, weighing between 250 g and 280 g purchased from the Animal house, Department of Anatomy, University of Benin, Nigeria, were utilized for this study. The animals were left to

acclimatize for two (2) weeks before commencement of the experiment. During this period, they were allowed access to standard animal feed and water *ad libitum*.

Ethical Considerations: Each animal procedure was carried out in accordance with approved protocols and in compliance with the recommendations for the proper management and utilization of laboratory animals used for research (Buzek and Chastel, 2010).

Experimental Design: In this study, 24 animals were divided into 4 groups comprising of 6 rats per-group. Group A rats, which served as control, were placed in a cement dust-free dust distributor glass chamber (DDGC). Group B rats were exposed to cement dust dispersed from 5 g of cement via DDGC for 1 hour daily for 30 days. Group C rats were exposed to cement dust dispersed from 10 g of cement via DDGC for 1 hour daily for 30 days. Group D rats were exposed to cement dust dispersed from 20 g of cement via DDGC for 1 hour daily for 30 days. The weights of the animals in each group were taken and recorded weekly and the difference noted.

At the end of 30th day of exposure, the animals were weighed and euthanized under chloroform anaesthesia. Blood samples were collected through cardiac puncture into plain specimen bottles for haematological analysis.

Statistical Analysis: Statistical analysis was carried out with Statistical Software Package, Microsoft Excel, (2010) and Statistical Package for Social Sciences (S.P.S.S.) version 20. Results were presented as Mean (X) \pm Standard error of mean (SEM). The one-way Analysis of Variance (ANOVA) was used to determine the significance of the difference in means at 95% confidence interval. $P < 0.05$ was considered significant.

Results

Changes in body weights of the animals in all the experimental groups are presented in Table 1. It was observed that there was a significant increase in body weights of the rats in Group A (Control Group) while Group B, C and D (Groups that were exposed to cement dust) showed a significant decrease in body weight.

Table1: Comparison of Body Weights of the Rats in all Experimental Groups:

Period of Exposure	Group- A	Group- B	Group- C	Group -D	P- Values
Ist week	5.60 ± 0.68*	0.60 ± 0.19*	0.42 ± 0.16*	0.38 ± 0.16*	0.000
2nd week	6.70 ± 0.93*	0.30 ± 0.05*	0.30 ± 0.09*	0.20 ± 0.14*	0.000
3 rd week	7.40 ± 1.24*	0.06 ± 0.17*	0.20 ± 0.05*	0.16 ± 0.07*	0.000
4 th week	7.74 ± 0.60*	0.18 ± 0.09*	0.36 ± 0.10*	0.04 ± 0.08*	0.000

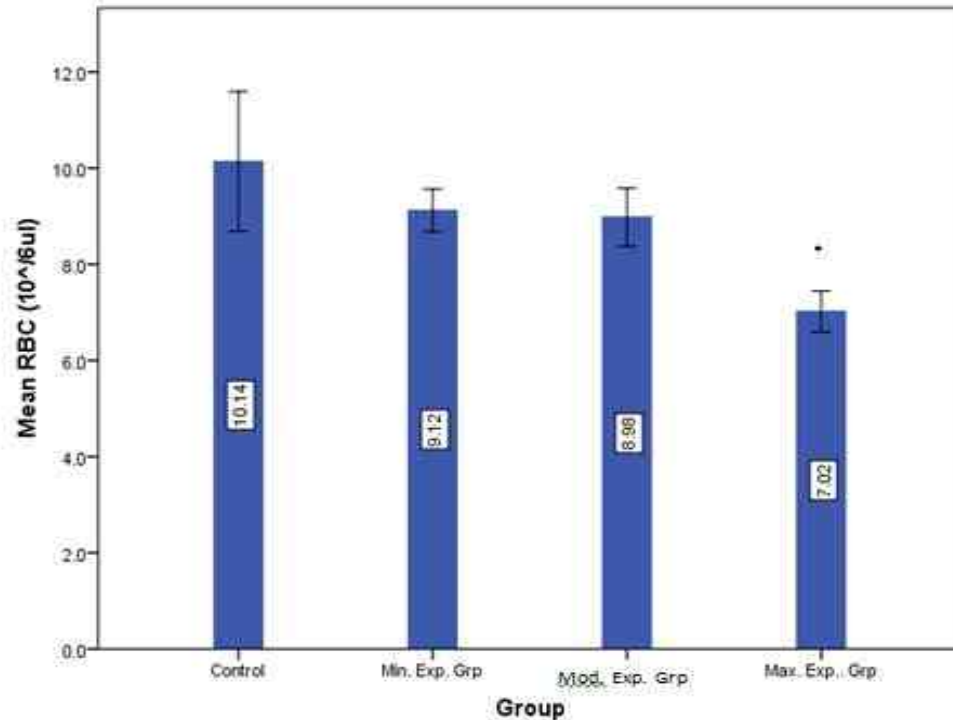
n=6; Values are Mean ± S.E.M

Table 2: Comparison of Haematological Parameters in all Experimental Groups

Haematological Parameters	Group				P-values
	Group A (Control)	Group B (5 g of Cement)	Group C (10 g of Cement)	Group D (20 g of Cement)	
WBC (10 ³)	11.06 ± 3.00	10.48 ± 2.34	9.66 ± 0.88	8.22 ± 1.65	0.799
LYM (%)	79.78 ± 1.07	75.04 ± 3.52	70.02 ± 5.58	59.20 ± 3.04*	0.007
MON (%)	26.84 ± 6.70	21.50 ± 1.38	20.40 ± 1.74	18.94 ± 2.09	0.474
NEU (%)	8.64 ± 0.99	7.92 ± 1.02	6.20 ± 1.29	5.34 ± 0.96	0.155
EOS (%)	1.94 ± 1.37	1.38 ± 0.54	1.02 ± 0.46	0.70 ± 0.27	0.715
BAS (%)	9.56 ± 1.15	6.12 ± 1.82	4.66 ± 0.79	3.92 ± 0.58*	0.018
RBC (10 ⁶ /ul)	10.14 ± 0.73	9.12 ± 0.22	8.98 ± 0.30	7.02 ± 0.21*	0.001
HGB (g/dl)	13.04 ± 0.73	12.12 ± 0.33	11.10 ± 0.35*	10.76 ± 0.23*	0.010
HCT (%)	43.30 ± 1.66	42.56 ± 2.06	38.38 ± 1.35	35.52 ± 1.34*	0.012
MCV (um ³)	46.60 ± 0.38	45.32 ± 0.61	44.34 ± 0.40*	42.84 ± 0.47*	0.000
MCH (ng)	17.16 ± 0.21	16.90 ± 0.24	16.30 ± 0.17	15.10 ± 0.25*	0.000
MCHC (%)	35.78 ± 0.36	35.06 ± 0.32	34.98 ± 0.30	34.02 ± 0.02*	0.005
PLT (10 ³ /uL)	826.00 ± 18.87	802.60 ± 59.09	798.40 ± 57.83	741.20 ± 52.47	0.674
RET (%)	0.12 ± 0.02	0.54 ± 0.11*	0.98 ± 0.40*	1.60 ± 0.72*	0.000

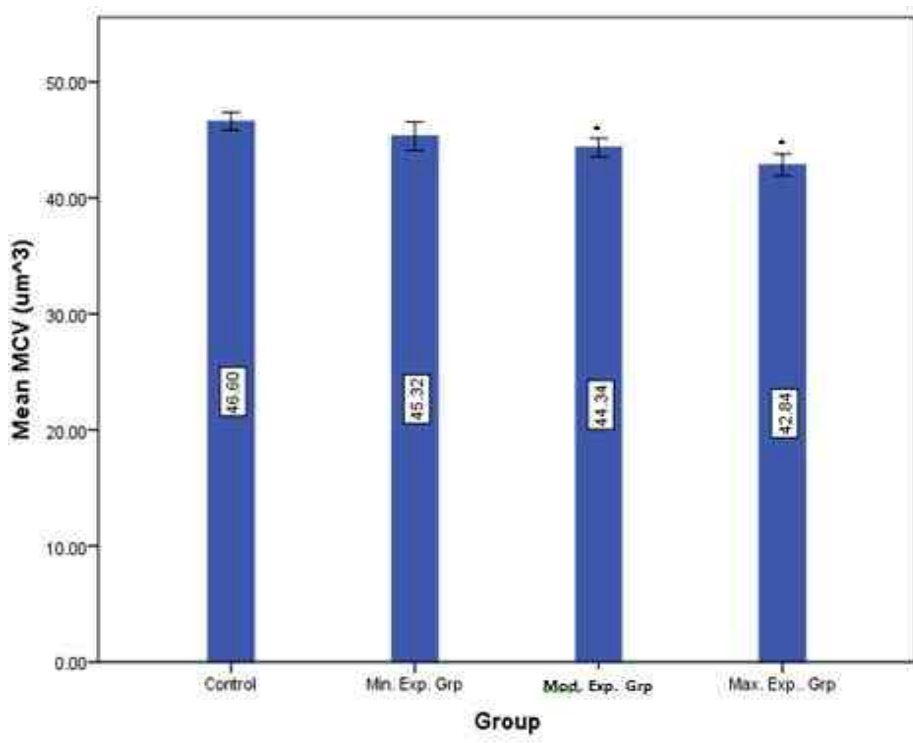
Values are Mean ± S.E.M *p<0.05 vs. control.

Key: White blood cells (WBC), Lymphocytes (LYM), Monocytes (MON), Neutrophils (NEU), Eosinophils (EOS), Basophils (BAS), Red blood cells (RBC), Haemoglobin (HGB), Haematocrit (HCT), Mean cell volume (MCV), Mean cell haemoglobin (MCH), Mean cell haemoglobin concentration (MCHC), Platelets (PLT), Reticulocytes (RET).



Error Bars: +/- 2 SE

Figure 1: Chart shows the values of red blood cell count detected in the unexposed and exposed groups. The red blood cell counts in the exposed Group D when compared with the control (Group A) showed significant decrease ($P < 0.05$).



Error Bars: +/- 2 SE

Figure 2: This chart shows the value of mean cell volume in all the experimental groups. When compared with the control, Groups C & D show significant decrease at $P < 0.05$.

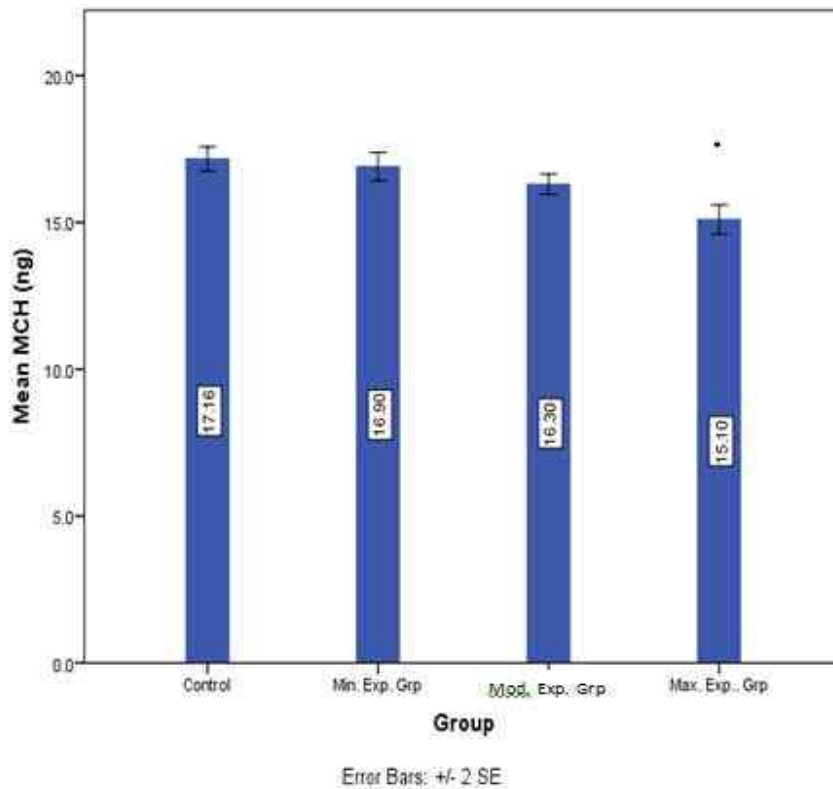


Figure 3: This chart shows the value of mean cell haemoglobin in all the experimental groups. When compared with the control, Group D shows significant decrease at $P < 0.05$.

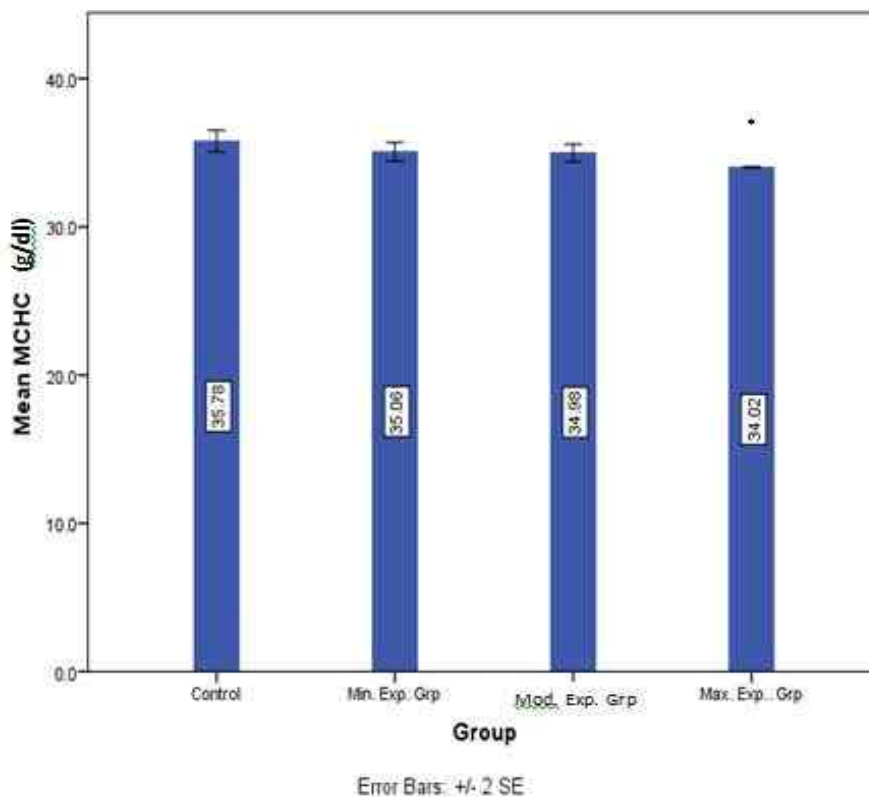


Figure 4: This chart shows the value of mean cell haemoglobin concentration in all the experimental groups. When compared with the control, Group D shows significant decrease at $P < 0.05$.

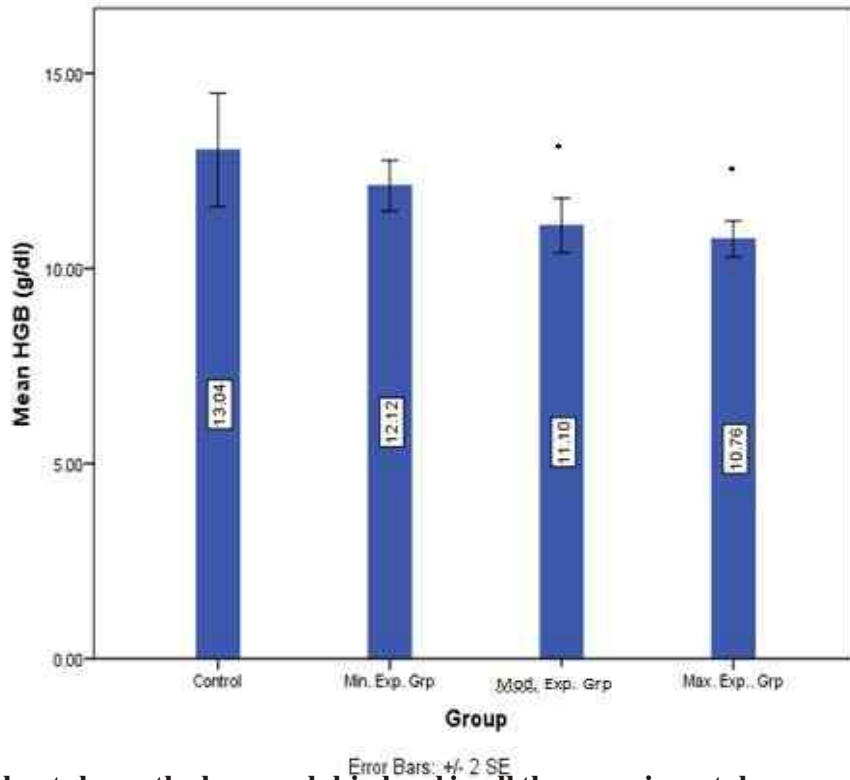


Figure 5: This chart shows the haemoglobin level in all the experimental groups. When compared with the control, group C & D show significant decrease at $P < 0.05$.

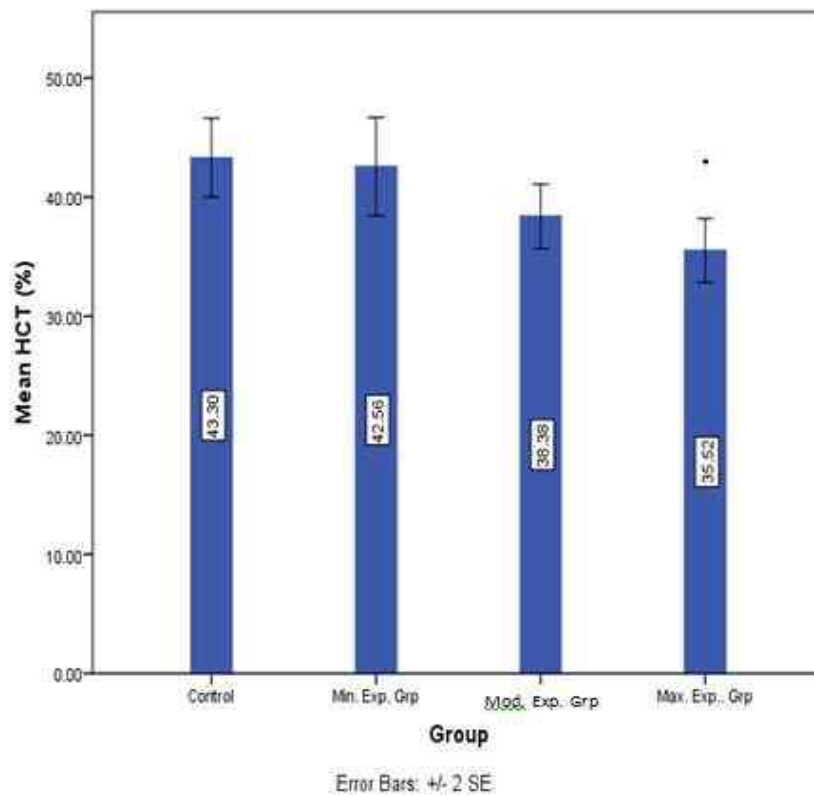


Figure 6: This chart shows the haematocrit value in all the experimental groups. When compared with the control, Group D shows significant decrease at $P < 0.05$.

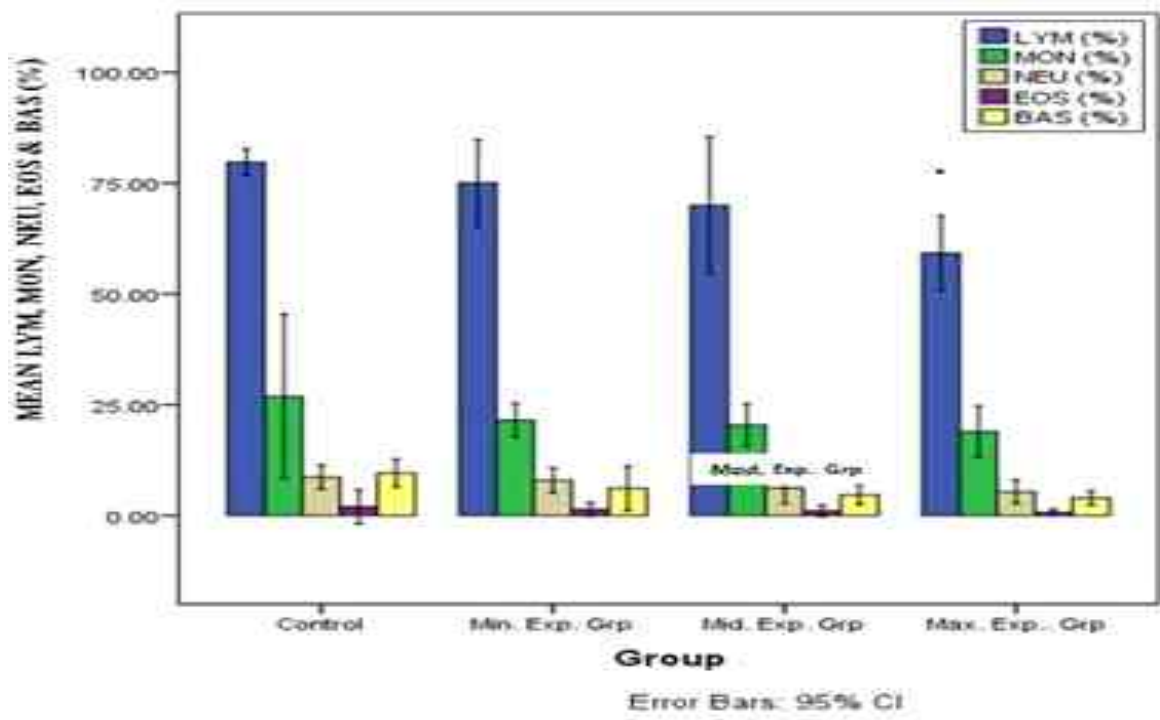


Figure 7: Chart shows the level of lymphocytes, monocytes, neutrophils, eosinophils and basophils in all the experimental groups. When compared with the control, Group D shows significant decrease in lymphocytes and basophils at $P < 0.05$

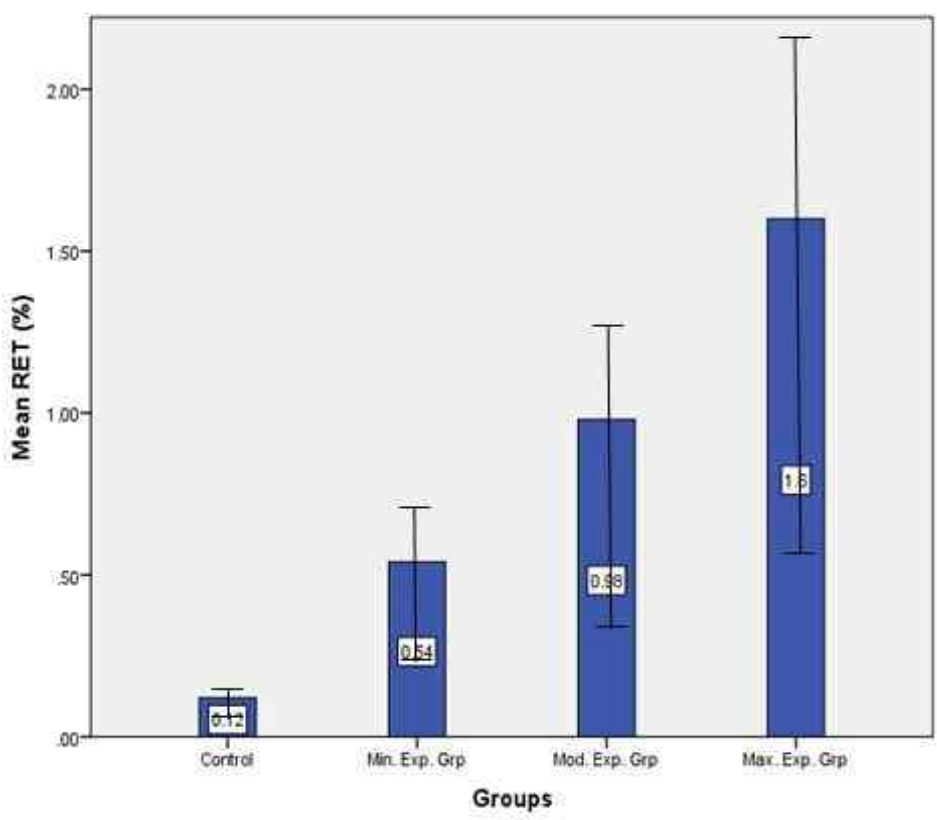


Figure 8: This chart shows the value of reticulocytes in all the experimental groups. When compared with the control, Group B, C and D show significant increase at $P < 0.05$.

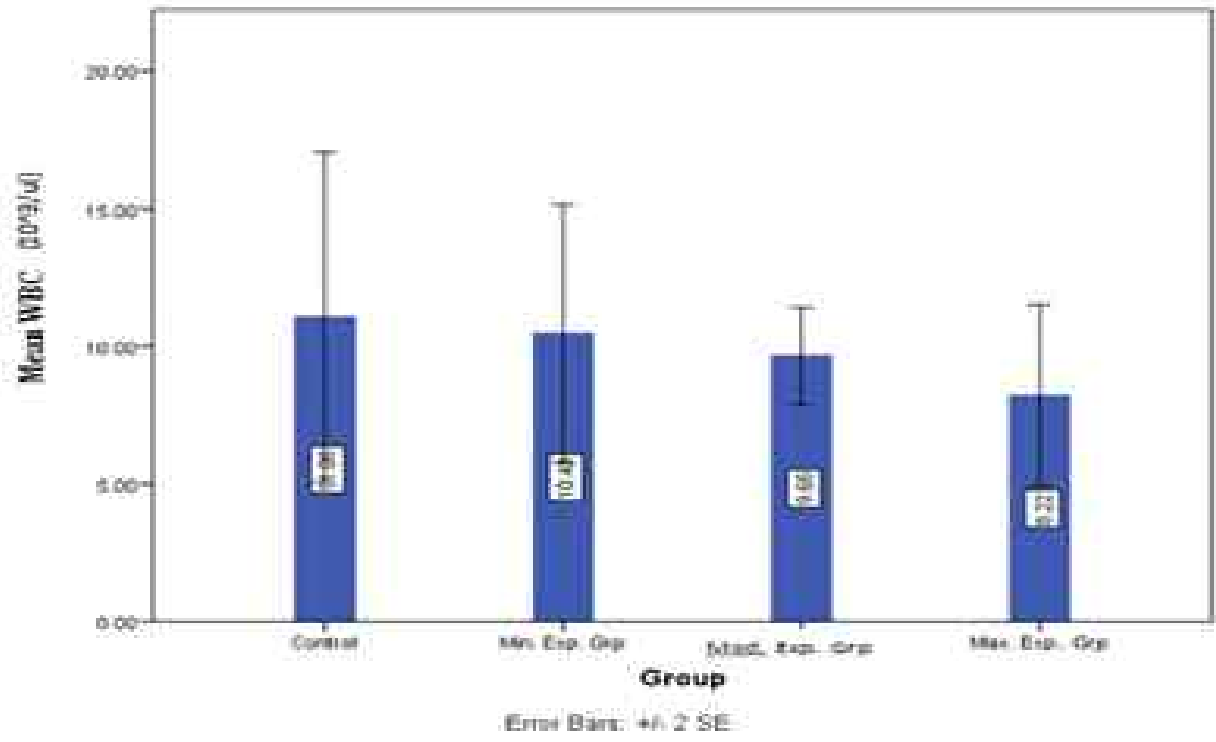


Figure 9: This chart shows the white blood cell counts in all the experimental groups. When compared with the control, Group B, C & D show no significant difference at $P > 0.05$.

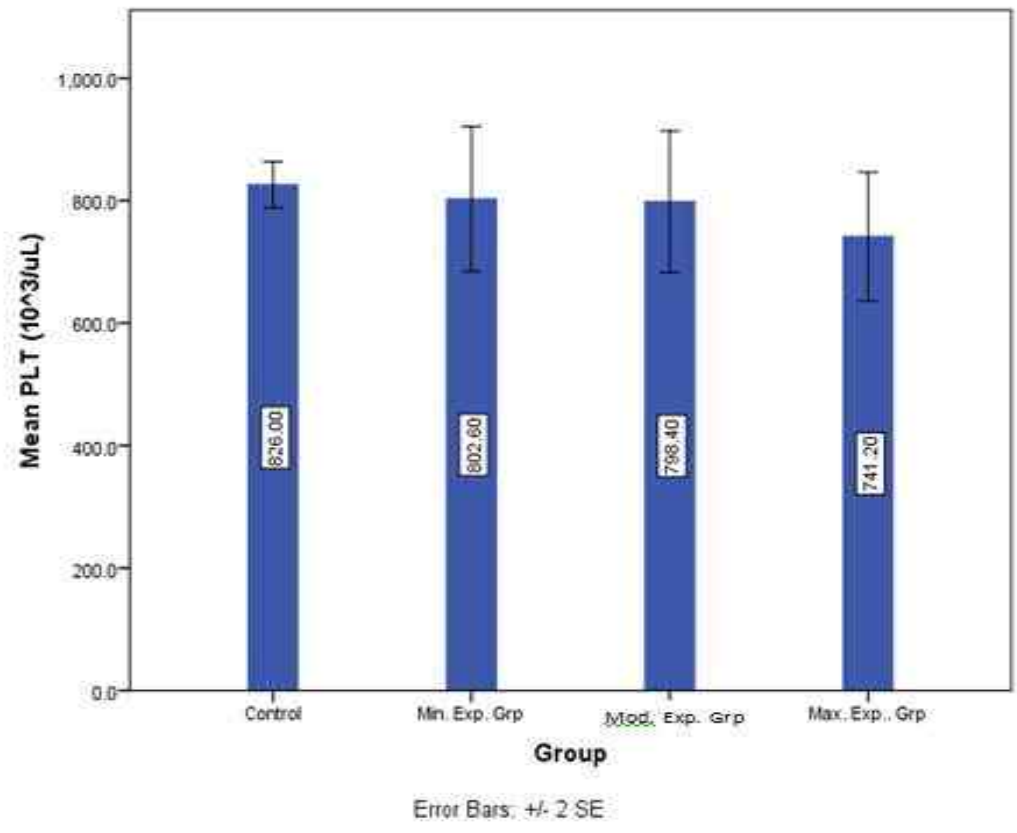


Figure 10: This chart shows the value of platelet counts in all the experimental groups. When compared with the control, Group B, C and D show no significant difference.

Discussion

Cement dust inhalation has been implicated in a variety of maladies including anaemia, tracheitis, lung alveolitis, bronchiectasis, bronchiolitis, pneumoconiosis and other cement factory respiratory diseases both in animals and humans. However, due to the unavailability of appropriate chamber for laboratory use, investigations to determine the impact of cement dust on the haematological parameters of Wistar rats have been limited (Akinola *et al.*, 2018). Against this background, this study was designed to investigate the effects of cement dust on the weight and haematological parameters of Wistar rats.

As shown in Table 1, there was a significant increase in body weight of rats in the control group (Group A). This can be attributed to normal growth during the period of the study. A significant decrease was observed in the body weight of rats in Group B, C and D that were exposed to cement dust. This may be due to the fact that cement dust is toxic. Our finding is consistent with previous works (Alakija *et al.*, 2015; Nwafor *et al.*, 2019). The weight loss could be attributable to dysgeusia (Alakija *et al.*, 2015), anorexia (Akpan *et al.*, 2014) or toxicity of the basic constituents of cement dust (Nwafor *et al.*, 2019).

Findings of the study for haematological parameters showed that exposure to cement dust causes derangements in haematological parameters such as lymphocytes, basophils, haemoglobin and haematocrit (Table 2, Figure 2-11). There was a decrease in immune cells such as lymphocytes and basophils in the exposed groups (Table 2, Figure 7) thereby resulting in increased susceptibility to infections. Reduced values of red blood cells (Table 2, Figure 1) and other red cell indices such as mean cell volume, mean cell haemoglobin and mean cell haemoglobin concentration, indicating microcytic normochromic anaemia (Table 2, Figures 2, 3 and 4) were observed in the exposed animals. Our finding is consistent with a previous report by Okonkwo *et al.* (2015). Furthermore, there was a decrease in haemoglobin and haematocrit levels (Figures 5 and 6) in the exposed groups with corresponding increase in reticulocytes (Table 2, Figure 8) indicating an effective erythropoietic response.

These haematological derangements indicate diseases, signs and pathological symptoms of a variety of maladies including microcytic hypochromic anaemia, basopenia, lymphocytopenia and reticulocytosis.

Conclusion

Exposure to cement dust causes body weight loss and deranged in haematological parameters including anaemia, basopenia, lymphocytopenia and reticulocytosis. The effects were seen to be directly proportional to the dosage as the results were more undesirable at higher doses and capable of compromising haematological functions which could ultimately lead to mortality of the research animals.

Competing Interest Declaration: I hereby declare that there is no competing interest in this work.

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